Marine Resources CEQA Assessment for the Sylmar Ground Return System Replacement Project

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Project No. 74727

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prepared for

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LIST OF ABBREVIATIONS

Abbreviation	**Term/Phrase/Name**
APE	area of potential effect
ASTM	American Society for Testing and Materials
BIO	Biological Community
BMP	Best Management Practices
CEQA	California Environmental Quality Act
DDT	dichlorodiphenyltrichloroethane
EMF	electro-magnetic field
ER-L	effects range- low
ER-M	effects range- medium
ICNIRP	International Commission on Non-Ionizing Radiation Protection
LADWP	Los Angeles Department of Water and Power
MM	mitigation measures
PCB	polychlorinated biphenyl
PDCI	Pacific DC Intertie
SWQ	sediment and water quality
USEPA	United States Environmental Protection Agency

UNITS OF MEASURE

Abbreviation	**Unit**
A	ampere
ft	feet or foot
kW	kilowatt
mi	mile
µg	microgram
µT	microTesla
mg	milligram
nV	nanovolt
V	volt
%	percent

1.0 INTRODUCTION

The Los Angeles Department of Water and Power (LADWP) is proposing to replace the existing underground and marine electrical cables and the existing marine electrode portions of the Sylmar Ground Return System (SGRS). The project is known as the Sylmar Ground Return System Replacement Project (Project). The existing SGRS is the ground return system for the Pacific Direct Current Intertie Transmission Line (PDCI), which transmits bulk direct current (DC) power between Los Angeles and the Pacific Northwest. The existing SGRS runs from the Sylmar Converter Station in the San Fernando Valley in Los Angeles, California, into the Santa Monica Bay and terminates in an electrode array on the ocean floor off the coast of the Pacific Palisades community of Los Angeles approximately 6,000 feet (ft) (1.1 miles [mi]) from shore. LADWP has determined that based on the continued physical degradation of the marine cables and the offshore electrode itself, a full replacement of the marine portion of the SGRS is required.

The purpose of this document is to assess the potential impacts from decommissioning the old marine cable and electrode system, construction of the new cable and electrode system, and operation of the new system once in place. The document is focused on the marine portion of the Project only and has been organized to comply with Appendix G of the California Environmental Quality Act (CEQA) Guidelines to assess the potential for impacts to the marine environment as a result of the Project. The document is organized into eight main sections: 1) Introduction, 2) Existing Conditions, 3) Project Description, 4) Biological Resources Impact Analysis, 5) Hydrology and Water Quality Impact Analysis, 6) Cumulative Impacts, 7) Mitigation Measures, and 8) References. Sections 4 and 5 each contain sub-sections on the Methodology and Threshold of Significance and the` CEQA Significance Threshold Discussion for that section, in order to be consistent with Appendix G of the CEQA Guidelines.

2.0 EXISTING CONDITIONS

2.1 Existing Sylmar Ground Return System

The location of the existing marine portion of the SGRS is shown in Figure 2-1. It is located offshore from the cities of Los Angeles and Malibu, California in Santa Monica Bay within the Southern California Bight in the U.S. Geological Survey (USGS) 7.5-Minute Series Topanga, California Quadrangle. The marine segment of the existing SGRS starts at the Sunset Vault in Pacific Palisades. From this vault, two copper submarine cables run under the beach and adjacent seafloor to a point approximately 1,000 ft offshore in Santa Monica Bay. From this location the SGRS cables run along the ocean floor to approximately 6,000 ft offshore, where the cables are connected to an electrical ground point consisting of an array of 48electrode elements (electrode array). Pairs of electrodes are suspended in 24 precast concrete vaults; each vault is 7 ft wide, 11 ft long, and 6 ft high. The vaults are placed from 10 to 23 ft apart and the total length of the existing electrode array is approximately 540 ft. The electrode is located directly on the ocean floor, approximately 60 ft below mean sea level. Two unlit, anchored buoys are located at the water’s surface approximately 25 ft from either end of the array.

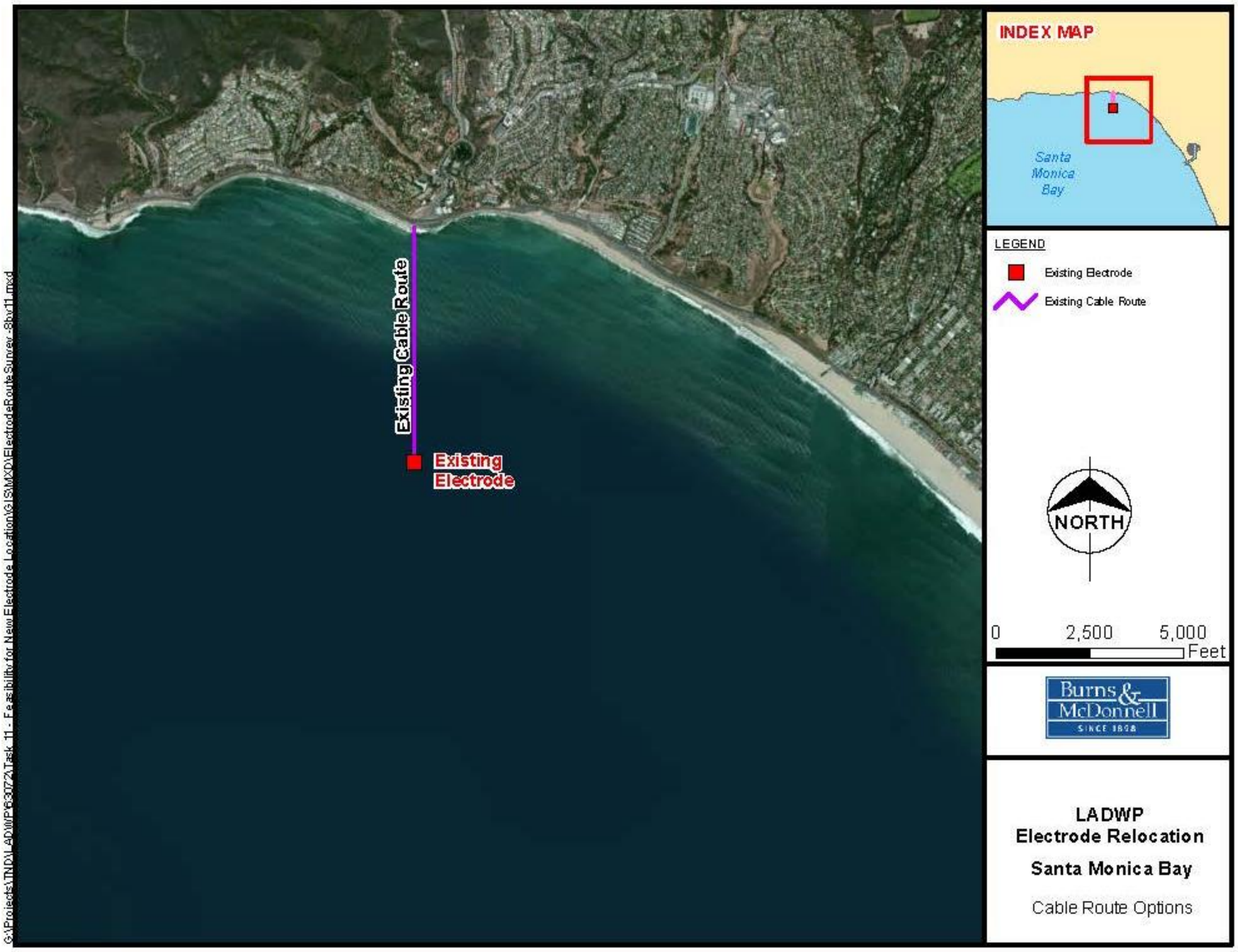

Figure 2-1. Existing Sylmar Ground Return System Marine Electrode Location in Santa Monica Bay

3.0 PROJECT DESCRIPTION

In this section, conditions of the existing SGRS system and the system proposed for the Project are summarized to provide background for the impact assessments in subsequent sections. This section also provides the regulatory framework for the assessment and the environmental setting for the proposed Project.

3.1 Proposed Sylmar Ground Return System

The ocean-based portion of this Project includes replacement and relocation of the existing marine cables and offshore electrode. LADWP considered two options as part of the process for selecting the location of the new cable route and offshore electrode array as shown in Figure 3-1 (the existing electrode is also shown for comparison). An assessment of marine resources in the vicinity of the SGRS conducted by Weston Solutions in 2012 identified the marine resources that may be impacted by the installation and long-term operation of the SGRS (the marine resources assessment can be found in Appendix A). Cable route Option 2 has been selected for the new

SGRS location. Under this option, a vault would be constructed near the intersection of West Channel Road and Pacific Coast Highway (West Channel Vault). From the proposed West Channel Vault, eight marine cables would extend to a new location in Santa Monica Bay approximately 3 mi offshore. From the West Channel Vault to a location approximately 1,000 ft offshore, the cables would be installed under Will Rogers State Beach and the ocean floor within two bore holes (four cables per hole) via directional drilling. From this location, the cables would be installed in two parallel furrows, each approximately 5 ft deep as practicable. The route would continue from 1,000 ft offshore in a west-southwesterly direction, circumventing two artificial reef areas and an existing natural patch reef before straightening out and terminating at an electrode array approximately 3 mi from shore at a depth of approximately 160 ft.

Based on the current preliminary design, the electrode array would be composed of 88 cylindrical concrete boxes weighing about 100 tons each arranged in a circular formation approximately ¼ mi in diameter. The cylindrical boxes would be approximately 7 ft high with an internal diameter of approximately 13 ft. The base for each box would be 25 ft in diameter and two ft high. Each cylindrical box would house an electrode element covered with a thick layer of metallurgical coke followed by a final top layer of gravel. Each of the 11 smaller marine cables contained within the eight larger cables would connect to a cylindrical box.

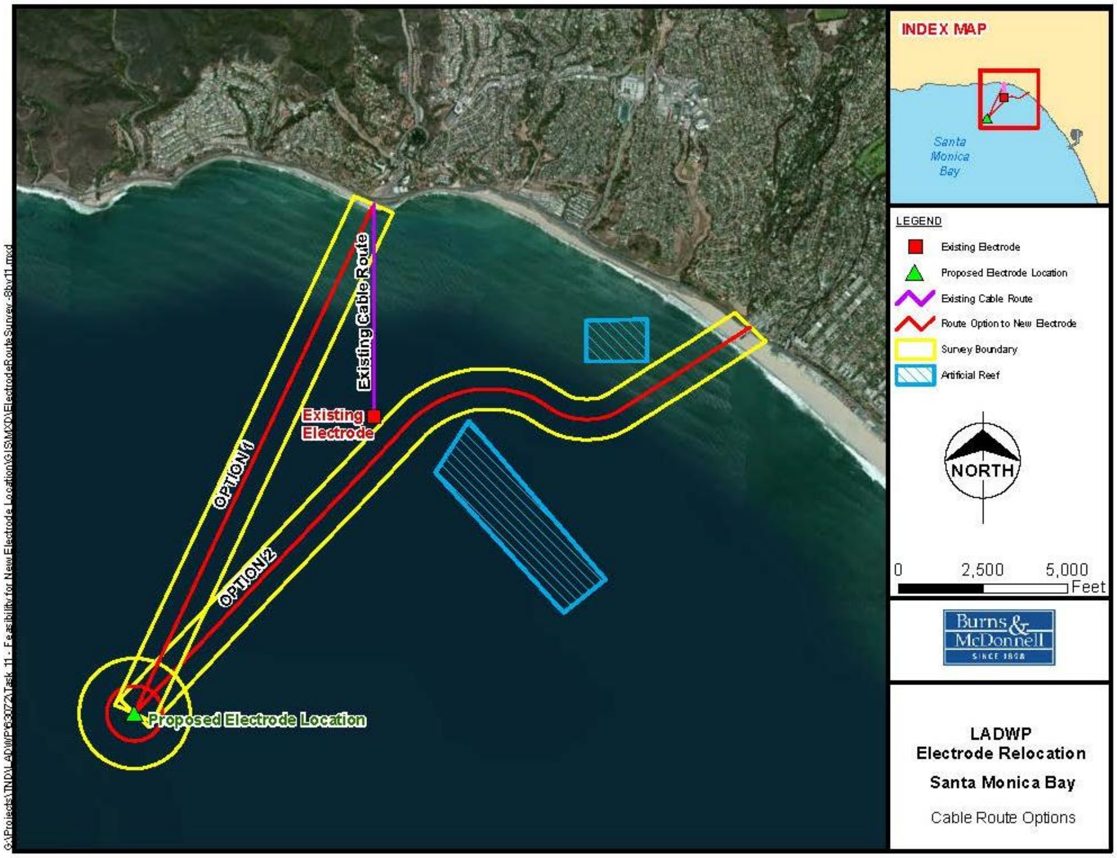

Figure 3-1. Existing Sylmar Ground Return System Marine Electrode Location in Santa Monica Bay and Proposed Alternate Routes Option 1 and Option 2

To install the eight cables, two furrows up to approximately 20 ft apart would be required. It is assumed that the furrows would be created with jet plowing or similar process with the assistance of a surface barge. A set of four cables bundled together would be installed within each of the two furrows. Either the barge would utilize two adjacent jet plows in a single pass, or the installation process would be repeated a second time in an adjacent alignment. As the barge and jet plow(s) advance, cables would be fed into the narrow furrows from the back end of the plow as it moves along the ocean floor. The plow would bury the cables approximately 5 ft below the ocean floor, as practicable, in a plowing/jetting procedure whereby the furrow will be opened, the cable will be laid, and the furrow will be filled by sediment resettling on top of the cable, closing the furrow in a single process. At the electrode location, the concrete vaults for the electrode array will be lowered to the ocean floor from a winch or crane located on a barge at the ocean surface. The entire marine construction process is anticipated to last approximately nine months.

After Project construction is completed, the existing SGRS marine segment would be abandoned in place or recovered as necessary and feasible; however, it is likely the existing marine cables would be removed and the existing electrode array would be decommissioned, but the concrete structures would remain in place, providing a hard substrate for marine life. Removing the existing submarine cables would begin by disconnecting the two cables from switchgear located at the existing vault located on shore. From shore to 1,000 ft offshore, the submarine cables would likely be removed by pulling them in through the vault, which is unlikely to disturb the overlying sediment. Removing the cables at sea would most likely occur from a marine barge.

3.2 Operational Parameters

The existing SGRS is located approximately 1.1 mi from shore at a water depth of approximately 60 ft. The electrode system has a maximum operational current of 3,100 Amps (A). Normally, there is little or no current being transmitted on the existing SGRS. To support the operation of the PDCI, however, the SGRS is typically used for a total of approximately 20 hours per year. Use is limited to a number of short, discrete events of typically 30 minutes or less.

The new proposed SGRS electrode would be located farther offshore (approximately 3 mi from shore) in deeper water (approximately 160 ft) than the existing system. The proposed system would be operated at a maximum of 3,100 A. Similar to the existing system, the proposed system is expected to typically operate for approximately 20 hours per year (with a conceptual operational limit of 50 hours per year), also with discrete events of short duration.

3.3 Assessment Process

Burns & McDonnell (BMcD) conducted studies to assess the potential impacts of the proposed Project on marine life, humans, and surroundings within Santa Monica Bay resulting from the installation of the new offshore SGRS (the marine assessment conducted by Weston Solutions is presented in Appendix A). To accomplish this, existing biological resources and activities within the Area of Potential Effect (APE) associated with the Project were assessed through video surveillance, direct observation, sample collection and analysis (water and sediment), and a literature review. For the marine assessment, the APE was defined as the area within the proposed Project footprint, approximately 600 ft on either side of cable route Options 1 and 2 and the proposed electrode array location (identified by the yellow lines in Figure 3-1). Potential impacts to these resources and activities from short-term construction of the cable route and placement of the electrode array as well as potential long-term effects of electrode operation were also assessed. A secondary objective for this assessment included recommending strategies to mitigate any potential Project impacts to these resources.

In addition to the marine resources assessment conducted for the Project, LADWP contracted BMcD to assess the operational requirements of the existing SGRS and provide a review and alternatives for future electrode operation. The electrical behavior of the electrode was modeled and the potential electric field emissions and chlorine production capacity of the new SGRS electrode array were computed under different scenarios of operation by CESI in 2011 and 2012 (the operational assessment is provided in Appendix B). The modeled data in the operational assessment, along with information from numerous studies conducted as part of the literature review in the marine assessment, were used in the impact assessment of this report to assess potential impacts on marine biota from the operation of the new system.

3.4 Regulatory Framework

Potential impacts to biological resources as a result of the proposed Project were analyzed based upon applicable environmental policies, regulations, and standards; existing regional monitoring surveys and monitoring assessments specific to the Project; and an extensive literature review on potential impacts to marine species from similar projects.

Applicable and/or relevant ordinances related to potential impacts on the marine portion of the Project are summarized in Table 3-1.

Table 3-1. Summary of Relevant Biological Resource Regulations

Regulation	Applicability
Federal	
Bald and Golden Eagle Protection Act	Protects bald and golden eagles by prohibiting “anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles, including their parts, nests, or eggs.
Clean Water Act	Established the basic structure for regulating discharges of pollutants into the waters of the U.S. and established minimum water quality standards for surface waters. Enforcement of the Clean Water Act (CWA) falls under the U.S. Environmental Protection Agency (USEPA) and U.S. Coast Guard (USCG) and is enforced in California through the State Water Resource Control Board (SWRCB) and Regional Water Quality Control Boards.
Coastal Zone Management Act	Administered by the National Oceanographic and Atmospheric Administration (NOAA) Office of Ocean and Coastal Resource Management, this Act provides for management of the nation's coastal resources and balances economic development with conservation.
Endangered Species Act	The Endangered Species Act (ESA) of 1973 protects and conserves threatened and endangered species of plants and animals and their ecosystems.

Regulation	Applicability
Marine Mammal Protection Act	Prohibits the "take" of marine mammals in the U.S. It defines "take" to mean "to hunt harass, capture, or kill" any marine mammal or attempt to do so.
Migratory Bird Treaty Act	Prohibits the "take" of migratory birds, their eggs, feathers or nests without a permit. "Take" is defined to include "by any means or in any manner, any attempt at hunting, pursuing, wounding, killing, possessing or transporting any migratory bird, nest, egg, or part thereof."
State	
California Coastal Act of 1976	Designed to guide local and state decision-makers in the management of coastal and marine resources, includes protections for environmentally sensitive habitat, water quality, and wetlands, stating that "Marine resources shall be maintained, enhanced, and, where feasible, restored".
California ESA	The California Endangered Species Act (CESA) provides for the protection of all native endangered or threatened species of plants and animals, and their habitats, within the State of California.
California Fish and Game Code	The California Fish and Game Code places restrictions on the take of protected species, defines sport fishing and hunting regulations and seasons, defines refuge boundaries and addresses other licensure requirements for particular varieties of fish and game.
California Environmental Quality Act of 1970	The Act that institutes a statewide policy for environmental protection. CEQA requires state and local agencies within California to follow a protocol of analysis, provide public disclosure of environmental impacts for proposed projects, and adopt feasible measures to mitigate any perceived impacts to the environment from said project.
California Ocean Plan of 2012	Provides for the "protection of the quality of the ocean waters for use and enjoyment by the people of the State" by setting forth provisions for the discharge of waste to ocean waters. Essentially, the California Ocean Plan (COP) specifies water quality criteria for the protection of beneficial uses of ocean waters of California.
Water Quality Control Plan: Los Angeles Region Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties	Establishes beneficial uses, water quality objectives, and actions necessary to maintain beneficial uses and control point and non-point sources of pollution for water bodies.
Marine Life Protection Act of 1999	Directs the state of California to reevaluate and redesign California's network of Marine Protected Areas (MPAs) to more effectively protect the state's biological marine resources and to improve recreational, scientific, and educational opportunities provided by minimally disturbed marine ecosystems.
California Marine Managed Areas Improvement Act of 2000	Extends the California Department of Parks and Recreation (DPR) management jurisdiction into the marine environment and gives priority to MPAs adjacent to protected terrestrial lands.
Local	
County of Los Angeles Local Coastal Plan	Allows the County of Los Angeles to directly apply the development, conservation, environmental, and public access protection goals of the Coastal Act to development within their jurisdictions.
The Santa Monica Bay Restoration Plan	Set of goals, objectives, and milestones to fulfill its mission to "improve water quality, conserve and rehabilitate natural resources, and protect the Bay's benefits and values".

3.5 Environmental Setting

3.5.1 Habitat Types

Santa Monica Bay is a large, open-water embayment of the Pacific Ocean that is bordered on the north by rocky headlands at Point Dume and is bordered on the south by the headlands on the Palos Verdes Peninsula. Santa Monica Bay extends seaward a distance of approximately 11 mi from the Santa Monica shoreline. Water depths within the Bay range up to approximately 300 ft along the nearshore continental shelf that extends from the shoreline to an offshore distance of approximately 4 mi. As the continental shelf ends and becomes the continental slope and eventually the Santa Monica Basin, water depths within the Bay increase to over 2,500 ft.

Nearshore habitats within the study area range from sandy beach and rocky intertidal areas along the shoreline to soft bottom habitat interspersed with seagrass beds and small rocky reefs in the nearshore subtidal zone (Appendix A). Further offshore, soft bottom and open ocean habitats predominate, with only a small percentage of rocky reef. Kelp forest habitat within Santa Monica Bay is primarily located in the shallow subtidal zone around Malibu and Palos Verdes. Based on a review of kelp maps, large kelp beds are not found within the APE, although small kelp stands may be present. The pelagic habitat, which is the largest habitat within the Bay, is a highly productive offshore region of open ocean that supports nearly all of the Bay’s marine life. The vast majority of the phytoplankton, which is the basis for the Bay’s marine food web, is primarily grown in the pelagic habitat. As a result of the Bay’s diverse bathymetry, abundant nutrients, and wide range of habitats, it is considered to be a highly productive biological environment used by both migratory and resident species of marine mammals, fish, birds, and invertebrates.

The following habitat descriptions were derived from the marine resources assessment provided in Appendix A.

3.5.1.1 Sandy Shoreline

Sandy shorelines in the Southern California Bight typically consist of exposed medium- to coarse-grain sand beaches. Santa Monica Bay has approximately 26 mi of sandy shoreline, extending from Malibu Point to Flat Rock Point, located near the Palos Verdes Peninsula. Sandy shoreline can be relatively dynamic in nature since it is subjected to tidal extremes, nearshore currents, storm surge, and wave activity that can move sand within the littoral cell and re-contour beach profiles. The Project is not anticipated to impact sandy shoreline habitat. The marine cables will pass from the West Channel Vault under the sandy shoreline habitat at Will Rogers State Beach and will continue under the ocean floor to a point in Santa Monica Bay approximately 1,000 ft from shore.

3.5.1.2 Subtidal Soft-Bottom Habitat

Muddy substrates are the predominant habitat throughout Santa Monica Bay, from the 20-meter (m) isobath to the adjacent Santa Monica basin floor (780 m) based upon multi-beam sonar imagery (Edwards *et al.*, 2003). Coarser-grained sandy substrates lie predominantly along the innermost mainland shelf and a narrow outer shelf band north of Santa Monica Canyon, while cobble and gravel substrates are predominantly restricted to the innermost shelf south of El Segundo and limited parts of the shelf edge.

The soft-bottom habitat of Santa Monica Bay supports a diverse infaunal community (animals that live within the substrate). Summer and winter infaunal surveys conducted in the Bay in 2002 identified 28,184 individuals in 625 taxa during National Pollutant Discharge Elimination System (NPDES) monitoring. The ten most common species inhabiting soft-bottom habitats were the polychaete worms: *Spiophanes duplex, Paraprionospio pinnata, Euclymeninae sp., Prionospio jubata, Paradiopatra parva,* and *Glycera nana;* the brittle star *Amphiodia urtica,* the horseshoe worm *Phoronis* sp.; the capitellid worm Mediomastus sp.; and the amphipod *Ampelisca brevisimulata* (City of Los Angeles, 2003).

Most polychaetes feed by engulfing soft sediments and detritus and digesting the entrained microorganisms, while others filter feed on bits of organic detritus in the water, or prey on other infauna. Other common infaunal groups include crustaceans, such as amphipods, mollusks, and echinoderms. The abundance and distribution of infauna has been shown to vary both spatially and temporally (City of Los Angeles, 2003).

Epibenthic invertebrates (animals that live on the surface of the substrate) of Santa Monica Bay include sea stars, sea cucumbers, sand dollars, sea urchins, crabs, shrimp, snails, tube worms, nudibranchs, and sea slugs. During quarterly trawls at nine stations in Santa Monica Bay in 2001, a total of 15,820 individuals representing 53 species were captured. In 2002, the quarterly trawls yielded a total of 8,780 individuals representing 55 species. The most abundant species were echinoderms in terms of both numbers and biomass. The white urchin *Lytechinus pictus* and the spiny sea star *Astropecten verrilli* were the most abundant species throughout the Bay. The third most abundant invertebrate was the California sea cucumber *Parastichopus californicus* followed by the ridgeback prawn *Sicyonia ingentis,* sea slug *Philine auriformis*, sandstar *Luidia foliolata*, the serpent star *Ophiura lutkeni*, and the spiny brittle star *Ophiothrix spiculata* (City of Los Angeles, 2003).

Subtidal Soft-bottom habitat is the dominant habitat type in Santa Monica Bay. It is also the major habitat type along the proposed cable route and proposed electrode location, comprising over 99% of this area.

3.5.1.3 Subtidal Hard-Bottom Habitat

Natural hard substrate in Santa Monica Bay occurs primarily along the Bay's periphery near the headlands of Point Dume and Palos Verdes, along the edges of the three submarine canyons, and on the rocky plateau known as the Short Bank that lies between the Santa Monica Canyon and the Redondo Canyon (Terry *et al.*, 1956). Although no large subtidal reef areas are known to occur within the study area, shifting sediments and sand may periodically expose small patches of hard substrate or uncover marine debris.

Hard-bottom substrates provide surface area for attachment of a wide variety of plants and sessile organisms, as well as shelter and a place to forage for fish and invertebrates. Sessile species that utilize hard-bottom substrates include mussels, sponges, anemones, tunicates, barnacles, rock scallops, sea fans, and a variety of tube worms. These species primarily feed by filtering plankton from the water column. Invertebrates such as shrimp, crabs, sea stars, nudibranchs, octopods, lobsters, abalone, and sea urchins forage along reefs and utilize crevices for protection against predators. Within the intertidal zone, both sessile and mobile invertebrates such as crabs and mussels are an important food source for foraging birds. In deeper water, nearshore reefs provide an anchoring point for a variety of marine algal species, such as giant kelp, bull kelp, feather boa kelp, coralline algae, oar weed, and sea palms. Larger algal species, such as the kelps and sea palms, provide a key vertical over-story component to the relatively low-relief hard-substrate habitat of Santa Monica Bay.

Information detailed in the marine resource assessment conducted for the proposed Project (Appendix A) and the associated literature review indicate that very limited areas (< 1%) of subtidal hard-bottom habitat occur in along the proposed cable route or proposed electrode location. In addition to the artificial reefs described below, there is a small natural rocky reef within the proposed cable route, located in approximately 25 ft of water, approximately 7,000 ft from shore. The reef is approximately 50 ft in diameter and 10 ft high. No other sub-tidal hard bottom habitat was found along the proposed cable route or electrode array location. The cable route would avoid this natural reef as well as the artificial reefs described below.

3.5.1.4 Kelp Beds

Kelp beds occur predominantly around rocky subtidal habitat off the northern and southern headlands of Santa Monica Bay. Giant kelp (*Macrocystis pyrifera*) plays a key role in the nearshore ecosystem by providing vertical structure within the water column that is utilized by fish, invertebrates, and marine mammals as a nursery and for food and shelter from predators. Giant kelp is an exceptionally large and fast growing brown alga that commonly grows to more than 100 ft in length and provides a three-dimensional over story to smaller algal species such as feather boa (*Egretia menziesii*) and sea palms (*Eisenia arborea*). Some of the fish species that are common to kelp forest habitat include halfmoon (*Medialuna californiensis*), sargo (*Anisotremus davidsonii*), senorita (*Oxyjulis californica*), sheephead (*Semicossyphus pulcher*), ocean sunfish (*Mola mola*), cabezon (*Scorpaenichthys marmoratus*), various rockfish (*Sebastes spp.*) blacksmith (*Chromus punctipinnus),* giant sea bass (*Sterolepis gigas*), leopard shark (*Triakis semifasciata*), horn shark (*Heterodontus franscisci*), and important sport fishing species such as kelp bass (*Paralabrax clathratus*), white sea bass (*Atractoscion nobilis*) and yellowtail (*Seriola lalandi*).

Kelp forest is considered to be Essential Fish Habitat (EFH) by the federal government. Thus, any project that may adversely impact kelp forest requires consultation with the National Marine Fisheries Service (NMFS). Information detailed in the marine resource assessment conducted for the proposed Project and the literature search indicated that kelp forest habitat is not found in the study area along the proposed cable route or proposed electrode location.

3.5.1.5 Artificial Reefs

Over 33 artificial reefs have been constructed in the Southern California area since 1958. These reefs have been successful in attracting fish and invertebrate species. Subsequent attempts to replicate reef structures were implemented in an experimental fashion to determine the cost-effectiveness of materials and the success of different structural designs. Various materials were used to construct these reefs, ranging from automobiles, streetcars, scuttled ships, cement boxes and quarry rocks. Many of these older reefs were successful in attracting fish, but deteriorated over time due to the materials used. Reefs built in the last twenty years have used cement and quarry rock to create reef habitats for marine species with greater longevity than their predecessors.

Artificial reefs have been constructed in Santa Monica Bay since 1960 to provide additional hard-bottom habitat for marine species, since the Bay is characterized primarily by soft-bottom substrates (Santa Monica Bay Restoration Commission, 2010). Of the nine artificial reefs that still remain intact in the Bay, two of the reefs fall within the study area: the Topanga Artificial Reef (TAR) and the Santa Monica Artificial Reef (SMAR) / Santa Monica Bay Artificial Reef (SMBAR) complex. Located within approximately 1 mi of each other (Figure 3-2), each artificial reef varies in design, purpose, and construction materials. Built in 1961, SMAR is the oldest and smallest of the three reefs and is located approximately 60 ft below the surface. It was constructed from quarry rock, concrete shelters, car bodies and pier pilings. TAR is located approximately 28 ft below the surface and covers an area of approximately 2 acres. SMBAR consists of three separate modules located at the depths of 42, 57, and 72 ft and covers 3.58 acres. Both SMBAR and TAR were constructed in 1987, using only quarry rock.

Although artificial reefs are located in Santa Monica Bay within the general region of the Project, the proposed cable route has been routed to circumvent the TAR and SMAR/SMBAR complex in the vicinity (see Figure 3-1).

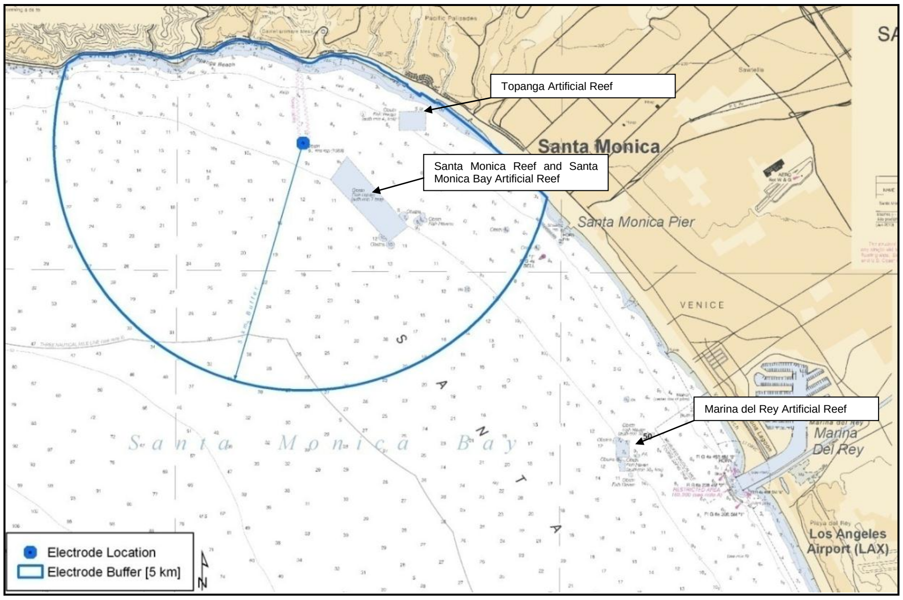

Figure 3-2. Artificial Reef Locations within the Study Area in Santa Monica Bay

3.5.2 Sensitive Species

Santa Monica Bay is home to sensitive and special status marine species ranging from marine mammals and sea turtles to marine birds, mollusks, and bony and cartilaginous fishes. Although some of these species may only rarely enter Santa Monica Bay, others spend a significant portion of their lives within the Bay's diverse marine habitats. For the purposes of this document, species that have been observed within Santa Monica Bay's waters in the past are assumed to have the potential to occur in the study area. The following descriptions were derived from the marine resource assessment provided in Appendix A.

3.5.2.1 **Marine Mammals**

Over 40 different species of marine mammals are known to occur within the Southern California Bight (from Point Conception to the U.S.-Mexican border), including cetaceans (whales, dolphins, and porpoise), pinnipeds (seals and sea lions), and sea otters (Carretta *et al*., 2005). Special protections for each of these species fall under the Marine Mammal Protection Act (MMPA). Of these, five cetacean species that may be expected to occur within the nearshore waters of the study area are listed as federally endangered under the ESA. These include the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*) (U.S. Navy Southern California Range Complex EIS). Stocks of all species listed as endangered under the ESA are automatically considered to be “depleted” and “strategic” under the MMPA.

Seven cetacean species are commonly observed in nearshore waters in significant numbers and are likely to occur in the study area either seasonally or on a year-round basis. These species include bottlenose dolphin, short-beaked common dolphin, Risso’s dolphin, Dall’s porpoise, Pacific white-sided dolphin, long-beaked common dolphin, and gray whale. Each of the dolphin and porpoise species live in the region year-round, while a significant portion of the gray whale population (currently estimated to be approximately 22,000 animals) migrates through the area from December through April. Blue whales, fin whales, humpback whales, killer whales, and northern right whale dolphins have the possibility of entering the study area. Blue whales and fin whales are typically observed further offshore than the study area, but are known to feed close to shore during times when krill or bait fish are abundant. Similarly, killer whales are occasionally observed in this area during winter months as they hunt gray whale calves during the gray whale migration to and from Mexican breeding grounds. Northern right whale dolphins and humpback whales are also periodically observed in nearshore waters but generally prefer to frequent deeper offshore locations. Other cetacean species are less likely to occur within the study area due to their limited population size in Southern California, their preference for deeper offshore waters, or because Santa Monica Bay is considered to be outside of their existing range.

Three species of pinnipeds are abundant in nearshore waters of Southern California and are likely to occur in the study area. These include California sea lions (*Zalophus californianus*), northern elephant seals (*Mirounga angustirostris*), and harbor seals (*Phoca vitulina*). One fissiped species, the southern sea otter (*Enhydra lutris*), is typically found in nearshore waters north of Point Conception.

California sea lions, northern elephant seals, and harbor seals each maintain breeding colonies in the offshore Channel Islands. Sea lions have the ability to climb onto surface buoys, jetties, docks, and rock riprap to rest during the day when they are not actively feeding. Because harbor seals and elephant seals lack the large front flippers possessed by sea lions, they cannot climb onto structures and must haul out onto sandy beaches to seek refuge from the water. Pinnipeds frequently dive to depths greater than 300 ft in search of food. Major predators for pinnipeds in Southern California include white sharks and occasionally killer whales.

3.5.2.2 **Sea Turtles**

Four of the five species of sea turtles that have been observed along the west coast of the United States have the potential to occur within the study area. Olive Ridley (*Lepidochelys olivacea),* green (*Chelonia mydas*), and loggerhead (*Caretta Caretta*) sea turtles are listed as federally threatened species, while the leatherback sea turtle (*Dermochelys coriacea*) is listed as a federally endangered species. Each of these species have been observed along the coast of Southern California, however, there are no known nesting sites on the west coast of the U.S. for any of them (NOAA Fisheries, 2011).

NMFS and U.S. Fish and Wildlife Service (USFWS) have joint jurisdiction over sea turtles within the U.S. NOAA maintains jurisdiction over the aquatic marine environment while USFWS has jurisdiction over nesting beaches, which occur only on the southeastern seaboard within the U.S.

3.5.2.3 **Fish**

Santa Monica Bay has a rich diversity of migratory and resident species of fish. Fish are generally divided into two major groups based on whether they have a bony skeleton (Class Osteichthyes) or an internal support structure comprised of cartilage (Class Chondrichthyes). The dominant pelagic bony fish species in Santa Monica Bay are:

- Pacific (Chub) mackerel (*Scomber japonicas*);
- Jack mackerel (*Trachurus symmetricus*);
- Northern anchovy (*Engraulis mordax*); and
- Pacific sardine (*Sardinops sagax caerulea*).

The dominant cartilaginous fish in Santa Monica Bay tend to be sharks. Sharks species found in the Bay and common to the region include:

- Basking sharks (*Cetorhinus maximus*);
- Blue sharks (*Prionace glauca*);
- Gray Smoothhound sharks (*Mustelus californicus*);
- Great white sharks (*Carcharodon carcharias*);
- Leopard sharks (*Triakis seimfasciata);*
- Mako sharks (*Isurus oxyrinchus*); and
- Thresher sharks (*Alopias vulpinus*).

The extensive soft-bottom habitat within Santa Monica Bay supports an abundant and diverse assemblage of over 100 species of demersal fish. Soft-bottom species derive much of their food from benthic infauna. Flatfish, rockfish, sculpins, combfishes and eelpouts make up the majority of the soft-bottom fish found in the Bay (MBC, 1993). Quarterly trawls in 2001 and 2002 yielded a total of 15,122 individuals consisting of 58 species and 13,693 individuals representing 51 species respectively (City of Los Angeles, 2003). The number of fish species, abundance and biomass generally increase with water depth. Nearshore areas usually support a high abundance of species such as flatfish, surfperch, and croakers. Middle and outer shelf species include numerous kinds of flatfish, sculpin, and rockfish.

Several species of fish are prohibited to target, catch, or possess according to California Department of Fish and Wildlife (CDFW) regulations. These species include the giant black sea bass (*Stereolepis gigas*), white shark (*Carcharodon carcharias*), steelhead (*Oncorhynchus mykiss*), broomtail grouper (*Mycteroperca xenarcha*), Garibaldi (*Hypsypops rubicundus*), silver salmon (*Oncorhynchus kisutch*), bronzespotted rockfish (*Sebastes gilli*), canary rockfish (*Sebastes pinniger*), yelloweye rockfish (*Sebastes ruberrimus*), and cowcod rockfish (*Sebastes levs).*

Two of these species (cowcod rockfish and steelhead) are also listed as species of concern by NMFS. Other species of concern that may occur in Santa Monica Bay include the basking shark (*Cetorhinus maximus*), and the bocaccio rockfish (*Sebastes paucispinis*).

3.5.2.4 Sea Birds

The Southern California Bight, including Santa Monica Bay, supports an abundant and diverse population of both resident and migratory seabirds (Baird, 1993), also referred to as marine birds. Seabirds have adapted to life within the marine environments and generally live longer, breed later, and have fewer young than other birds. Most seabird species nest in colonies and rely on habitats within the Bay for nesting, foraging, and refuge.

Santa Monica Bay is located within the Pacific Flyway, a major north-south avian migratory route that extends from Alaska to South America. Every spring and fall, migratory birds travel some of all of the Flyway to follow food sources, head to breeding grounds or travel to overwintering sites. Each bird species tends to follow the same route with regard to both distance and timing. Therefore, distribution of seabird species within the Bay will likely exhibit both seasonal and spatial variation to some degree (Pierson *et al*., 2000).

Special status seabirds that occur in Santa Monica Bay (*i.e.*, are protected or were recently de-listed under state or federal ESAs) are presented in Table 3-2.

Table 3-2. Special Status Seabirds of the Southern California Bight

Common Name	Species	Status
Bald eagle	*Haliaeetus leucocephalus*	Delisted in 2007
California brown pelican	*Pelecanus occidentalis californicus*	Delisted in 2009
California least tern	*Sterna antillarum browni*	Federally listed
Western snowy plover	*Charadrius alexandrinus nivosus*	Federally listed
Marbled murrelet	*Brachyramphus marmoratus*	State Endangered
Xantus's murrelet	*Synthliboramphus hypoleucus*	State Threatened
Ashy storm petrel	*Oceanodroma homchroa*	State Species of Special Concern
Black storm petrel	*Oceanodroma melania*	State Species of Special Concern
Rhinoceros auklet	*Cerorhinca monocerata*	State Species of Special Concern

3.5.2.5 Invertebrates

Residing within sediments of the seafloor, abundance and distribution of infauna typically varies seasonally and inter-annually. However, in Santa Monica Bay the dominant infaunal organism is polychaete worms. Polychaete worms for the most part feed by ingesting sediments and digesting the attached bacteria, filter feed on bits of organic detritus in the water, or prey upon other infauna. Polychaetes play an important role in the marine benthos by reworking sediments, while serving as a food source for many demersal fish.

Santa Monica Bay has diverse and abundant assemblage of epibenthic invertebrates that reside on the seafloor. These species are larger than infauna and are generally less common. While single species tend to be dispersed spatially from each other, sand dollars and sea urchins tend to occur in dense, single-species patches. Epibenthic invertebrates can be motile (mobile) or sessile (non-mobile). Motile epibenthic invertebrates include: sea stars, sea cucumbers, sand dollars, sea urchins, crabs, lobster, snails, octopods, shrimp, and sea slugs. Sessile species often inhabit hard-bottom substrate and include mussels, rock scallops, barnacles, sponges, sea anemones, sea fans, feather duster worms, worm snails, and sea squirts. Most of these sessile invertebrates feed by filtering plankton and detritus from the water column.

Abalone are large marine snails historically found in rocky intertidal and subtidal areas, clinging to rocks and feeding off kelp and other algae. Abalone species used to constitute a highly valuable fishery in Southern California; however, their numbers have greatly dropped due to factors that include overharvesting, illegal harvesting, predation, disease, and El Niño events. Of the seven abalone species historically found in the Southern California Bight and Santa Monica Bay, four are federally listed as either endangered or as a species of concern and one (flat abalone) is no longer found south of Point Conception (Table 3-3).

Table 3-3. Abalone Species of the Santa Monica Bay

Common Name	Species Name	Protected Status	Preferred Depth (Feet)
Black Abalone	*Haliotis cracheirodii*	Federal Endangered	Intertidal to 20’
Green Abalone	*Haliotis fulgens*	Federal Species of Concern	Intertidal to > 30’
Pink Abalone	*Haliotis corrugate*	Federal Species of Concern	20’ to >120’
White Abalone	*Haliotis sorenseni*	Federal Endangered	Subtidal to >200’
Red Abalone	*Haliotis refescens*	None	Subtidal to >100’
Threaded Abalone	*Haliotis assimilis*	None	20’ to >80’

Source: CSLC, 2010

3.5.3 Water Quality

3.5.3.1 Historical Conditions

The following discussion on water quality was derived from the marine assessment provided in Appendix A. Water and sediment quality within Santa Monica Bay has been studied extensively in recent years, particularly near the Hyperion Wastewater Treatment Plant’s 5- mi outfall pipe and as part of the Southern California Bight Regional Monitoring Program. Research suggests that there are multiple pollutants of immediate concern in Santa Monica Bay, including metals, organics, and bacterial contaminants (Santa Monica Bay Restoration Commission [SMBRC], 2010). Sources and pathways of contaminants include industrial discharges, urban runoff into creeks and storm drains, municipal wastewater treatment plants (WWTPs), boating and shipping activities, dredging, and advection of pollutants from other areas. Approximately 645 million gallons of treated wastewater are discharged to Santa Monica Bay each day via seven major point-source facilities and more than 160 permitted smaller commercial and industrial facilities (SMBRC, 2010). As a result of the nearly 30 billion gallons of wastewater effluent that flows into Santa Monica Bay on a yearly basis, impacts to sediment quality are more apparent than those to water quality. SMBRC (2010) rated the water quality “good” overall in Santa Monica Bay, sediment quality was given a rating of “poor” at 59% of sites for sediment contaminants, and at 21% of sites for sediment toxicity.

Santa Monica Bay is located adjacent to a highly urbanized area, with approximately 12 million people residing along the coastal corridor. Approximately 400 square mi of varied landscape drains into the Bay, including the highly urbanized and channelized Ballona Creek Watershed, and the less developed, Malibu Creek Watershed. The SWRCB has listed Santa Monica Bay as an impaired waterbody under Section 303(d) of the Clean Water Act (CWA).

Historically, the pollutant pathway of most concern for Santa Monica Bay was point source discharges from industrial outfalls and large wastewater treatment facilities, including the Hyperion WWTP and the Joint Water Pollution Control Plant (JWPCP). Over the past few decades pollutants discharged from these treatment facilities have been greatly reduced as secondary treatment has been implemented. Currently, non-point sources constitute a larger source of contaminants to Santa Monica Bay than point sources (Schiff, 2000).

Currently, the primary pathway for pollutants entering the Bay is through non-point discharge from storm drains throughout the surrounding watersheds (Dojiri *et al*., 2003). The primary pollutants of concern for Santa Monica Bay are nutrients, bacteria, trash and metals, along with historical pesticides. The Los Angeles Regional Water Quality Control Board has implemented nine total maximum daily loads (TMDLs) to address the pollutant issues in the Bay. These TMDLS are mainly being implemented through incorporation of controls into existing NPDES permits. Over the next five years, at least seven more TMDLs are expected to be in development (SMBRC, 2010).

3.5.3.2 **Recent Survey**

As part of the assessment of marine resources in the vicinity of the SGRS conducted for the proposed Project, existing water quality and chemistry characteristics were assessed in 2012 through collection and analyses of water samples throughout the APE. Water samples were collected from one Reference Area location and from three sites within the proposed Electrode Array Area. The Reference Area was located approximately 500 feet from the sites within the Electrode Array Area at an equivalent depth (see Appendix A for site locations). Water samples were analyzed for trace metals, total residual chlorine, and both volatile and semi-volatile halogenated organic compounds. Halogenated organic compounds and chlorine produced oxidants (measured as total residual chlorine) were targeted for analysis based upon literature reviews that revealed the potential for halogenated and chlorinated compounds to form in the vicinity of subsea electrodes during electrode operation. Background levels of metals were targeted for analysis because they are a common sediment contaminant that can be re-suspended by construction activities and have the potential to cause toxicity to marine species.

Summary results of chemical analyses of water samples collected from the proposed Electrode Array Area (EA-1, EA-2, and EA-3) and the Reference Area (REF-1) are presented in Table 3-4. Site locations are depicted graphically on Figure 3-3 (monitoring details can be found in the marine resources assessment in Appendix A). COP Daily Maximum and Instantaneous Maximum water quality objectives for the protection of marine aquatic life are provided for comparison to sample results. The results indicate that there were no detectable concentrations of residual chlorine or halogenated organic compounds (volatile and semi-volatile) in any of the samples collected. Concentrations of trace metals were detected across all samples; however, all trace metal concentrations were substantially below the most conservative water quality objectives for the protection of marine life listed in the COP.

Table 3-4. Summary of Chemistry Analytical Results for Water Samples Collected from Electrode Array and Reference Areas (see Appendix A for Details)

Analyte	Units	Methods	*COP Daily Max.	**COP Instant. Max.	EA-1	EA-2	EA-3	REF-1
Trace Metals								
Arsenic	µg/L	USEPA 1640	32	80	1.78	1.7	1.61	1.59
Cadmium	µg/L	USEPA 1640	4	10	0.102	0.111	0.111	0.109
Chromium	µg/L	USEPA 1640	8	20	0.194J	0.159J	0.157J	0.183J
Copper	µg/L	USEPA 1640	12	30	0.327	0.245	0.249	0.22
Lead	µg/L	USEPA 1640	8	20	0.115	0.0896	0.0817	0.104
Mercury	µg/L	USEPA 7470A	16	4	<0.0321	<0.0321	<0.0321	<0.0321
Nickel	µg/L	USEPA 1640	20	50	1.41	1.51	1.73	1.74
Selenium	µg/L	USEPA 1640	60	150	0.0489J	0.0621	0.0479J	0.0453J
Silver	µg/L	USEPA 1640	28	7	0.139	0.143	0.137	0.141
Zinc	µg/L	USEPA 1640	80	200	1.73	1.49	1.87	1.03
Chlorine								
Chlorine, Total Residual	mg/L	SM 4500-Cl F	8	60	<0.042	<0.042	<0.042	<0.042
Halogenated Organic Compounds (volatile and semi-volatile)								
2,4,6-Trichlorophenol	µg/L	USEPA 625	4	10	<2.5	<2.5	<2.5	<2.5
2,4-Dichlorophenol	µg/L	USEPA 625	4	10	<2.5	<2.5	<2.5	<2.5
2-Chlorophenol	µg/L	USEPA 625	4	10	<2.3	<2.3	<2.3	<2.3
4-Chloro-3-Methylphenol	µg/L	USEPA 625	4	10	<2.4	<2.4	<2.4	<2.4
All other halogenated organic compounds were below detection limits								

*COP Daily Maximum concentration

**COP Instantaneous Maximum concentration

J - Results above the method detection limit but below the reporting limit. Result is estimated.

< - Result below method detection limit.

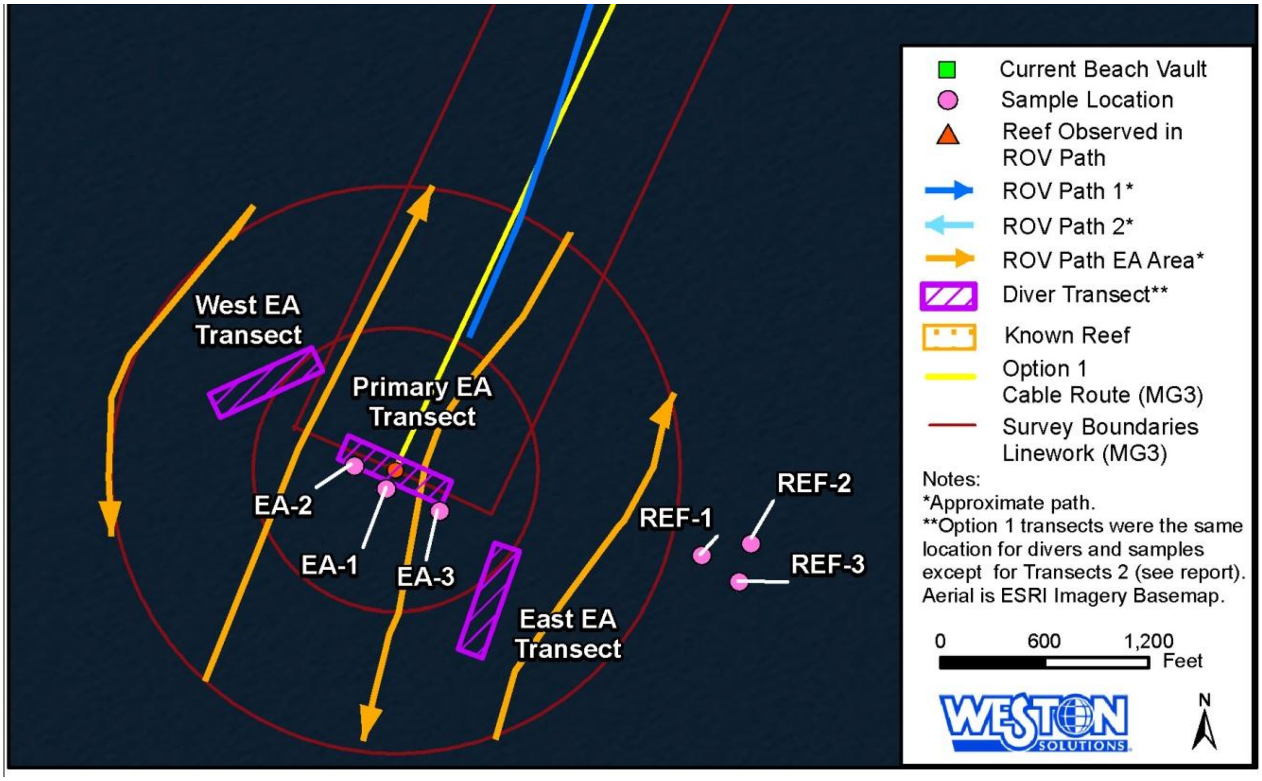

Figure 3-3. Sampling Sites at the Proposed Electrode Array Area and Adjacent Reference Sites Monitored as Part of the Marine Resources Assessment (See Appendix A for Details)

3.6 Best Management Practices

Several best management practices (BMPs) will be implemented throughout the course of this Project to minimize any potential impacts to biological resources (including candidate, sensitive or special status species), habitats (including sensitive natural communities), movement of native fish (including migratory corridors), and water quality. The BMPs that have been identified for the Project are listed below:

- Incorporate Project design elements and operating procedures that minimize the generation of electric fields so that field strengths are less than the International Commission on Non-ionizing Radiation Protection (ICNIRP) pre-standard of 1.25 V/m (IEC/PAS, 2007) (see discussion in Section 4.2).

- Perform a pre-construction survey of the proposed Project alignment to confirm baseline conditions and ensure that electrode array placement and cable routing avoids Habitat Areas of Particular Concern (HAPC), such as kelp forests and rocky reefs.

- Use cable installation methodologies that minimize disturbance and permanent habitat alteration of benthic habitat, to the extent practicable, including:

    - Performing directional drilling from the shoreline to 1,000 ft offshore to install cables in order to limit disturbance of the intertidal zone and rocky reefs in the nearshore environment.

  - Use jet plowing or mechanical plowing to install the cables extending from 1,000 ft offshore to the electrode array to restore soft bottom habitat.
  - Bury cables to a depth of approximately 5 ft, as practicable, to limit potential for biological interaction during burrowing and foraging.

- Use electrode materials and design elements that limit the production of chlorine gas to the maximum extent practicable.

4.0 BIOLOGICAL RESOURCES IMPACT ANALYSIS

Biological resource impacts can be direct, indirect, or cumulative. Direct impacts occur when biological resources are altered, disturbed, or destroyed during or after project implementation. Examples include installation of pilings or other hard structures in marine sediment, encroaching into wetland buffers, diverting surface water flows, and the loss of individual species or their habitats during construction or over time. Indirect impacts that could affect biological resources include elevated noise levels, increased human activity, and degraded water or sediment quality. Cumulative impacts occur when biological resources are either directly or indirectly impacted to a minor extent as a result of a specific project, but the project-related impacts are part of a larger pattern of similar minor impacts that may be related to other projects in the same area. The overall result of these minor impacts from multiple separate projects is considered a cumulative impact to biological resources.

Biological resources impacts may also be classified as temporary or permanent. Temporary impacts can be direct or indirect and are considered short-term and recoverable. Examples in the marine environment include transient changes in water quality from sediment disturbance during construction. Permanent impacts can be direct or indirect and are not considered recoverable. Examples include the removal or change of habitat in areas that will have permanent structures placed on them.

For each potential impact associated with the proposed Project, a determination was made regarding level of significance. Conclusions of significance are defined in the CEQA Checklist as follows: potentially significant impact, less than significant with mitigation incorporated, less than significant, and no impact.

4.1 Methodology and Threshold of Significance

The following significance thresholds are based on the environmental checklist presented in Section IV (Biological Resources) of Appendix G of the CEQA Guidelines. They are used to describe the potential impacts of the proposed Project on the sensitive marine biological resources that may occur in the proposed APE. A project would have a significant impact on biological resources if it would:

a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFW or USFWS.

b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the CDFW or USFWS.
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means.
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan.

The types of potential direct and indirect impacts on biological resources due to the proposed Project activities are described below.

4.2 CEQA Significance Threshold Discussion for Biological Resources

This section evaluates the direct and indirect impacts, including both temporary and permanent impacts, of the proposed Project on the biological resources that occur or have the potential to occur within the APE. Potential sources of impacts from the proposed Project include construction activities and ongoing operation of the SGRS.

While empirical measurements and observations of impacts of offshore energy-related projects are extremely limited, potential effects of marine energy projects on marine resources have been summarized (Kramer *et al*., 2010; U.S.DOE, 2009) and reviewed specifically for this Project (see literature review in the marine resources assessment in Appendix A). The following cited potential effects that have applicability to the proposed Project are:

1) Alteration of substrates and sediment transport and deposition;
2) Interference with animal movements and migrations, including fish (prey and predators) and invertebrate attraction to subsurface components of device;
3) Alteration of habitats for benthic organisms;
4) Sound and vibration in water column during construction;
5) Generation of electromagnetic fields (EMFs) by the SGRS;
6) Release into water column of toxic chemicals from paints, lubricants, antifouling coatings, as well as spills of petroleum products from service vessels.

Construction of the undersea portion of the SGRS would involve placement of subsea cables and the electrode array on the soft bottom habitat of Santa Monica Bay over approximately nine-months. Proposed Project construction would primarily result in temporary direct and indirect impacts that would extend throughout the duration of construction activities. Laying of cables by jet plowing and burial would result in temporary disturbance of the seafloor, which could directly impact slow-moving or non-motile benthic organisms. Suspension of sediments could indirectly impact nearby benthic, epibenthic, and water column species due to temporary reductions in water quality. Additionally, increased vessel operations and lowering of equipment through the water column could have the potential to temporarily impact swimming biota, as well as birds, that transit, forage, or reside in the region. These potential impacts are anticipated to be highly localized to the APE, temporary as they will only extend throughout the period of construction, and less than significant with mitigation. Lastly, construction of the 88-vault electrode array would result in mortality of slow moving or non-motile benthic organisms and would result in the permanent conversion of approximately one acre of soft bottom habitat to hard substrate. The hard substrate of the vaults would provide habitat heterogeneity that would likely lead to an increase in species diversity compared to the existing soft-bottom substrate, but the increase of hard bottom habitat could attract species that could forage on soft bottom species, potentially resulting in an indirect increase in predation levels.

Operation of the electrode has the potential to impact marine biota during construction and through the long-term production of EMFs and the generation of chlorine gas. A mathematical model was created to estimate the dispersed charge from the proposed electrode and the estimated volume of chlorine gas that the electrode may produce (see Appendix B). Values from this model were used to assess the potential impacts to marine biota associated with operation of the proposed electrode.

Mitigation Measures (MMs) to avoid or minimize potential Project impacts are suggested in Section 7.0.

a) Would the project have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFW of USFWS?

There are 42 candidate, sensitive or special-status species that have the potential to occur within the APE (Appendix A). These species include five federally endangered cetaceans, seven other cetaceans protected by the MMPA, three pinnipeds, four sea turtles, ten fish, nine birds, and four abalone, as detailed in Section 3.5.2. These marine mammals, sea turtles, fish, and birds all are highly motile and capable of avoiding the majority of direct impacts of Project construction, as described below. The abalone species are less motile; however, they only have the potential to occur in hard bottom habitats, which will be avoided by the proposed electrode array configuration and cable route.

Potential Construction Impacts

Installation of the cables in the nearshore environment (*i.e.*, within 1,000 ft of the shoreline) would be accomplished using directional drilling, avoiding impacts to the intertidal and shallow subtidal environment and associated biota. Within deeper portions of the APE, cables would be installed using furrowing and burial. Concrete electrode vaults would be lowered through the water column from a barge and set in place on the ocean floor. All construction is to occur in areas of soft bottom habitat. Both electrode and cable installation would result in impacts to non-motile or slow moving benthic species, including epifauna and infauna. These species do not include candidate, sensitive, or special-status species.

Construction activities could temporarily impede foraging by species that have the potential to occur in the APE. However, these effects would only extend throughout the duration of construction within the APE and are therefore not anticipated to result in adverse population-level impacts to candidate, sensitive, or special-status species. Moreover, the proposed Project would not have population-level impacts on any benthic species observed within the APE since these species consist of common species found throughout Santa Monica Bay and the Southern California Bight.

Special-status species observed, or that have the potential to occur, within the APE include highly motile species that can avoid construction activities, such as pinnipeds, cetaceans, sea turtles, and birds. Given the small footprint of the Project relative to Santa Monica Bay, the construction of the Project would not interfere substantially with the movement or foraging of any native or migratory marine or avian species. However, vessels could collide with marine mammals or sea turtles, resulting in a potential “take” of special-status species, which would be a significant impact. Therefore, it is recommended that vessels transporting equipment and supplies to the site and performing construction activities follow mitigation measures (Section 7.0) to minimize this potential impact.

Installation of the electrode vaults would result in a permanent loss of soft bottom habitat and replacement with hard bottom habitat. Additionally, the increase of hard bottom habitat could attract species that could forage on soft bottom species, potentially resulting in an indirect increase in predation levels. However, the hard substrate provided by the electrode vaults would provide habitat heterogeneity that would likely lead to an increase in species diversity on the soft-bottom substrate of Santa Monica Bay. The low profile nature of the vaults and the depth at which they will be placed (approximately 160 ft deep) will likely minimize any potential impacts on candidate, sensitive, or special-status species.

The impacts related to construction noise have been considered based on the cable laying activities because, based on the nature of the construction activities for the marine portion of the SGRS, it is anticipated that the cable laying, which would involve the operation of vessels at the surface and a jet plow on the ocean floor, would create the highest levels of noise. The installation of the electrode array itself would also involve the operation of vessels at the surface, but the actual setting of the cylindrical boxes on the ocean floor is not anticipated to create substantial noise.

Limited studies have been conducted on potential noise impacts from the installation (or removal) and operation of sub-sea cables (reviewed by BERR, 2008, Nedwell *et al.*, 2007). Although studies have been conducted on potential impacts to marine species associated with construction and operation of offshore wind farms (reviewed by Madsen *et al*., 2006), the majority of these assessments have focused on impacts related to pile driving and continuous operation, which are not applicable to the construction or operational activities anticipated with the SGRS Project. One of the difficulties in assessing noise impacts on marine species from underwater construction is the wide range of hearing capabilities among fish and marine mammal species. In order to standardize noise impacts on marine fauna, Nedwell *et al.* (1998) developed a scale based on a hearing threshold (ht) of sound perception on the DeciBel (dB) scale for individual marine species. This species-specific scale dB_{ht} (species) accounts for the hearing threshold of individual species and allows for an assessment of potential impacts of a given level of noise on a species-specific basis. The dB_{ht} (species) scale is the only metric that quantifies the risk of behavioral effects across a wide range of species having varying hearing ability. It gives a species-specific noise level referenced to an animal's hearing ability and therefore a measure of the potential of the noise to cause an effect. The measure that is obtained represents the "loudness" of the sound for that animal. Generally, maximum sound pressure levels related to the installation or operation of cables are moderate to low and there are no clear indications that noise impacts related to the installation and operation of subsea cables pose a high risk of harming marine fauna (BERR, 2008).

Nedwell *et al.*, (2003a) measured the noise associated with cable laying construction at varying distances from trenching operations and compared noise levels in the field to the hearing thresholds of several fish and marine mammal species using the dB_{ht} (species) scale. Based on the scale, avoidance reactions were considered mild at species-specific sound levels greater than 75 dB_{ht} (species), significant at levels greater than 90 dB_{ht} (species), and strong at levels greater than 100 dB_{ht} (species). This model was validated for a variety of fish species and marine mammals by Nedwell *et al.* (2007). They found that, with one exception, all of the noise measurements in the field associated with cable trenching were less than 70 dB_{ht} (species) for all species tested. Thus, based on the classification reaction outlined above, the sound associated with trenching during the cable-laying process was less than the level at which significant avoidance reactions would be expected (*i.e.*, 90 dB_{ht} [species]).

Disturbance caused by noise generated from cable-laying operations (as well as noise associated with vessels and equipment) may displace fish within the water column from the vicinity of operations. However, because the cable laying activity for the SGRS would occur for a very brief period in any given location, this is seen as a localized and temporary effect, which in isolation, would not represent a significant impact on marine biological resources.

Potential Operational Impacts

Potential impacts associated with operation of the proposed electrode involve the generation of electric and magnetic fields (the two components of the EMF), as well as chlorine gas. Mathematical models were prepared to estimate the dispersed charge from the proposed electrode and the estimated volume of chlorine gas that the electrode may produce (Appendix B). The Duty Cycle 2 (DC2) for the electrode design was based on a maximal operational limit of 50 hours per year with a duration of 160 minutes per event (approximately 19 DC2 events per year). Each DC2 event in the model consisted of 30 minutes of operation at 3,650 A, a 10 minute ramp down to 2,000 A, and 120 minutes at 2,000 A.

The electric field generated by the proposed 88-vault electrode array in the DC2 Model described above is modeled to be 1.077 V/m at a position of 0.4 inches above the vault gravel surface (Appendix B). The model used a worst case scenario that assumed that only six of the eight electrode sections were functioning. Even using this scenario, the strength of the field is below the IEC threshold of 1.25 V/m. The strength of the field decreases exponentially with distance from the electrode array, and was modeled to be 0.056 V/m at a distance of 21 ft from the electrode vault surface (*i.e.*, at a depth of 131 ft). At these levels, species with electrical sensory abilities, such as elasmobranchs, may be able to detect the field, since these species have been reported to detect electric fields as weak as 1 nV/m (Fisher and Slater, 2010). While predicted strength of the electric field is within the detection limits of select marine species, the strength is below reported thresholds for harmful effects on fish, including electronarcosis and paralysis, which were detected at fields greater than 15 V/m (Balayev, 1980; Balayev and Fursa, 1980). Based on the generation of an electric field below the IEC threshold during discrete, short-duration events associated with operation of the proposed electrode at a conceptual maximum of 19 events per year, potential impacts to sensitive species are predicted to be less than significant.

A model has been produced to estimate the magnetic field generated by the proposed SGRS (Appendix B). The model focused on potential impacts from the SGRS on ship navigation and therefore estimated the magnetic field associated with the SGRS at the sea surface. At this location, the magnetic field is modeled to be a maximum of 10 microTesla (µT). The magnetic field at the surface of the cables is expected to be greater than that at the sea surface and may therefore pose a greater potential risk to marine biota in the vicinity. In order to understand the potential impacts associated with the magnetic field at the sea floor (closest to the marine cables), LADWP has estimated the magnetic field strength at varying distances from the cables within the water column. LADWP estimated that the maximum magnetic field produced by the SGRS on the surface of the ocean floor would be generated where the two four-cable bundles exit the trench at the electrode array and split into a total of eight individual cables that would lie on the surface (not buried by sediment). Up to this point, the cables would be buried under sediment, and, therefore, the magnetic field at the surface of the ocean floor would be substantially reduced. This location, approximately three miles offshore at a water depth of approximately 160 ft, would present the greatest magnetic field strength to which marine organisms in the water column would potentially be exposed, associated with the operation of the SGRS. LADWP estimates that each cable would produce 387.5 A, resulting in a magnetic field of approximately 3,000 µT at a one-inch radius from the cable. The strength of the magnetic field would dissipate rapidly with distance and is calculated to be approximately 500 µT at a distance of 6 in from the cable, 250 µT at 1 ft, 50 µT at 5 ft, and 25 µT at 10 ft. To put these values in perspective, the earth's magnetic field in Southern California is approximately 50 µT (U.S. DOI, 2011).

Potential impacts to magnetosensitive species from an altered magnetic field in the vicinity of a cable would depend upon how a species uses its magnetic sense. While it has been well established that some species can detect magnetic fields, the importance of the magnetic sense for orientation or navigation, is not well understood (Walker *et al*., 2007). The effects of magnetic fields from undersea power cables on marine species were recently reviewed by the U.S. Department of the Interior (U.S. DOI, 2011). The most sensitive organisms to magnetic fields include elasmobranch fishes (sharks and rays) and some teleost fishes (*e.g.,* eels), which have sensitivities as low as a few µT. Other organisms that are sensitive to magnetic fields and may use them for navigation include sea turtles, salmonids, whales, and dolphins (reviewed by Fisher and Slater, 2010 and U.S. DOI, 2011). While infrastructure-induced magnetic fields have been reported to be detectable by a number of marine species, there is no evidence in the literature that the levels anticipated to be produced by the proposed SGRS electrode would adversely affect the navigational capabilities or migration patterns of marine species that may inhabit or pass through the area. The magnetic field calculated by LADWP suggests that the greatest magnetic field produced by the electrode will be in the range of levels detected by marine biota cited in the literature, but will be limited to approximately a 10-foot radius of the undersea cables. The Duty Cycle for the electrode design was based on a maximal operational limit of 50 hours per year with a duration of 160 minutes per event (approximately 19 events per year). The SGRS would operate at the peak electrical current for only 30 minutes during each individual event. In addition, it is anticipated that the electrode would actually operate at only approximately 20 hours per year (approximately 8 events per year). These short duration, infrequent events of relatively low magnetic field production are likely to have a less than significant impact on marine biota.

In addition to EMF production, operation of the proposed electrode system is anticipated to generate chlorine gas as a byproduct of the electrolysis process. Chlorine is an oxidizing biocide that is non-selective in terms of the organisms that it has the potential to affect. Free chlorine (chlorine gas dissolved in water) can be toxic to fish and aquatic organisms at concentrations greater than 0.01 mg/L. However, its dangers are relatively short-lived because it reacts quickly with other substances in water or dissipates as a gas into the atmosphere.

Chlorine production from a marine electrode is based on the dispersed charge and may be significant for electrodes normally operated in continuous service (*i.e.,* rated current kept constant for long periods, such as months). However, the SGRS electrode will be characterized by short cycles, normally very limited in time and number and, according to the model chlorine release to the ocean is expected to be minimal (Appendix B). Based on the duty cycle of the proposed SGRS electrode (DC2, described above), the model estimated that over one DC2 cycle, the global chlorine gas release would be approximately 16.5 pounds per event dispersed over the entire ¼-mi diameter electrode footprint. Based on the discrete, short-duration events associated with operation of the proposed electrode, combined with the relatively few events per year (anticipated maximum of 19) and the small amount of chlorine gas produced per event over a large geographical area, the chlorine concentration in the water column associated with the electrode is expected to be minimal. In addition, the chlorine that will be released to the water column is expected to be short-lived because it reacts quickly with other substances in water and should dissipate rapidly. Therefore, the potential impact on marine biota from chlorine produced by operation of the electrode is expected to be less than significant.

Moreover, the values used to model electric field and chlorine production are considered to be conservative estimates. It is expected that the proposed Project would typically operate at 3,100 A (as opposed to the 3,650 A in the model) and would be operational substantially less than 50 hours per year. In addition, the model for chlorine gas production was considered to be an overestimate that assumed a large selectivity for chlorine of 90% (*i.e.,* 90% of the discharge product is chlorine and just 10% is oxygen).

Operation of the proposed Project would not emit any sound; therefore, there would be no impacts from noise on candidate, sensitive, or special-statues species.

In summary, impacts from the Project on candidate, sensitive, and special-status species would be less than significant with the BMPs listed in the Project Description (Section 3.0) and the Mitigation Measures described in Section 7.0.

b) Would the project have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the CDFW or USFWS?

Within Santa Monica Bay, sensitive natural marine communities include canopy kelp, rocky reefs, and seagrass, which are defined as HAPC within areas determined to be EFH (Pacific Fisheries Management Council, 2012). The Magnuson-Stevens Fishery Conservation and Management Act (16 USC 1801 *et seq*) defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” The Act requires Fishery Management Councils to describe and identify EFH in fishery management plans, which are then approved by NMFS. Santa Monica Bay, along with the entirety of the offshore waters of the West Coast to a depth of 3,500 ft and associated sea mounts, is considered to be EFH for Pacific Coast Groundfish (Pacific Fishery Management Council, 2012).

Placement of the concrete electrode vaults on the seabed would be confined to areas with soft bottom habitat, and therefore would not adversely affect HAPC, including canopy kelp, rocky reefs, and seagrass. There is one small natural patch of reef and two artificial reefs within the Project vicinity (TAR and SMAR/SMBAR reef complex). The selected cable route and electrode placement has been designed to circumvent these hard structures. Additionally, there are no anticipated Project operational impacts on the artificial reefs, rocky reefs, canopy kelp, or seagrass, since these habitat areas would be avoided.

The placement of the 25-ft-diameter by approximately 7.0-ft-tall concrete electrode vaults would result in the loss of soft-bottom habitat that supports benthic infaunal, epifaunal, and demersal species, including Pacific coast groundfish. Cables connecting the electrode arrays within the electrode array area would be exposed, further altering the soft bottom habitat in this area. The concrete vaults would replace the soft bottom habitat with hard bottom structure, providing increased habitat heterogeneity. The concrete vaults would be analogous to the artificial reefs in Santa Monica Bay, since they would aggregate and support a more diverse assemblage of marine algae, invertebrates, and fish than soft-bottom habitat alone. Given the small area of the Project, the loss of soft bottom habitat resulting from the Project would not have a substantial adverse effect on the Pacific coast groundfish EFH in Santa Monica Bay or along the West Coast.

In summary, impacts from the Project to sensitive natural marine communities would be less than significant with the BMPs listed in the Project Description (Section 3.0) and the Mitigation Measures described in Section 7.0.

c) Would the project have a substantial adverse effect on federal protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh,

vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?

The marine portion of the proposed Project would not be located in an area of federally protected wetlands.

d) Would the project interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?

The SGRS structures would not substantially interfere with the movement of native or migratory species. The marine cables would be laid beneath the ocean floor at a depth of approximately 5 ft and therefore would not impact movement of native or resident species. Additionally, the concrete electrode vaults would be relatively low profile (approximately 7 ft in height) and confined to a small area of Santa Monica Bay at a depth of approximately 160 ft. Fish and other migratory species could utilize more than 150 ft of the water column to traverse the area. Potential disturbance related to the movement of fish or wildlife species during construction of the proposed Project is expected to be minimal, as the entire marine construction process is expected to last approximately nine months and any disturbances to movements of fish or wildlife species will be temporary.

As discussed above, the electric field generated by the proposed 88-vault electrode array is modeled to be 1.077 V/m at a position of 0.4 in (1 cm) above the vault gravel surface (Appendix B). The model used a worst case scenario that assumed that only six of the eight electrode sections were functioning. Even using this scenario, the strength of the field is below the pre-standard IEC 62344 of 1.25 V/m to protect biota. The strength of the field decreases exponentially with distance from the electrode array, and was modeled to be 0.056 V/m at a distance of 21 ft from the electrode vault surface (*i.e.,* at a depth of 131 ft). At these levels, species with electrical sensory abilities, such as elasmobranchs, may be able to detect the field, since these species have been reported to detect electric fields as weak as 1 nV/m (Fisher and Slater, 2010). While predicted strength of the electric field is within the detection limits of select marine species, the strength is below reported thresholds for clearly harmful effects on fish, including electronarcosis and paralysis, which were detected at fields greater than 15 V/m (Balayev, 1980; Balayev and Fursa, 1980).

A model has been produced to estimate the magnetic field generated by the proposed SGRS (Appendix B). The model focused on potential impacts from the SGRS on ship navigation and therefore estimated the magnetic field associated with the SGRS at the sea surface. At this location, the magnetic field is modelled to be a maximum of 10 µT. The magnetic field at the surface of the cables is expected to be greater than that at the sea surface and may therefore pose a greater potential risk to marine biota in the vicinity. In order to understand the potential impacts associated with the magnetic field at the sea floor (closest to the marine cables), LADWP has estimated the magnetic field strength at varying distances from the cables within the water column. LADWP estimated that the maximum magnetic field produced by the SGRS on the surface of the ocean floor would be generated where the two four-cable bundles exit the trench at the electrode array and split into a total of eight individual cables that would lie on the surface (not buried by sediment). Up to this point, the cables would be buried under sediment, and, therefore, the magnetic field at the surface of the ocean floor would be substantially reduced. At this location, approximately three miles offshore at a water depth of approximately 160 ft, would represent the greatest magnetic field strength to which marine organisms in the water column would potentially be exposed associated with the operation of the SGRS. LADWP estimates that each cable would produce 387.5 A, resulting in a magnetic field of approximately 3,000 µT at a one-inch radius from the cable. The strength of the magnetic field would dissipate rapidly with distance and is calculated to be approximately 500 µT at a distance of 6 in from the cable, 250 µT at 1 ft, 50 µT at 5 ft, and 25 µT at 10 ft. To put these values in perspective, the earth's magnetic field in Southern California is approximately 50 µT (U.S. DOI, 2011).

Potential impacts to magnetosensitive species from an altered magnetic field in the vicinity of a cable would depend upon how a species uses its magnetic sense. While it has been well established that some species can detect magnetic fields, the importance of the magnetic sense for orientation or navigation, is not well understood (Walker *et al.*, 2007). The effects of magnetic fields from undersea power cables on marine species were recently reviewed by the U.S. Department of the Interior (U.S. DOI, 2011). The most sensitive organisms to magnetic fields include elasmobranch fishes (sharks and rays) and some teleost fishes (*e.g.*, eels), which have sensitivities as low as a few µT. Other organisms that are sensitive to magnetic fields and may use them for navigation include sea turtles, salmonids, whales, and dolphins (reviewed by Fisher and Slater, 2010 and U.S. DOI, 2011). While infrastructure-induced magnetic fields have been reported to be detectable by a number of marine species, there is no evidence in the literature that the levels anticipated to be produced by the proposed SGRS electrode would adversely affect the navigational capabilities or migration patterns of marine species that may inhabit or pass through the area. The magnetic field calculated by LADWP suggests that the greatest magnetic field produced by the electrode will be in the range of levels detected by marine biota cited in the literature, but will be limited to approximately a 10-foot radius of the undersea cables. The Duty Cycle for the electrode design was based on a maximal operational limit of 50 hours per year with a duration of 160 minutes per event (approximately 19 events per year). The SGRS would operate at the peak electrical current, which would produce the maximum amperage of 387.5 A at the electrode array, for only 30 minutes during each individual event. In addition, it is anticipated that the electrode would actually operate at only approximately 20 hours per year (approximately 8 events per year). These short duration, infrequent events of relatively low magnetic field production are likely to have a less than significant impact on marine biota.

In summary, the Project would not interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites. Impacts from the Project relative to these issues would be less than significant with the BMPs listed in the Project Description (Section 3.0) and the Mitigation Measures described in Section 7.0.

e) Would the project conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?

No, the Project would not conflict with any local policies or ordinances protecting marine biological resources.

f) Would the project conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?

The Santa Monica Bay Restoration Plan (BRP), which is administered by the Santa Monica Restoration Commission, is a National Estuary Program charged by the USEPA to develop and implement a Comprehensive Conservation Management Plan for Bay protection and management. The BRP includes goals, objectives, and milestones that are organized into three sections: (1) improve water quality, (2) conserve and rehabilitate natural resources, and (3) protect the Bay's benefits and values.

The proposed Project would not conflict with the goals, objectives, and milestones of the RBP or other adopted Habitat Conservation Plans, Natural Community Conservation Plans, or other approved local, regional, or state conservation plans.

5.0 HYDROLOGY AND WATER QUALITY IMPACT ANALYSIS

5.1 Methodology and Threshold of Significance

This section evaluates short- and long-term impacts to sediment and water quality that could result from Project construction and ongoing operation within the APE. Mitigation measures are suggested to avoid or minimize potential Project impacts.

The following significance thresholds are based on the environmental checklist presented in Appendix G of the CEQA Guidelines in Section IX (Hydrology and Water Quality). They are used to determine the potential impacts of the proposed Project upon hydrology and water quality in the proposed APE. A project would have a significant impact on hydrology and water quality if it would result in one or more of the following:

a) Violate any water quality standards or waste discharge requirements.
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (*e.g*., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site.
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site.
e) Create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff.
f) Otherwise substantially degrade water quality.
g) Place housing within a 100-year floodplain, as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map, or other flood hazard delineation map.
h) Place within a 100-year floodplain structures that would impede or redirect flood flows.
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam.
j) Inundation by seiche, tsunami, or mudflow.

5.2 CEQA Significance Threshold Discussion for Hydrology and Water Quality

Only two of these guidelines are applicable to the marine portion of the Project: a) and f). Each question is addressed below.

A project would have a significant impact on hydrology and water quality if it would result in one or more of the following:

a) Violate any water quality standards or waste discharge requirements.

As defined in Section 13030 of the California Water Code, water quality inputs of concern include discharges that create pollution, contamination, or nuisance or that release toxic substances deleterious to humans, fish, bird, or plant life. The use of vessels during construction operations can increase the potential for localized accidental spills of hazardous chemicals, such as oil; however, this risk is no greater than ongoing recreational and commercial vessel operations within the region. Additionally, small spills would be unlikely to cause a significant adverse effect to water or sediment quality because wave action and current dynamics within Santa Monica Bay would disperse and dilute potential inputs, reducing concentrations below levels expected to have toxic effects on biota (California State Lands Commission, 2010). These potential impacts would be less than significant with the BMPs listed in the Project Description (Section 3.0) and the Mitigation Measures described in Section 7.0.

Construction activities, including the placement of electrodes and laying of cables, also have the potential to result in the suspension of sediments within the APE. Sediment suspension could increase turbidity and contaminant concentrations within the water column. Increases in turbidity would only last for the duration of immediate construction activities, reducing light penetration to the seafloor. Reductions in light penetration are most relevant to photosynthetic organisms, such as algae; however, observations of the habitat and biological community showed that the benthos along the cable route and at the electrode field proposed for the Project consists primarily of soft bottom habitat (99%) with very low levels of algal cover. Additionally, reduced light levels could also impact species that rely on visual cues for foraging, such as motile invertebrates, fish, and mammals.

It is anticipated that the cable furrowing for the proposed Project will be accomplished with jet plows (or a similar process). Comprehensive reviews of this technology along with other underwater furrowing systems have shown that jetting systems produce a low level of disturbance in marine sediments composed of sand and silt (BERR, 2008), as is found in the selected cable route for the proposed Project. Studies conducted in the North Atlantic on impacts from cable furrowing associated with the wind farm industry (reviewed in BERR, 2008) suggest that during cable furrowing, fine sediments disperse throughout the water column and background concentrations of total suspended solids (TSS) are only raised by a few percent. The results indicated that dispersion of sediment was rapid, with concentrations dropping to less than 1 mg/L above background within a single flood or ebb excursion. This level of impact is well within the natural variability associated with waves, tidal action, and storm events experienced in Santa Monica Bay and substantially less than that associated with anthropogenic impacts from dredging or aggressive fishing practices (BERR, 2008). It is unlikely that construction activities would increase turbidity beyond levels commonly encountered during high wave events and storms; therefore, the impact of construction on turbidity would be both short term and within the natural level of variability.

Sediment re-suspension also has the potential to increase the concentrations of contaminants in the water column; however, this potential impact is likely to be minimal since concentrations of contaminants of concern measured within the APE as part of the Marine Resources Assessment for the Project (Appendix A) were below the thresholds for likely toxicity. This was determined by comparing concentrations of chemicals in the sediment along the proposed route for the Project to Effects Range-Low (ER-L) and Effects Range-Median (ER-M) values developed by Long *et al*. (1995). The effects range values are helpful in assessing the potential significance of elevated sediment-associated contaminants of concern. Briefly, these values were developed from a large data set where results of both benthic organism effects (*e.g.*, toxicity tests and benthic assessments) and chemical concentrations were available for individual samples. To derive these guidelines, the chemical values for paired data demonstrating benthic impairment were sorted in ascending chemical concentration. The 10th percentile of this rank order distribution was identified as the ER-L and the 50th percentile as the ER-M. Contaminant concentrations in sediment less than the ER-M values are considered below the thresholds likely for toxicity.

Concentrations of all contaminants of concern measured within the proposed cable route and electrode location collected as part of the marine resource assessment for the Project were below ER-Ms (*i.e.*, chemical concentration thresholds for likely toxicity based on prior laboratory studies). There were a limited number of contaminants, such as DDT, mercury, and total PCBs that were found at concentrations above ER-Ls (*i.e*., chemical concentrations that may have some potential for biological effects based on prior laboratory studies); however, bioassay tests of the sediments collected within the APE during this assessment did not show evidence of toxicity. These contaminants occurred at concentrations that are typically found in Santa Monica Bay. It has been estimated from large-scale regional studies that 90% of the surface sediments of the bay are contaminated (Schiff, 2000); largely due to legacy inputs of pollutants. Therefore, re-suspension due to construction activities associated with cable furrowing or installation of the electrode would not be expected to result in an increase in the distribution of contaminants of concern above baywide background levels. Additionally, sediment suspension would not necessarily result in increased bioavailability of contaminants in the water column since contaminants are often bound to sediment particles that quickly settle following disturbance events and may not substantially increase contaminant concentrations in the overlying water (Chadwick *et al*., 1999).

Thus, short term impacts on sediment and water quality during construction of the Project would be less than significant with the BMPs listed in the Project Description (Section 3.0) and the Mitigation Measures described in Section 7.0.

Once the electrode system construction has been completed, the system is unlikely to result in re-suspension of sediments that could impact water quality. Routine maintenance activities would not require excavation or disturbance of sediments. In the event that one or more of the cables required repair or replacement, excavation could result in sediment re-suspension and potential short term impacts to water quality as previously discussed.

Impacts on sediment and water quality during potential repair or replacement of the new SGRS would be less than significant with the BMPs listed in the Project Description (Section 3.0) and the Mitigation Measures described in Section 7.0.

Operation of the proposed electrode is expected to generate chlorine gas as a byproduct of the electrolysis process. Chlorine is an oxidizing biocide that is non-selective in terms of the organisms that it has the potential to affect. Free chlorine (chlorine gas dissolved in water) can be toxic to fish and aquatic organisms at concentrations greater than 0.01 mg/L. However, its dangers are relatively short-lived because it reacts quickly with other substances in water or dissipates as a gas into the atmosphere.

In anticipation of the proposed Project, a model was produced that identified the anticipated chlorine gas expected to be produced by the new electrode (see Appendix B). The production of chlorine can be a problem for electrodes normally operated in continuous service (*i.e.,* rated current kept constant for long periods, such as months). As the production of chlorine depends on the dispersed charge, this may lead to significant chlorine releases in the environment. However, the model produced for the Project concluded that in the case of the SGRS electrode, the operation will be characterized by short cycles, normally very limited in time and number. Therefore, chlorine release in the ocean will be minimal.

The COP has established an instantaneous maximum for total residual chlorine in ocean receiving waters of 60 µg/L. It is unclear if the existing electrode or the new electrode proposed for this Project will produce chlorine in excess of that that threshold, since samples have not been collected from ocean receiving waters adjacent to the existing electrode during operation (when chlorine gas may be produced). However, the SGRS electrode will be characterized by short cycles, normally very limited in time and number and, according to the operational model, chlorine release to the ocean is expected to be minimal. Based on the duty cycle of the proposed SGRS electrode (DC2, described above), it is estimated that over one DC2 cycle, the global chlorine gas release would be approximately 16.5 pounds per event dispersed over the entire ¼-mi diameter electrode footprint. Based on the discrete, short-duration events associated with operation of the proposed electrode, combined with the relatively few events per year (anticipated maximum of 19) and the small amount of chlorine gas produced per event over a large geographical area, the chlorine concentration in the water column associated with the electrode is expected to be minimal. Based on the design parameters of the model, the Project would have less than significant impact on water quality with the BMPs listed in the Project Description (Section 3.0) and the Mitigation Measures described in Section 7.0.

f) Otherwise substantially degrade water quality.

As discussed above, the Project would implement mitigation measures that would eliminate potential effects on water quality in the coastal zone (through directional drilling), reduce potential for accidental spills and discharges that could impact water and sediment quality during construction by adhering to a comprehensive spill prevention plan, minimize the effects of sediment re-suspension by using the appropriate cable installation methods, and limit production of chlorine gas by using the appropriate electrode materials and design elements. The Project would also adhere to all requirements of applicable permits throughout the Project to minimize water quality impacts. Potential Project-related water quality degradation would thus be minimized, and impacts would be less than significant.

6.0 CUMULATIVE IMPACTS

The proposed Project would not result in a significant adverse cumulative impact to marine biological resources. The proposed Project would involve the replacement of an existing electrode system with a new electrode system, both of which are located in Santa Monica Bay. The undersea portion of the SGRS would extend from the shoreline to approximately 3 mi offshore in an area composed of soft-bottom habitat. Since the Project would be routed in areas that avoid rare or sensitive habitat, such as rocky reefs and kelp forests, it would not significantly reduce or contribute to a trend of reducing critical marine habitat. Additionally, the Project would not directly impact or contribute to a cumulative trend of direct impact to a sensitive or protected species, water resource, or natural community. The potential impacts of the proposed Project would be less than significant with the proposed mitigation measures incorporated and there would be no cumulative impact to sensitive biological resources. Thus, the proposed Project would not have impacts that are cumulatively considerable.

7.0 MITIGATION MEASURES

This section summarizes the mitigation measures recommended for successful completion of the Project in Sections 3 (Biological Resources) and 4 (Hydrology and Water Quality).

7.1 Biological Resources

- **MM BIO-1:** Implement standard marine mammal and sea turtle avoidance mitigation measures, including:
    - Requiring vessels involved in construction activities to maintain a steady course and speed.
    - Avoidance of the immediate areas with marine mammals or sea turtles whenever possible.
    - Requiring the presence of a biological monitor on vessels during construction activities.
    - Training construction and vessel crews to recognize and avoid marine mammals and sea turtles prior to initiation of Project construction activities.
    - Reporting of collisions with marine wildlife promptly to federal and state resource agencies.

7.2 Hydrology and Water Quality

- **MM SWQ-1**: To reduce potential for accidental spills and discharges that could impact water and sediment quality during construction, the following BMPs are recommended:
    - Discharge of hazardous materials during construction activities shall be prohibited.
    - A comprehensive spill prevention plan shall be developed that documents that management practices that vessels will enact to limit the potential for accidental spills.
    - An environmental protection plan shall be developed that addresses issues related to storage and handling of fuel, waste disposal, vessel operation, and field policies.
    - All debris and trash shall be disposed in appropriate trash containers on land or on construction barges by the end of each construction day.

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APPENDIX A

Assessment of Marine Resources in the Vicinity of the Sylmar Ground Return System Undersea Electrode

Assessment of Marine Resources in the Vicinity of the Sylmar Ground Return System Undersea Electrode

Literature and Existing Data Review of Human Activities and Infrastructure, Marine Biota, and the Surrounding Environment

Final Report

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June 2012

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ACRONYMS AND ABBREVIATIONS

A	amps
ASBS	Areas of Special Biological Significance
ºC	degrees Celsius
CDFG	California Department of Fish and Game
CESA	California Endangered Species Act
CEQA	California Environmental Quality Act
CWA	Clean Water Act
DDT	dichlorodiphenyltrichloroethane
DO	dissolved oxygen
DPR	Department of Parks and Recreation
EFH	Essential Fish Habitat
ESA	Endangered Species Act
EIR	Environmental Impact Report
ºF	degrees Fahrenheit
ft	feet
km	kilometer
km^2	square kilometers
LADWP	Los Angeles Department of Water and Power
LARWQCB	Los Angeles Regional Water Quality Control Board
m	meter
MBTA	Migratory Bird Treaty Act
MGD	millions of gallons per day
MLPA	Marine Life Protection Act
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Area
MW	megawatts
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PDCI	Pacific Direct Current Intertie
pH	hydrogen ion concentration
SCCWRP	Southern California Coastal Water Research Project
SMAR	Santa Monica Artificial Reef
SMBAR	Santa Monica Bay Artificial Reef
SMBRC	Santa Monica Bay Restoration Coallition
SMCA	State Marine Conservation Area
SMP	State Marine Park
SMR	State Marine Reserve
SWRCB	State Water Resources Control Board
TAR	Topanga Artificial Reef
TSS	Total suspended solids
US	United States

USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
USGS	United States Geological Service
WPCP	Water Pollution Control Plant
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

The Los Angeles Department of Water and Power (LADWP) is engaged in studies to support the proposed upgrading of its Pacific Direct Current Intertie (PDCI) by approximately 600 megawatts (MW) to accommodate the transfer of wind and hydroelectric power. This upgrade will require enhancements to the PDCI ocean electrode system located off the coast of Santa Monica, California. The enhancement includes replacement of two subsea electrical cables, which currently extend from the Gladstone Vault, located at Sunset Blvd and Pacific Coast Highway, to approximately 6,000 feet (ft) offshore to an electrode array. The existing electrode array, which consists of 24 electrode elements placed within concrete vaults that are spaced at intervals 10 to 23 feet and extend to a total length of 543 feet, will also require retrofitting or replacement and potential relocation.

An Initial Study prepared by LADWP determined that the Sylmar Ground Return System Replacement Project (Project) will require an Environmental Impact Report (EIR) based on identification of site-specific impacts and evaluations of potential significance under the California Environmental Quality Act (CEQA). The Initial Study determined that replacement or rehabilitation of the cables and electrode array has the potential to significantly impact marine resources due to construction-related impacts. The Sylmar Electrode System is projected to be operated approximately 50 hours per year at a maximum amperage of 3,650 amps (A), as compared to the maximum amperage of the existing system of 3,100 A. During periods of use, the subsea system has the potential to produce electromagnetic fields and electrochemical reactions that may impact marine organisms and the surrounding environment.

This report details the marine conditions and resources that are reported to occur within the vicinity of the existing electrode in Santa Monica Bay, California. The purpose of the report is to provide a review of historical oceanographic conditions, marine habitats and species in the Bay, and human uses and infrastructure within the vicinity of the Project.

1.1 Project Objectives and Description

The objective of the Project is to replace and upgrade the existing electrode system that extends from the Sylmar Converter Station to an offshore location in the Pacific Ocean. This Project will involve replacing up to 23 miles of overhead transmission cables, including 31 in-ground vaults located on streets, and 1.1 miles of submarine cable running from the Gladstone Vault to an offshore location in Santa Monica Bay. The marine portion of the Project will involve directional boring beginning at the Gladstone Vault to a distance of approximately 1,000 feet (ft) offshore at a depth of 15 to 25 ft (Figure 1-1). Copper submarine cables will then be pushed through the bored conduit from the vault and exit from below the seafloor at a distance of approximately 1,000 ft. Beyond 1,000 ft from shore, the submarine cables will then travel along the seafloor and terminate at an electrode array, which is anticipated to be consist of a series of concrete vaults, as described below. The final location of the new system has yet to be determined but will likely reside between 6,000 and 15,000 ft (1.1 to 2.8 miles) offshore in 60 to 180 ft of water. The nearshore portion (i.e., within 1,000 ft of shore) of the existing electrode cables is targeted for removal, while the remaining cables and electrode array are expected to be abandoned in place.

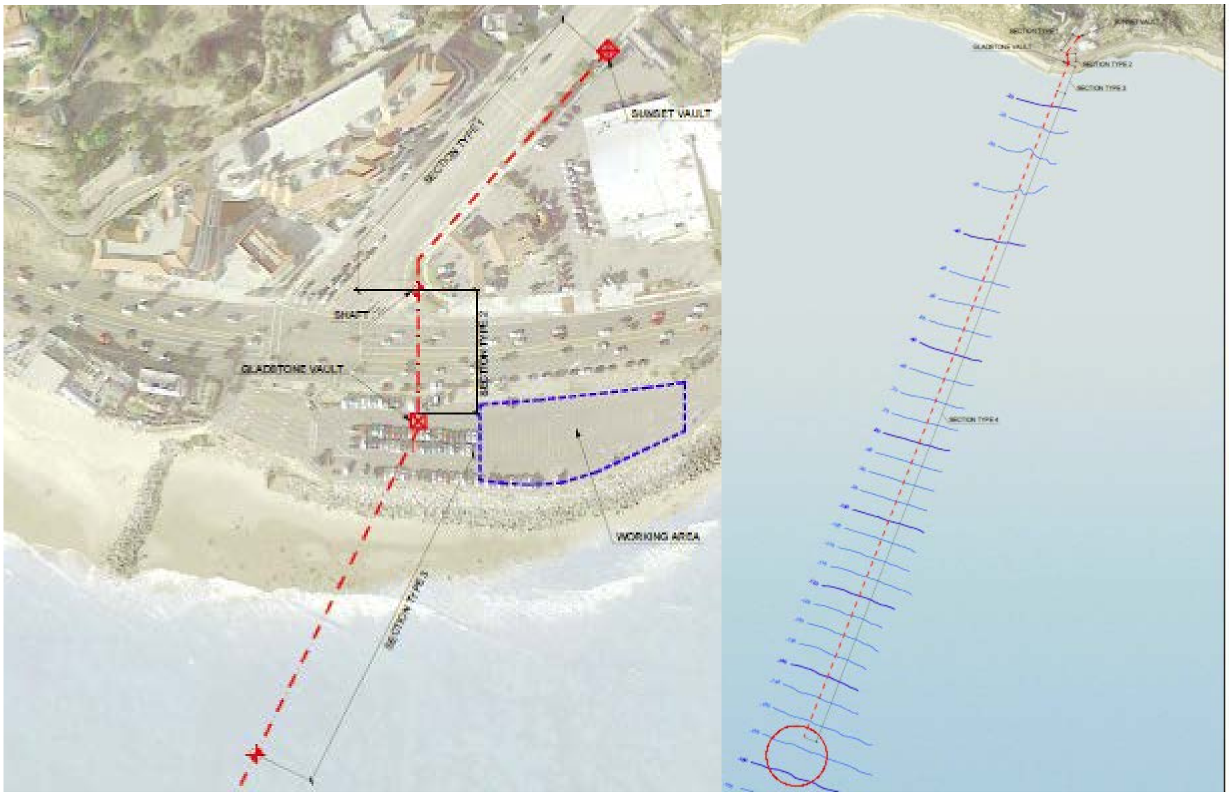


Figure 1-1. General Location of Cable Route from the Gladstone Vault to the Offshore Electrode (Taken from Burns and McDonnell, 2012a)

The new system will be capable of operating at a maximum amperage of 3,650 A even under the condition when up to two of the eight sections of the array (25%) are not available for operation due to failure or maintenance (Burns and McDonnell, 2012a). This choice increases the overall rated current value to 4,867A (3,650A*8/6). The duty cycle of the system is expected to have a total cycle time of 120 minutes and a total time expected in operation of less than 50 hours per year (Burns and McDonnell, 2012a).

1.1.1 Electrode Array

A description of the electrode array is provided in two reports: Task 2 "Electrode Cables Evaluation and Design" – FINAL REPORT (Burns and McDonnell, 2012a), and Submarine Electrode Technical Specification – Annex to Task 1 & 11 Final Report (Burns and McDonnell, 2012b). The basic characteristics of the electrode array described in the two documents are summarized below.

The perimeter of the electrode will be formed by using 88 concrete cylindrical boxes, regularly spaced and laid on the seabed in a circle with a diameter of approximately 1,380 ft. The distance between the centers of two adjacent boxes will be approximately 50 ft. The electrode will be electrically subdivided into 8 sections of 11 boxes (i.e., sub-electrodes) each (Figure 1-2, from Burns and McDonnell, 2012a).

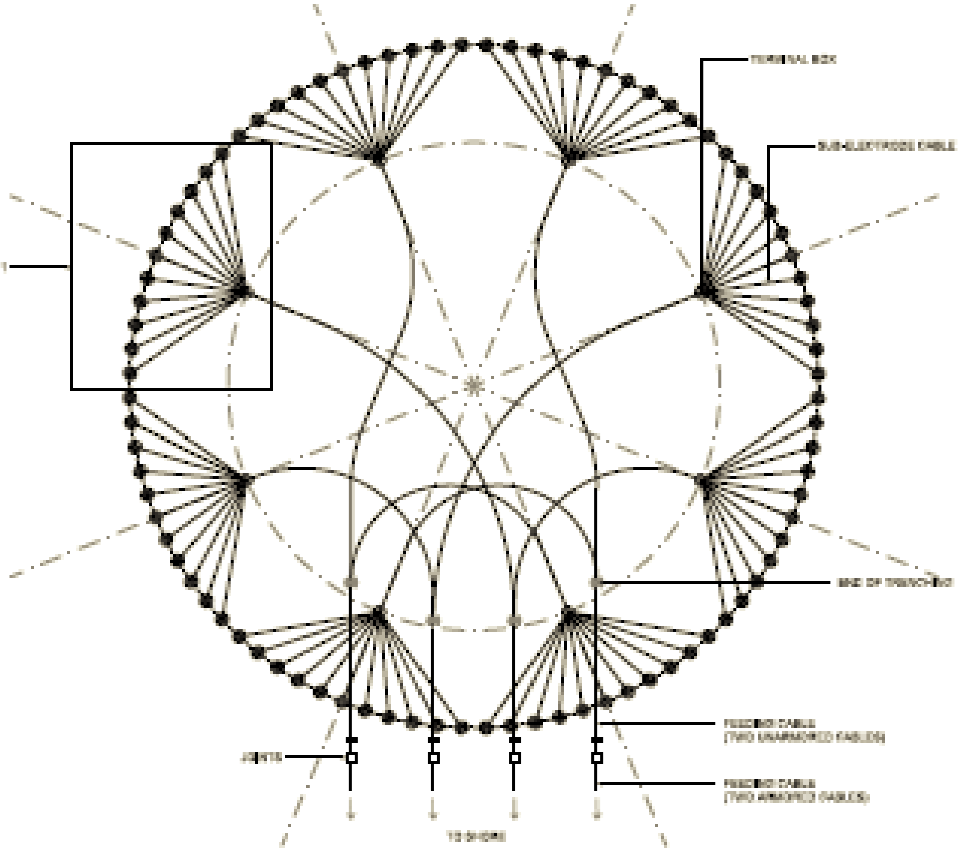
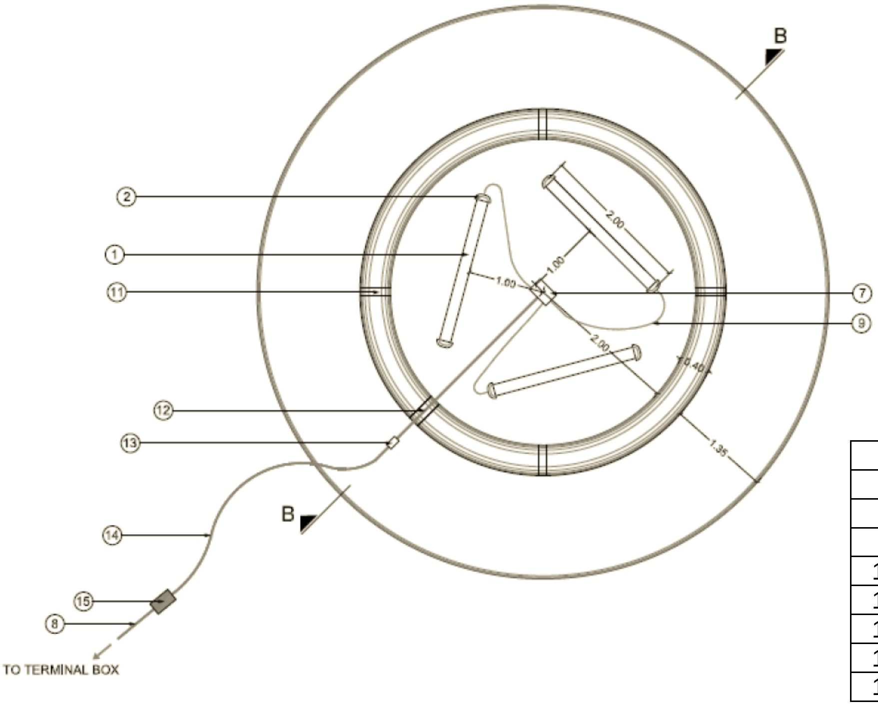


Figure 1-2. Schematic of the Electrode System Proposed for the Sylmar Ground Return System Undersea Electrode (Taken from Burns and McDonnell, 2012a)

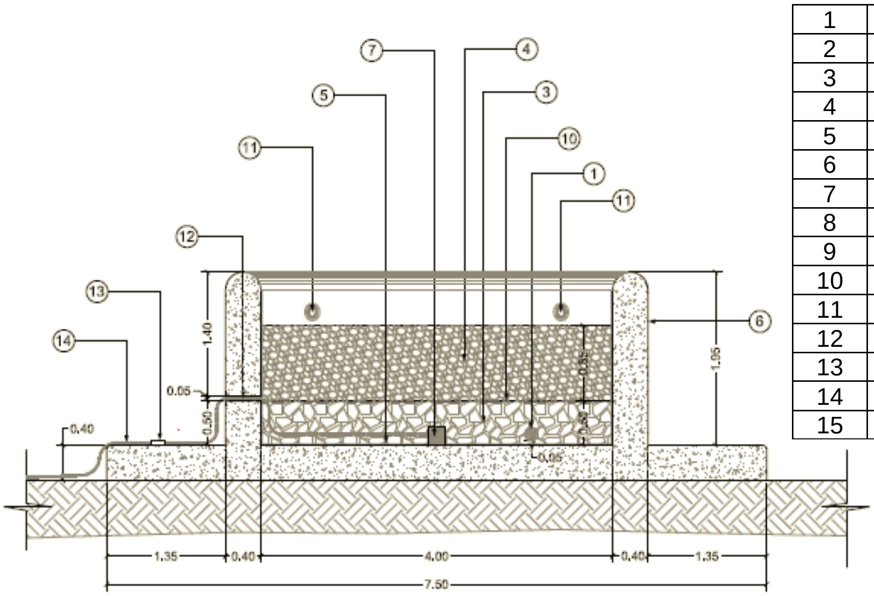
Each box has an internal cylindrical cavity with a diameter of 13 ft. Each cavity will contain three 5-ft long graphite bars with a diameter of approximately 6 inches tangentially disposed to form an “unclosed triangle” (Figure 1-3). The midpoint of each bar will be located approximately 3 ft from the center of the box. The bars will be laid on a 2-inch thick layer of metallurgical coke within the box (which is lined with high density polyethylene (HDPE)) as shown in Figure 1-4 (taken from Burns and McDonnell, 2012b). The graphite bars will be connected to copper cables sealed in flexible plastic conduits. Each of the three cables will be wired to a single sub-electrode pigtail, which will exit the box and be connected to the rest of the array as shown in Figure 1-2.

After the graphite bars have been wired inside each box, they will be covered with a 1.5 ft thick layer of metallurgical coke followed by a final top layer of gravel (approximately 3 ft thick) (Burns and McDonnell, 2012b). If, for any reason, it is necessary to prevent the diffusion of coke particles inside the gravel or to prevent coke contamination coming through the gravel, a sheet of porous/woven polyester fabric or other suitable material can be optionally inserted on the top of the coke, before the final covering with gravel.



1	Graphite bar
2	Waterproof cap
7	Resin-casted junction box
8	Sub-electrode cable
11	Lifting hole
12	Cable inlet HDPE pipe
13	Cable clamp
14	Sub-electrode pig tail
15	"Plug-in" connector

Figure 1-3. Plan View Schematic of Cylindrical Concrete Box Used to House Electrode Terminus (88 Boxes will be used in the Final Electrode Array) (Taken from Burns and McDonnell, 2012b)

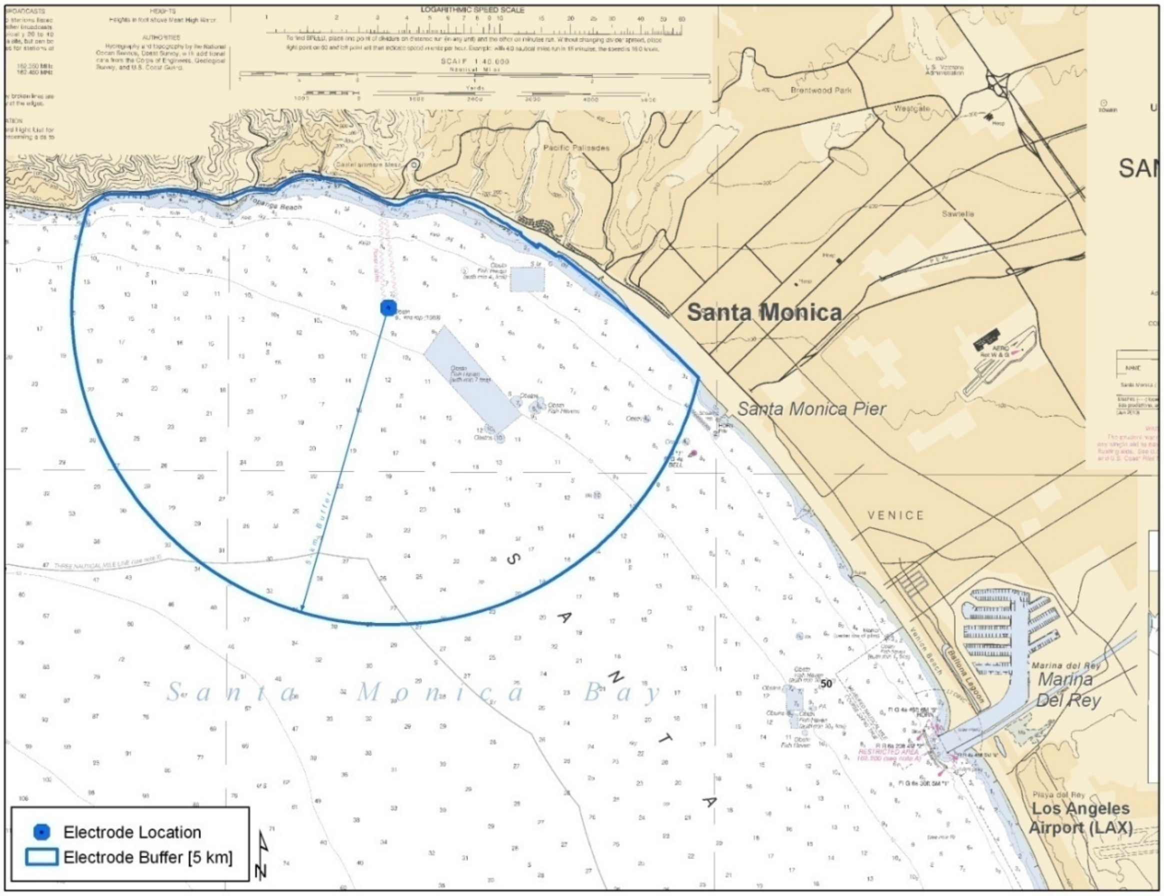


1	Graphite bar
2	Waterproof cap
3	Coke
4	Gravel
5	HDPE liner
6	Epoxy paint
7	Resin-casted junction box
8	Sub-electrode cable
9	Graphite bar cable
10	Porous woven sheet
11	Lifting hole
12	Cable inlet HDPE pipe
13	Cable clamp
14	Sub-electrode pig tail
15	"Plug-in" connector

Figure 1-4. Cross Section Schematic of Cylindrical Concrete Box Used to House Electrode Terminus (Taken from Burns and McDonnell, 2012b)

1.2 Study Area

The study area for the existing marine portion of the electrode system encompasses a 3-mile (5 kilometer) radius extending offshore from the existing electrode array (Figure 1-5). The study area comprises the marine environment located offshore of the cities of Los Angeles and Malibu, California in Santa Monica Bay within the Southern California Bight (Bight). It is located within the U.S. Geological Survey (USGS) 7.5-Minute Series Topanga, California Quadrangle.



Source: http://www.charts.noaa.gov

Figure 1-5. Study Area in Santa Monica Bay

Santa Monica Bay is a large, open-water embayment of the Pacific Ocean that is bordered on the north by rocky headlands at Point Dume and is bordered on the south by the headlands on the Palos Verdes Peninsula. Santa Monica Bay extends seaward a distance of approximately 11 miles from the Santa Monica shoreline. Water depths within the Bay range from approximately 0 to 300 ft along the nearshore continental shelf that extends from the shoreline to an offshore distance of approximately 4 miles. As the continental shelf ends and becomes the continental slope and eventually the Santa Monica Basin, water depths within the Bay increase to over 2,500 ft.

Nearshore habitats within the study area range from sandy beach and rocky intertidal areas along the shoreline to soft bottom habitat interspersed with seagrass beds and small rocky reefs in the nearshore subtidal zone. Further offshore, soft bottom and open ocean habitats predominate, with only a small percentage of rocky reef. Kelp forest habitat within Santa Monica Bay is primarily located in the shallow subtidal zone around Malibu and Palos Verdes. Based on a review of kelp maps, large kelp beds are not indicated in the study area, although small kelp stands are likely to be present. Small kelp stands or individual plants attach to hard substrates such as reefs or debris that are located up to 60 feet in depth. The pelagic habitat, which is the largest habitat within the Bay, is a highly productive offshore region of open ocean that supports nearly all of the Bay's marine life. The vast majority of the phytoplankton, which is the basis for the Bay's marine food web, is primarily grown in the pelagic habitat.

1.3 Literature and Existing Data Review Approach

The objective of this literature and existing data review is to characterize baseline conditions of marine resources within a 3-mile (5-kilometer) radius of the existing electrode in Santa Monica Bay. The review describes historical oceanographic conditions, water and sediment quality, marine organisms and habitats, and human activities and infrastructure that have the potential to be affected by the construction, operation, and maintenance of the undersea electrode system.

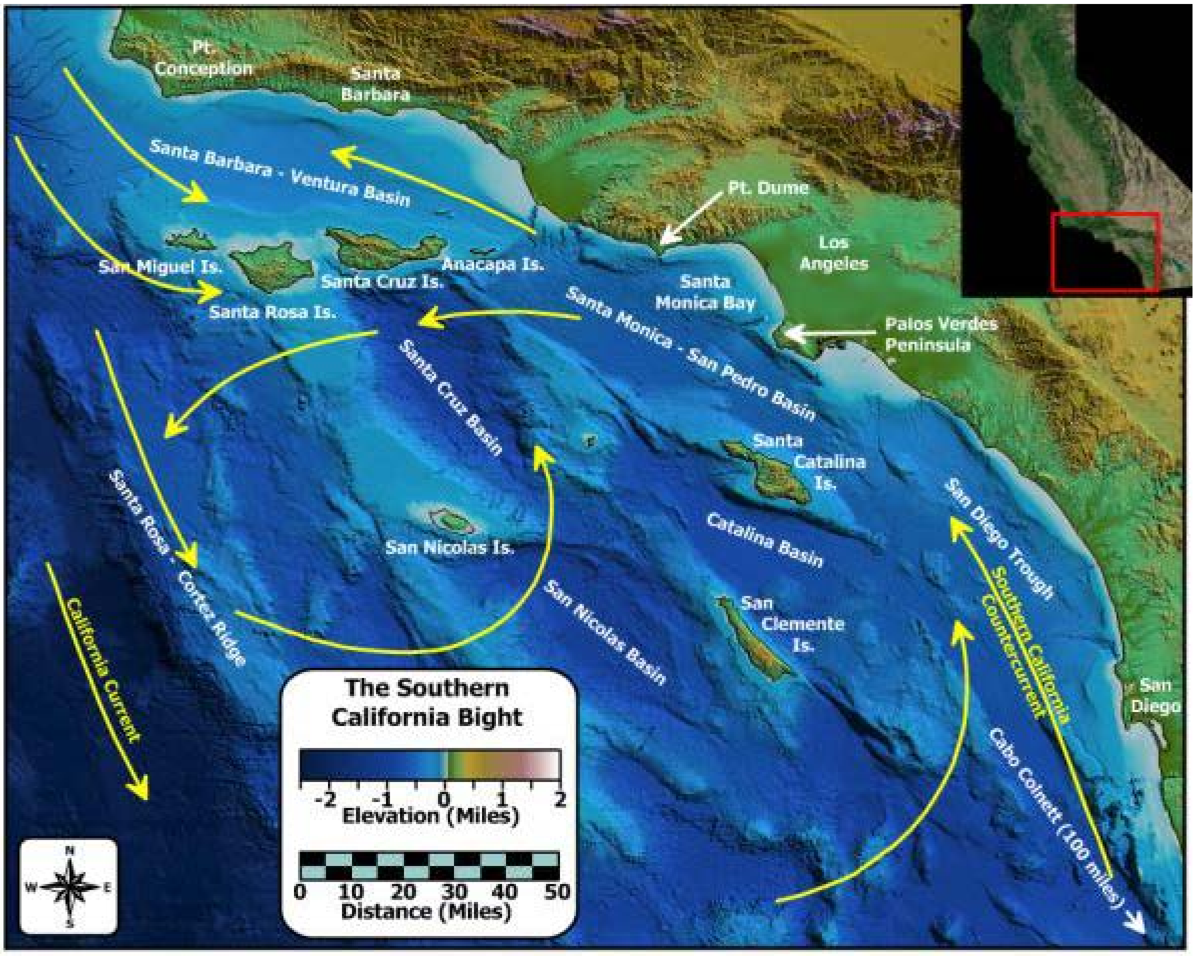
The results of the literature and existing data review will be combined with the findings of field studies to accomplish the following specific objectives:

- Determine potential impacts on humans, marine life, plants, and surroundings from electric and magnetic fields generated by the new electrode array and submarine cables and propose recommendations to mitigate such impacts;
- Analyze the potential short-term effects on marine biota in the vicinity of the electrode array and submarine cables from construction of the new or upgraded electrode array and submarine cables; and
- Address possible chemical effects on nearby surroundings and marine organisms due to electrochemical reactions that occur on the surface of the electrodes, such as chlorine production and other electrolysis products formed at the electrode elements.

A review of natural resource databases, National Marine Fisheries Service (NMFS) lists of threatened and endangered species, EIRs in the Project vicinity, local resource management plans, scientific articles, and regional monitoring reports for the Bight were used to determine the locations and types of natural resources that have the potential to exist in the vicinity of the proposed Project. Additionally, the review highlights the regulatory agencies, policies, and laws that must be engaged and adhered to in order to protect environmental resources.

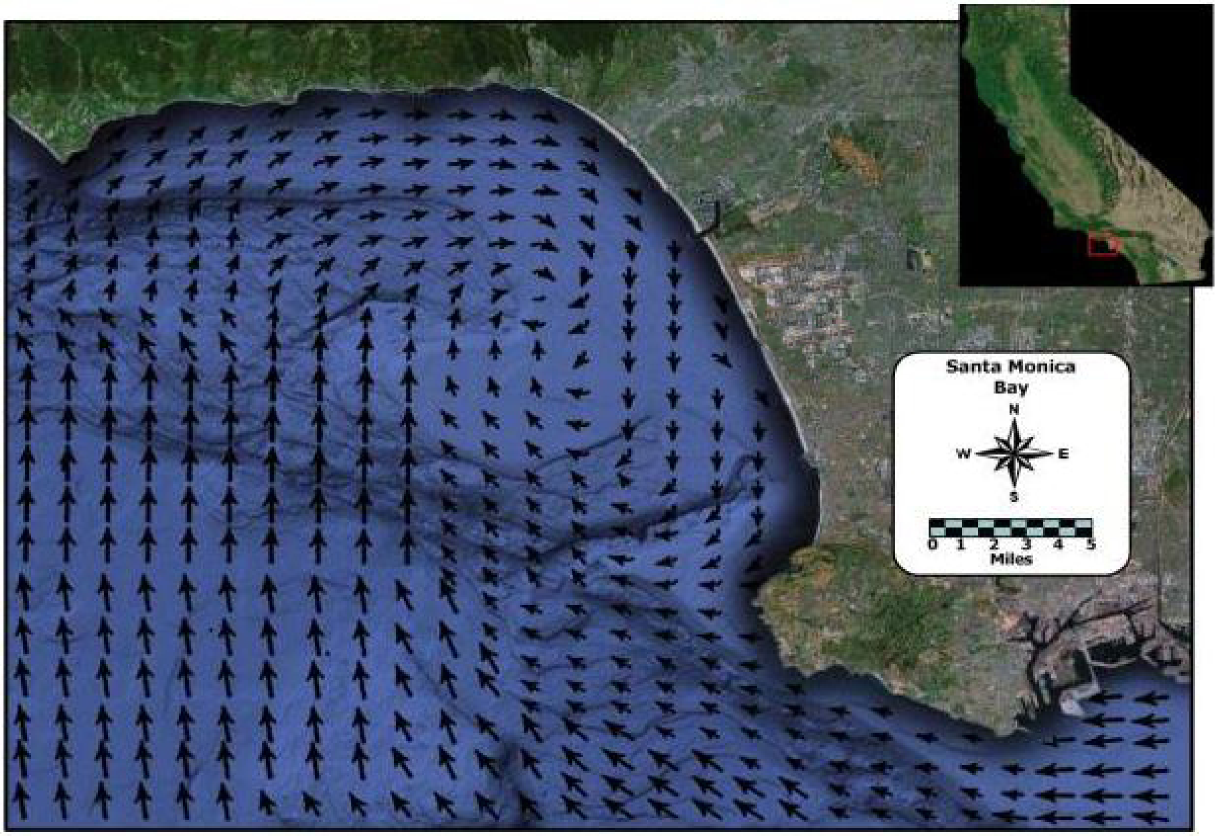
2.0 OCEANOGRAPHY

The large-scale oceanic flow within the Southern California Bight is dominated by the California Current System, which includes the southward-flowing California Current and the northward-flowing Southern California Countercurrent, as shown in Figure 2-1 (Hickey, 1979; 1992; 1998). The California Current is the dominant oceanic current along the Pacific Coast, which is characterized by seasonably stable low salinities, low temperatures, and high nutrient concentrations. The Southern California Countercurrent is the predominant current that affects Santa Monica Bay, transporting warmer, saltier, subtropical water northward along the coast. For most of the year, strong currents flow mainly toward the northwest, and occasionally the northward-flowing coastal current forms a diffuse clockwise-rotating eddy within the Bay (Figure 2-2).



Source: California State Lands Commission (CSLC), 2010

Figure 2-1. Oceanic Currents in the Southern California Bight Region

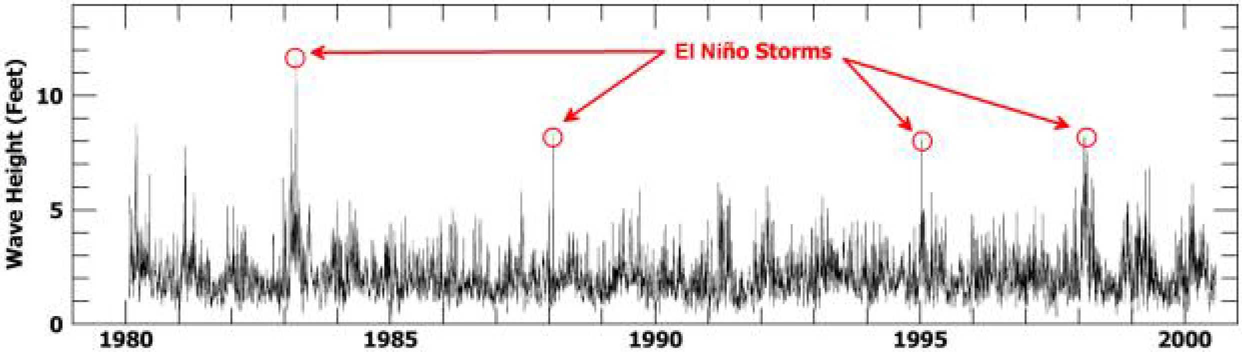


Source: CSLC, 2010

Figure 2-2. Dominant Northwest Flowing Santa Monica Bay Currents

Seasonal surface-circulation patterns within the Bight and Santa Monica Bay respond to a combination of large-scale changes in coastal surface winds (Di Lorenzo, 2003) and fluctuations in the large-scale, long-shore oceanic pressure gradient (Hickey et al., 2003). Thus, currents can flow in a uniform direction throughout the Bay, or they can flow in a clockwise or counterclockwise gyre within the Bay. The mean circulation pattern within the Bay during spring and summer can form a double gyre, with a southeastward nearshore flow along the coastline in the lower half of the Bay and a northwestward coastal flow in the northern reaches (California State Lands Commission [CSLC], 2010). Additionally, upwelling events that usually occur between March and June affect circulation within the Bay, causing surface water to be replaced by deep, cool, nutrient rich seawater. The nutrients brought to the surface during upwelling drive primary production, including planktonic blooms, which support the productive fishery along the southern California coast (CSLC, 2010).

Wave patterns in the Santa Monica Bay are a mixture of remotely generated ocean swell and local winds. Two meteorological sources generate significant swell energy offshore California─winter storms that impinge on the California coastline from the northwest and storm swells generated from the south during summer months. The interactions that steer and focus deep-water swell are sensitive to the direction of the arriving swell. Swells arriving from slightly different directions can result in significantly enhanced wave heights entering Santa Monica Bay. Additionally, nearshore bathymetry can locally amplify swell height as the waves approach the Bay’s coastline (CSLC, 2010). Due to the position within the Bight, Santa Monica Bay is comparatively sheltered from swells. Figure 2-3 depicts record wave heights during El Niño storm events.



Source: Jenkins and Wasyl, 2005. Note: Swell generated by the El Niño storm on January 13, 1993, with 7.4-foot (2.3-m), 15-second waves entering Santa Monica Bay from 265°.

Figure 2-3. Wave Height during El Niño Events

Winds within Santa Monica Bay are usually light and exhibit a diurnal variation throughout most of the year (Morris, 2006). Meteorological data recorded from the Santa Monica Pier from August, 2004 through October, 2011 showed an average wind speed of two miles per hour (mph). In addition, the average water temperature recorded was 57.3 °F (14.1 °C) and the average precipitation was approximately 10 inches per year (Weather Underground, 2011).

To further summarize the localized Santa Monica Bay ocean conditions, data collected from Scripps Institute of Oceanography Buoy # 46221, located in the center of Santa Monica Bay (Figure 2-4), were analyzed from 2004 through 2010. A summary of these data is presented in Table 2-1 to Table 2-4 below. Mean monthly water temperature during this time period ranged from 14.23 ºC in March to 19.55 ºC in August (Table 2-1). Wave directions were predominantly from the southwest, ranging from a monthly mean of 211 degrees in July to 256 degrees in February (Table 2-2). Average monthly wave heights were greatest during the winter months of January and February (1.2 meters), while the monthly average wave height was lowest in August (0.82 meters) (Table 2-3). The average monthly wave period ranged from 6.1 seconds in May to 7.5 seconds in January (Table 2-4).

Figure 2-4. Locations of Scripps Ocean Buoy 46221 and Santa Monica Weather Station

Table 2-1. Mean Water Temperature in Santa Monica Bay

Mean Water Temperature (^{o}C)								Mean Water Temperature (^{o}C) 2004-2010
Month	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	
January	NC	15.42	14.31	14.72	13.63	14.29	15.15	14.59
February		15.45	14.59	14.77	13.63	14.20	15.28	14.65
March		16.03	13.05	14.01	13.76	13.92	14.64	14.23
April		14.21	14.80	14.11	13.92	14.30	14.53	14.31
May		15.97	16.57	14.88	16.14	16.78	14.70	15.84
June		16.66	18.58	17.87	18.40	17.76	17.56	17.81
July		18.86	21.08	19.95	19.48	19.27	17.20	19.31
August		19.59	20.84	20.19	20.75	19.29	16.66	19.55
September	21.02	17.25	19.39	20.21	19.72	21.03	17.13	19.39
October	18.61	17.81	18.46	16.42	18.37	19.32	18.32	18.19
November	17.19	17.24	17.90	16.73	17.16	17.06	16.41	17.10
December	15.68	15.33	15.81	14.52	15.49	15.36	14.26	15.21

NC = Not Collected
Source: Santa Monica Bay Buoy #46221 (2004 – 2010) (NOAA National Buoy Data Center at NOAA.gov)

Table 2-2. Mean Wave Direction in Santa Monica Bay

Month	Mean Monthly Wave Direction by Year (Degrees)							Mean Wave Direction (Degrees) (2008-2010)
	2004	2005	2006	2007	2008	2009	2010	
January	NC				247.05	251.09	257.17	251.77
February					257.52	250.89	260.03	256.15
March					236.33	236.46	248.50	240.43
April					232.19	233.59	237.03	234.27
May					229.46	230.81	229.60	229.96
June					224.40	206.55	228.44	219.80
July					213.25	207.01	211.46	210.57
August					208.22	211.91	209.60	209.91
September					213.62	230.84	225.46	223.30
October					216.17	231.47	222.80	223.48
November					242.36	252.76	250.81	248.64
December					251.07	258.80	244.00	251.29

NC = Not Collected
Source: Santa Monica Bay Buoy #46221 (2004 – 2010) (NOAA National Buoy Data Center at NOAA.gov)

Table 2-3. Mean Wave Height in Santa Monica Bay

Month/Year	Mean Monthly Wave Height by Year (m)							Mean Wave Height (m) 2004-2010
	2004	2005	2006	2007	2008	2009	2010	
January	NC	1.21	1.31	1.03	1.23	0.85	1.58	1.20
February		1.07	1.04	1.31	1.24	1.14	1.41	1.20
March		1.27	1.23	0.99	1.23	0.96	1.27	1.16
April		1.16	1.01	1.23	1.06	1.10	1.35	1.15
May		1.00	1.00	0.88	1.05	0.95	1.20	1.01
June		1.02	1.02	0.88	1.05	0.87	1.03	0.98
July		0.86	0.93	0.92	0.91	0.93	0.90	0.91
August		0.69	0.88	0.82	0.81	0.85	0.89	0.82
September	0.97	0.88	0.96	0.94	0.94	0.89	0.85	0.92
October	0.91	0.87	0.87	0.93	0.94	1.02	0.93	0.92
November	0.86	0.87	1.02	0.82	1.03	0.99	1.01	0.94
December	1.07	1.26	1.16	1.23	1.02	1.23	1.15	1.16

NC = Not Collected
Source: Santa Monica Bay Buoy #46221 (2004 – 2010) (NOAA National Buoy Data Center at NOAA.gov)

Table 2-4. Mean Wave Period in Santa Monica Bay

Month	Mean Monthly Wave Period by Year (sec)							Mean Wave Period (sec) 2008-2010
	2004	2005	2006	2007	2008	2009	2010	Total Average
January	NC				5.86	7.57	9.06	7.50
February					7.21	6.87	7.97	7.35
March					6.89	6.68	7.54	7.04
April					6.13	6.60	7.24	6.66
May					5.97	5.96	6.48	6.14
June					6.93	6.53	6.86	6.77
July					6.73	6.32	7.39	6.81
August					6.33	6.19	6.58	6.37
September					6.30	6.38	6.68	6.45
October					7.06	6.45	7.85	7.12
November					7.21	6.89	6.92	7.01
December					6.40	7.95	6.71	7.02

NC = Not Collected
Source: Santa Monica Bay Buoy #46221 (2004 – 2010) (NOAA National Buoy Data Center at NOAA.gov)

3.0 WATER & SEDIMENT QUALITY

Water and sediment quality within Santa Monica Bay has been studied extensively in recent years, particularly near the Hyperion Wastewater Treatment Plant’s 5- mile outfall pipe and as part of the Southern California Bight Regional Monitoring Program. Research suggests that there are multiple pollutants of immediate concern in Santa Monica Bay, including metals, organics, and bacterial contaminants (Santa Monica Bay Restoration Commission [SMBRC], 2010). Sources and pathways of contaminants include industrial discharges, urban runoff into creeks and storm drains, municipal wastewater treatment plants (WWTPs), boating and shipping activities, dredging, and advection of pollutants from other areas (Martin et al., 1996). Approximately 645 million gallons of treated wastewater are discharged to Santa Monica Bay each day via seven major point-source facilities and more than 160 permitted smaller commercial and industrial facilities (SMBRC, 2010). As a result of the nearly 30 billion gallons of wastewater effluent that flows into Santa Monica Bay on a yearly basis, impacts to sediment quality are more apparent than those to water quality. SMBRC (2010) rated the water quality “good” overall in Santa Monica Bay, sediment quality was given a rating of “poor” at 59% of sites for sediment contaminants, and at 21% of sites for sediment toxicity.

3.1 Background & Pollutant Sources

Santa Monica Bay is located adjacent to a highly urbanized area, with approximately 12 million people residing along the coastal corridor. Approximately 400 square miles of varied landscape drains into the Bay, including the highly urbanized and channelized Ballona Creek Watershed, and the less developed, Malibu Creek Watershed. The State Water Resources Control Board (SWRCB) has listed Santa Monica Bay as an impaired waterbody under Section 303(d) of the Clean Water Act (CWA).

Historically, the pollutant pathway of most concern for Santa Monica Bay was point source discharges from industrial outfalls and large wastewater treatment facilities, including the Hyperion WWTP and the Joint Water Pollution Control Plant (JWPCP). Over the past few decades pollutants discharged from these treatment facilities have been greatly reduced as secondary treatment has been implemented. Currently, non-point sources constitute a larger source of contaminants to Santa Monica Bay than point sources (Schiff et al., 2000).

Table 3-1 lists the major point source dischargers to the Bay. As of 2007, 193 facilities operated under National Pollutant Discharge Elimination System (NPDES) permits in the area surrounding the Bay, with the majority of them discharging to Ballona Creek (Los Angeles Regional Water Quality Control Board [LARWQCB], 2007a). Less than two percent of contaminants discharged to Santa Monica Bay are from minor point source discharges (LARWQCB, 2007b).

Currently, the primary pathway for pollutants entering the Bay is through non-point discharge from storm drains throughout the surrounding watersheds (Dojiri et al., 2003). The primary pollutants of concern for Santa Monica Bay are nutrients, bacteria, trash and metals, along with historical pesticides. The LARWQCB has implemented nine total maximum daily loads (TMDLs) to address the pollutant issues in the Bay (Table 3-2). These TMDLS are mainly being implemented through incorporation of controls into existing NPDES permits. Over the next five years, at least seven more TMDLs are expected to be in development (SMBRC, 2010).

Table 3-1. Mass Emissions from Major Point Sources through Discharges to Santa Monica

Analyte	Wastewater Plants		Electrical Power Stations			Chevron Refinery
	Hyperion WWTP	Joint WPCP	Redondo	El Segundo	Scattergood	
Flow (MGD)	315	322	661	412	254	6.7
Biological Oxygen Demand (5-day)	8,300	2,800	—	—	—	—
Total Suspended Solids	8,900	6,900	—	—	—	ND
Residual Chlorine	—	—	67	48	—	—
Ammonia Nitrogen	16,000	14,000	ND	ND	—	21
Oil and grease	200	ND	—	—	—	ND
Organic Nitrogen	1,686	2,541	—	—	—	—
Nitrate Nitrogen	9.6	2.9	93	ND	—	—
Total Phosphorus	1,282	352	—	—	—	—
Phenol	—	2.6	—	—	—	ND
Zinc	9.7	2.1	—	14	5.6	ND
Copper	9.2	2.7	ND	1.2	ND	0.019
Nickel	3.7	8.5	ND	ND	ND	0.013
Lead	1.8	ND	ND	ND	ND	ND
Chromium	0.65	ND	ND	3	—	ND
Cyanide	0.7	1.8	—	—	—	ND
Silver	0.62	ND	ND	ND	ND	ND
Arsenic	1.2	0.61	ND	ND	ND	0.217
Cadmium	0.08	ND	ND	ND	1.2	ND
Selenium	0.46	3.1	ND	ND	ND	0.93
Mercury	0.003	ND	ND	ND	ND	ND
Total DDT	0.13	ND	—	—	—	ND
PCB	ND	ND	—	—	—	ND
PAH	0.023	0.0089	—	—	—	ND

Constituents reported in Metric Tons

— Not reported, BOD = Biochemical Oxygen Demand, O&G = Oil and Grease
MGD = Million Gallons per Day
ND = Below detectable limits or no detectable difference between inlet and outlet samples
Sources: Steinberger and Schiff, 2003; Steinberger and Stein, 2004; Lyon et al., 2006

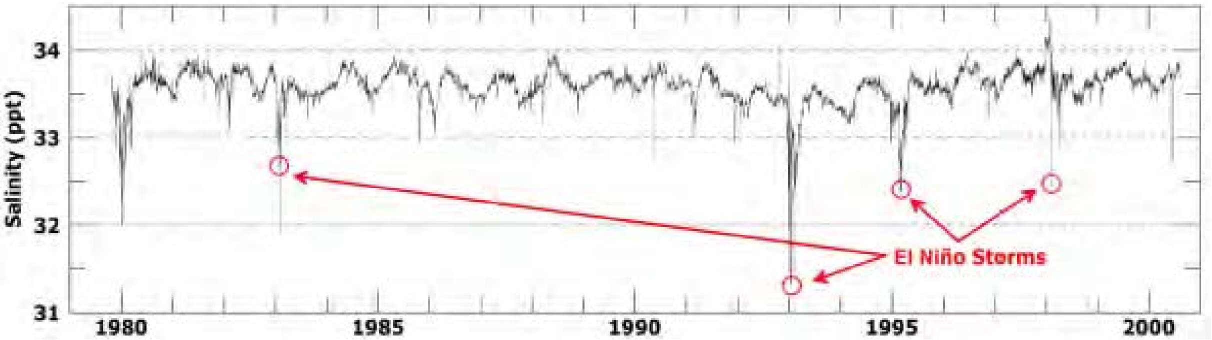
Table 3-2. Total Maximum Daily Loads for Santa Monica Bay Watershed

Pollutant	Water Body	Date of TMDL Adoption
Bacteria	Santa Monica Bay dry weather	2003
	Santa Monica Bay wet weather	2003
	Marina del Rey Harbor, Mother's Beach, and Back Basin	2004
	Malibu Creek	2006
	Ballona Creek, Estuary, Sepulveda Channel	2007
Metals and Toxics	Ballona Creek, Ballona Creek Estuary	2006
	Marina del Rey	2006
	Malibu Creek	Planned
	Malibu Creek	Planned
Nutrients	Malibu Creek	Planned
Historical Pesticides, Chlordane	Santa Monica Bay	Planned
Habitat Alteration, Hydromodification, Exotic Vegetation	Ballona Wetlands	Planned
Benthic Community Effects	Malibu Lagoon	Planned
Marine Debris	Santa Monica Bay	Planned
Trash	Ballona Creek and Wetland	2002
	Malibu Creek	2008

Source: Santa Monica Bay Restoration Commission, 2010.

3.1.1 Water Quality

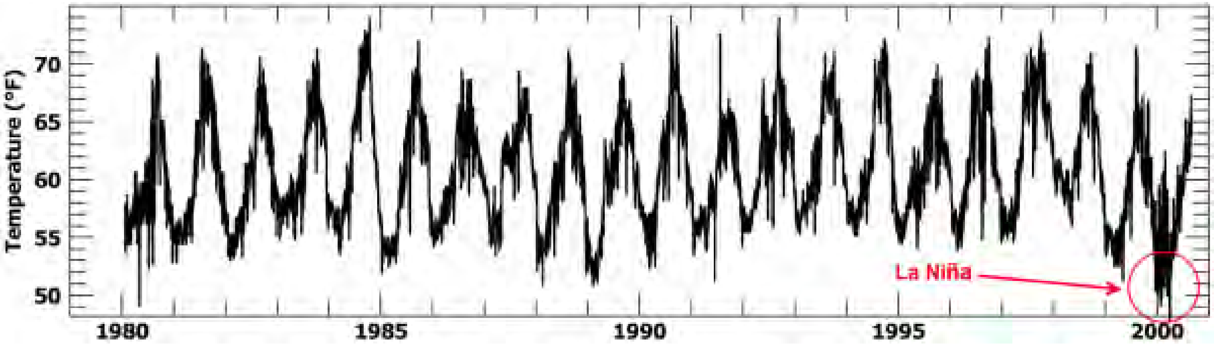
Marine water quality is evaluated using both chemical and physical properties. Various monitoring programs across the Bight and inside Santa Monica Bay monitor and measure salinity, temperature, hydrogen-ion concentration (pH), turbidity, dissolved oxygen (DO), trace-metals, and bacteria concentrations. Within Santa Monica Bay, spatial and temporal variations of physicochemical properties occur from interactions of topography, vertical mixing, biological processes, and freshwater influx (Nezlin et al., 2004; CSLC, 2010). Across most of the Bay, the annual mean salinity is close to 33.40 practical salinity units (psu), while offshore areas adjacent to mouths of creeks, such as Ballona and Malibu creeks, often have sustained lower salinities. Data collected near the Chevron Marine Terminal show seasonal variation in salinity due to the large influx of winter storm runoff (Figure 3-1). Larger fluctuations are also seen based upon weather patterns such as the El Niño (CSLC, 2010).



Source: Jenkins and Wasyl, 2005

Figure 3-1. Daily Mean Seawater Salinity near the Chevron Marine Terminal in Santa Monica Bay

Across the Bight, typical surface water temperatures range from 52-73 ºF (11-23 ºC). Figure 3-2 illustrates the seasonal pattern of temperatures with data collected near the Chevron Marine Terminal (CSLC, 2010). Major weather patterns also impact the mean temperatures, as is illustrated by the La Niña event in 1999-2000.



Source: Jenkins and Wasyl, 2005

Figure 3-2. Daily Mean Sea Surface Temperature near the Chevron Marine Terminal in Santa Monica Bay

Bacterial decomposition of organic pollutants can deplete DO levels below the necessary level needed to maintain a healthy marine environment. The California Ocean Plan prohibits discharge of pollutants that will decrease DO concentrations more than 10% from the natural state (SWRCB, 2005a).

The pH of water in the Bay is slightly alkaline, ranging from 7.5-8.5. This is consistent with pH measurements in the world's oceans. Within the Bay, the highest pH levels occur during spring upwelling when photosynthesis increases, thus releasing higher levels of oxygen near the surface. (CSLC, 2010) Certain types of caustic or acidic pollutants can alter the pH of seawater. These effects are temporary and are moderated quickly by the well buffered ocean. pH altering pollutants are restricted by the California Ocean Plan and may not alter the pH of the receiving water by more than 0.2 pH units from naturally occurring levels.

Water clarity, light transmissivity, turbidity, and total suspended solids (TSS) concentrations are all measures that indicate how well light penetrates seawater. High turbidity can limit the ability of ambient light to penetrate into the upper levels of the water column, thus limiting the depth of the euphotic zone. Decreased light penetration can impact kelp and phytoplankton growth by lowering the rate of photosynthesis and decreasing the primary productivity of the impacted area (Gowen, 1978). Factors that can increase turbidity include ocean outfall wastewater discharges, storm water runoff, and sediment resuspension through construction or dredging activities.

The annual average light transmissivity in Santa Monica Bay indicates a relatively high level of water clarity. Surface waters in the middle of the Bay transmit 85% of ambient light (CSLC, 2010). Nearshore light transmittance, however, is generally lower near creek discharges (e.g., 66% of ambient light is transmitted at the mouth of Ballona Creek) and in other areas where sediment resuspension occurs as a result of wave action (Southern California Coastal Water Research Project [SCCWRP], 2004). Additionally, variability in light transmissivity occurs in nearshore waters as a result of the intermittent nature and variability of wave action (Nezlin et al., 2004).

3.1.2 Sediment Quality

Seafloor sediments are a frequent area of interest when conducting marine environmental quality assessments. Many pollutants accumulate within sediments and/or bind to particles that settle to the ocean floor. Some contaminants degrade over time with exposure to microorganisms, ultraviolet radiation, and/or geochemical processes; however, many pollutants do not naturally degrade and may exhibit persistent toxicity to the marine environment. Biological organisms can interact with the contaminated sediments (foraging, burrowing, etc.) and accumulate as well as transport these contaminants into the food chain and the greater environment.

For three and a half decades the Montrose Chemical Company manufactured the pesticide dichlorodiphenyltrichloroethane (DDT) at its plant near Torrance, CA and released 640 pounds of DDT compounds each day to the Los Angeles County sewer system that was discharged through the Joint WPCP ocean outfall at Whites Point onto the Palos Verdes Shelf and into the San Pedro Channel (MBC, 2008). Prevailing currents distributed the discharged DDT throughout the Bay and the Bight. While the most heavily DDT-contaminated area in the Southern California Bight is the Palos Verdes Shelf, in 2003 regional monitoring found measurable concentrations of DDT in 71% of samples collected in the SCB (Schiff et al., 2006). It is estimated that over 90% of surface sediment in the Bay is contaminated, often at levels considered high enough for potential concern (Schiff, 2000).

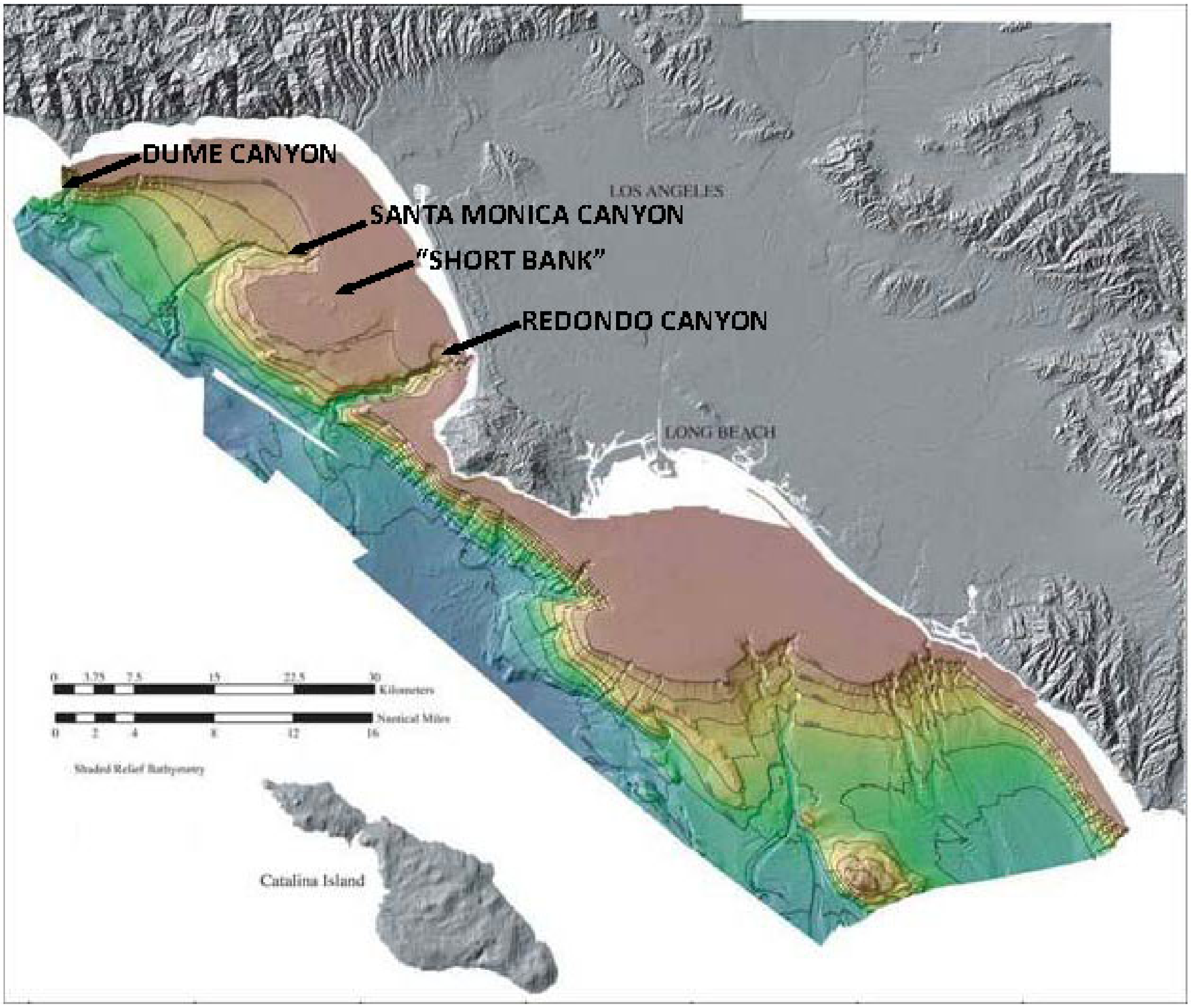
In 1998, studies showed elevated DDT, polychlorinated biphenyl (PCB), and chlordane levels near the Hyperion Plant five mile outfall (LARWCB and USEPA, 2005). These studies also revealed that DDT and PCB contaminated sediments are a major source of fish tissue contamination, particular amongst bottom-dwelling species. This contamination continues to be of concern as organic chemicals such as DDT and PCBs are released through resuspension and biological processes, impacting marine life. Although these contaminants may have been initially deposited near the original outfall location, they are prone to resuspension by waves, currents or other disturbance and can be transported far from the original location (Noble and Xu, 2003).

In January of 2006 the TMDL for metals and organics in sediments in Ballona Creek and adjacent estuary became effective. Elevated levels of organic pollutants and metals were found to be present in seafloor sediments offshore from Ballona Creek (Schiff and Bay, 2003). The TMDL established targets for cadmium, copper, lead, zinc, silver, total PAHs, Total PCBs, chlordane, and total DDT. Primary sources of contaminants in these sediments were found to be unrelated to the Hyperion WWTP but rather due to dry weather and stormwater runoff, NPDES permitted discharges, and atmospheric deposition.

Construction activities associated with the extension of the Sylmar Ground Return System will result in disturbance to the sea floor, which is likely to result in an increase in suspension of fine grain particles in the water column and an increase in turbidity. In addition to the impact on light transmittance, an increase in suspended particles may also have an adverse impact on fish and invertebrate habitat (Arruda et al., 1983), which could potentially result in sublethal and/or lethal impacts to some organisms (Newcombe and MacDonald, 1991; Newcombe and Jensen, 1996).

4.0 BIOLOGICAL RESOURCES

Santa Monica Bay contains a diversity of marine habitats and species. The offshore portion of the existing Sylmar Ground Return System is located in the nearshore waters of the central part of Santa Monica Bay between the metropolitan areas of Santa Monica and Malibu, California. Santa Monica Bay is a large, open-water embayment of the Pacific Ocean that is bordered on the north by rocky headlands at Point Dume and is bordered on the south by the headlands on the Palos Verdes Peninsula. Santa Monica Bay extends seaward a distance of approximately 11 miles from the Santa Monica shoreline. Water depths within the Bay range from approximately 0 to 300 ft along the nearshore continental shelf that extends from the shoreline to an offshore distance of approximately 4 miles. As the continental shelf ends and becomes the continental slope and eventually the Santa Monica Basin, water depths within the Bay increase to over 2,500 ft (Figure 4-1). As a result of the Bay's diverse bathymetry, abundant nutrients, and wide range of habitats, it is considered to be a highly productive biological environment used by both migratory and resident species of marine mammals, fish, birds, and invertebrates.



Source: http://www.charts.noaa.gov

Figure 4-1. Bathymetry of Santa Monica Bay

4.1 Marine Habitats

Seafloor habitat within Santa Monica Bay and within the study area is primarily comprised of mixtures of silt, sand, and clay, or “soft” sediment that slopes gradually away from the surrounding beaches. Soft-bottom habitat in nearshore areas typically consists of a high percentage of coarse-grained sediment such as sand, while soft-bottom habitat further offshore typically consists of fine-grained sediment (silts and clays). As previously stated, exposed rocky and sandstone reefs occur throughout the Bay in nearshore areas around Malibu, Point Dume, and the Palos Verdes Peninsula. It is in these areas that the majority of the kelp forest in the Bay is found (Figure 4-2).

Figure 4-2. Locations of Kelp Beds Occurring within Santa Monica Bay

A gently sloping continental shelf extends to the shelf break at a water depth of approximately 265 ft. In general, the shelf in Santa Monica Bay is very flat and narrow with shelf widths varying from 3 miles off the Malibu margin to 6 miles where the shelf grades into the northern side of the marginal plateau province. Shelf gradients generally are less than 0.5 degrees, although there are several localized zones of rock outcrops adjacent to Palos Verdes Peninsula that produce gradients of more than 85 degrees (Gardner et al., 2003). At the shelf break, the seafloor becomes steep along the slope before flattening out into the deep Santa Monica Basin at a depth of approximately 2,600 ft of water. Santa Monica Bay contains three submarine canyons: Dume Canyon near Malibu, Santa Monica Canyon bisecting the center of the bay, and Redondo Canyon near the Palos Verdes Peninsula (Figure 4-1). A shallow shelf, known as "Short Bank," exists between the Santa Monica and Redondo Canyons along the 50-m bathymetric contour and is characterized by patchy areas of exposed rock, gravel, and mixed sediments (Terry et al., 1956).

4.1.1 Subtidal Hard-Bottom Habitat

Natural hard substrate in Santa Monica Bay occurs primarily along the Bay's periphery near the headlands of Point Dume and Palos Verdes, along the edges of the three submarine canyons, and on the rocky plateau known as the Short Bank that lies between the Santa Monica Canyon and the Redondo Canyon (Terry et al., 1956). Although no large subtidal reef areas are known to occur within the study area, shifting sediments and sand may periodically expose small patches of hard substrate or uncover marine debris.

Hard-bottom substrates provide surface area for attachment of a wide variety of plants and sessile organisms, as well as shelter and a place to forage for fish and invertebrates. Sessile species that utilize hard-bottom substrates include mussels, sponges, anemones, tunicates, barnacles, rock scallops, sea fans, and a variety of tube worms. These species primarily feed by filtering plankton from the water column. Invertebrates such as shrimp, crabs, sea stars, nudibranchs, octopuses, lobsters, abalone, and sea urchins forage along reefs and utilize crevices for protection against predators. Within the intertidal zone, both sessile and mobile invertebrates such as crabs and mussels are an important food source for foraging birds. In deeper water, nearshore reefs provide an anchoring point for a variety of marine algal species, such as giant kelp, bull kelp, feather boa kelp, coralline algae, oar weed, and sea palms. Larger algal species, such as the kelps and sea palms, provide a key vertical over-story component to the relatively low-relief hard-substrate habitat of Santa Monica Bay.

4.1.1.1 Kelp Beds

Kelp beds occur predominantly around rocky subtidal habitat off the northern and southern headlands of Santa Monica Bay. Giant kelp (*Macrocystis pyrifera*) plays a key role in the nearshore ecosystem by providing vertical structure within the water column that is utilized by fish, invertebrates, and marine mammals as a nursery and for food and shelter from predators. Giant kelp is an exceptionally large and fast growing brown alga that commonly grows to more than 100 ft in length and provides a three-dimensional over story to smaller algal species such as feather boa (*Egretia menziesii*) and sea palms (*Eisenia arborea*). Some of the fish species that are common to kelp forest habitat include halfmoon (*Medialuna californiensis*), sargo (*Anisotremus davidsonii*), senorita (*Oxyjulis californica*), sheephead (*Semicossyphus pulcher*), ocean sunfish (*Mola mola*), cabezon (*Scorpaenichthys marmoratus*), various rockfish (*Sebastes spp.*) blacksmith (*Chromus punctipinnus),* giant sea bass (*Sterolepis gigas*), leopard shark (*Triakis semifasciata*), horn shark (*Heterodontus franscisci*) and important sport fishing species such as kelp bass (*Paralabrax clathratus*), white sea bass (*Atractoscion nobilis*) and yellowtail (*Seriola lalandi*).

Harbor seals and sea otters use kelp forest to hunt fish and sea urchins, respectively. Sea otters, and to a lesser extent, sheephead and spiny lobsters (*Panulirus interruptus*), are considered important species for maintaining kelp habitat as they prey upon sea urchin populations and keep them from overgrazing the kelp forest (Tegner and Levin, 2008). Kelp that has broken free from its holdfast is also utilized by a host of organisms. Fisherman and marine birds often look for free floating kelp patties, which provide habitat for baitfish and larger fish, such as yellowtail and California barracuda (*Sphyraena argentea*). As pieces of kelp or whole plants break free during storms or during periods of heavy wave action the kelp and any attached invertebrates are forage for fish and birds while at sea and by birds and insects on the wrack line of the beach.

Kelp forest is considered to be Essential Fish Habitat (EFH) by the federal government. Thus, any project that may adversely impact kelp forest requires consultation with the NMFS. Mitigation may be required if impacts to EFH are otherwise unavoidable (NMFS, 2011). The extent of kelp in Santa Monica Bay is considered to be stable around Palos Verdes; however, current canopy coverage remains low in comparison to historic coverage (MBC, 2008). Canopy coverage along the coastline of Malibu has increased somewhat in recent years, possibly as a result of restoration efforts (MBC, 2008).

4.1.1.2 Artificial Reefs

Over 33 artificial reefs have been constructed in the Southern California area since 1958. These reefs have been successful in attracting fish and invertebrate species. Subsequent attempts to replicate reef structures were implemented in an experimental fashion to determine the cost-effectiveness of materials and the success of different structural designs. Various materials were used to construct these reefs, ranging from automobiles, streetcars, scuttled ships, cement boxes and quarry rocks. Many of these older reefs were successful in attracting fish, but deteriorated over time due to the materials used. Reefs built in the last twenty years have used cement and quarry rock to create reef habitats for marine species with greater longevity than their predecessors.

Artificial reefs have been constructed in Santa Monica Bay since 1960 to provide additional hard-bottom habitat for marine species, since the Bay is characterized primarily by soft-bottom substrates (Santa Monica Bay Restoration Commission, 2010). Of the nine artificial reefs that still remain intact in the Bay, two of the reefs fall within the study area (Figure 4-3). The Santa Monica Artificial Reef (SMAR), Santa Monica Bay Artificial Reef (SMBAR), and Topanga Artificial Reef (TAR) were constructed near the location of the existing electrode array. Located within approximately 1.0 nautical mile of each other (Figure 4-3), each artificial reef varies in design, purpose, and construction materials. Built in 1961, SMAR is the oldest and smallest of the three reefs and is located approximately 60 feet below the surface. Both SMBAR and TAR were constructed in 1987, using only quarry rock. SMBAR consists of three separate modules located at the depths of 42, 57, and 72 ft and covers 3.58 acres. TAR is located approximately 28 ft below the surface and covers an area of approximately 2 acres. Table 4-1 provides additional descriptions and comparisons of SMAR, SBMAR, and TAR.

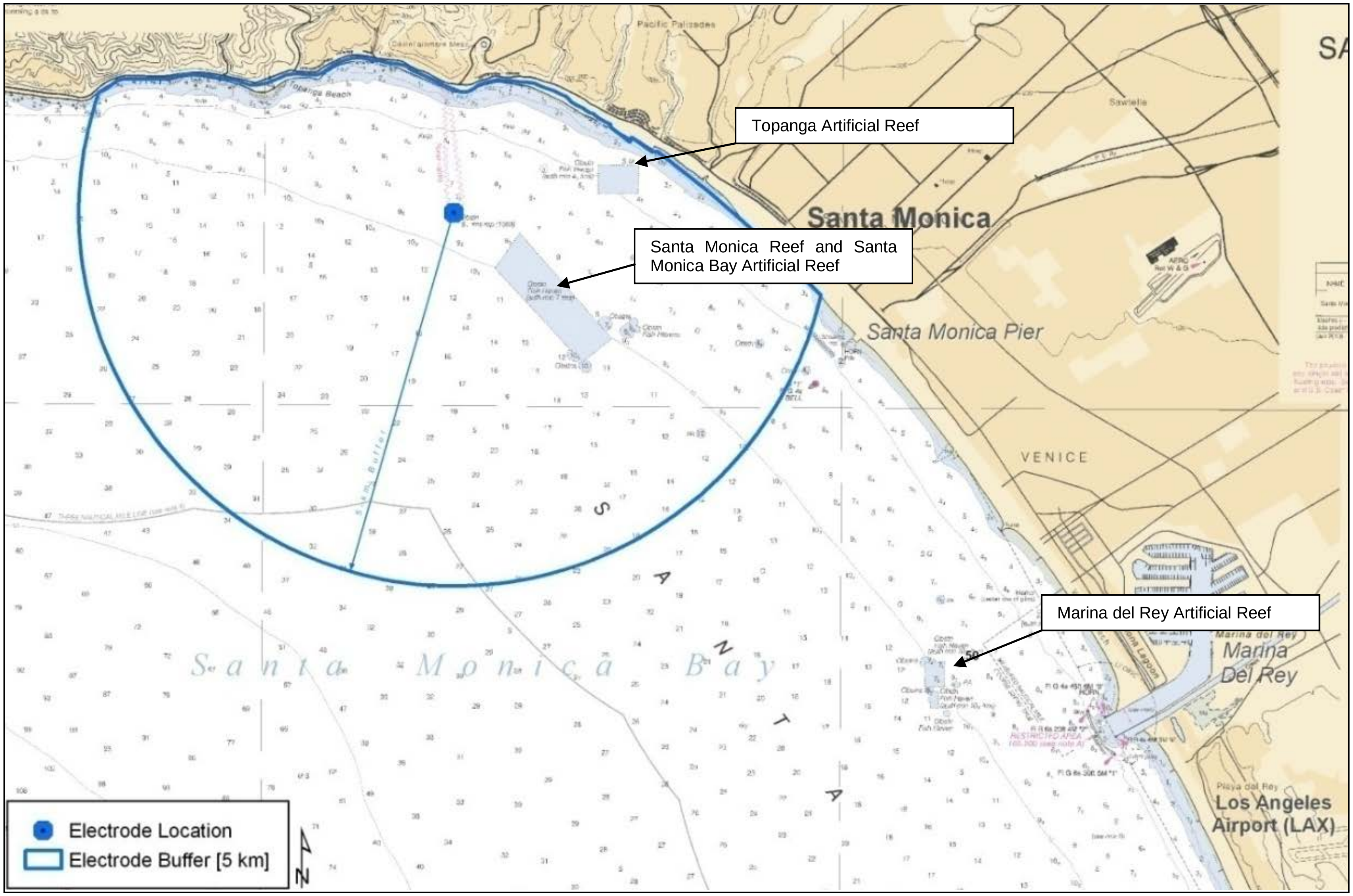


Figure 4-3. Artificial Reef Locations within the Study Area in Santa Monica Bay

Table 4-1. Description of Artificial Reefs within the Vicinity of the Study Area

Reef	Module	Depth (ft)	Height (ft)	Latitude (N)	Longitude (W)	Year Constructed	Area	Materials	Notes
Santa Monica Artificial Reef (SMAR)	SMAR	60	NA	34° 00' 34"	118° 31' 47"	1961	0.5	330 tons of quarry rock, 44 concrete shelters, 4 car bodies, 1 street car. 110 tons of pier pilings added in 1971	An original "replication reef." Automobiles and streetcar have disintegrated.
Santa Monica Bay Artificial Reef (SMBAR)	SMBAR 3	42	13	34° 01' 02"	118° 32' 09"	1987	3.58	20,000 tons of quarry rock	Designed to replicate environmental and structural variables in reefs.
	SMBAR 10	57	14	34° 00' 36"	118° 32' 02"				
	SMBAR 18	72	14	34° 00' 17"	118° 32' 13"				
Topanga Artificial Reef (TAR)	TAR	28	7	34° 01' 38"	118° 31' 54"	1987	2	10,000 tons of quarry rock	Designed to promote kelp habitat development.

4.1.2 Subtidal Soft-Bottom Habitat

Muddy substrates are the predominant habitat throughout Santa Monica Bay, from the 20-m isobath to the adjacent Santa Monica basin floor (780 m) based upon multi-beam sonar imagery (Edwards et al., 2003). Coarser-grained sandy substrates lie predominantly along the innermost mainland shelf and a narrow outer shelf band north of Santa Monica Canyon, while cobble and gravel substrates are predominantly restricted to the innermost shelf south of El Segundo and limited parts of the shelf edge.

4.1.2.1 Infauna

The soft-bottom habitat of Santa Monica Bay supports a diverse infaunal community (animals that live within the substrate). Summer and winter infaunal surveys conducted in the Bay in 2002 identified 28,184 individuals in 625 taxa during NPDES monitoring. The ten most common species inhabiting soft-bottom habitats were the polychaete worms: *Spiophanes duplex, Paraprionospio pinnata, Euclymeninae sp., Prionospio jubata, Paradiopatra parva,* and *Glycera nana;* the brittle star *Amphiodia urtica,* the horseshoe worm *Phoronis* sp.; the capitellid worm Mediomastus sp.; and the amphipod *Ampelisca brevisimulata* (City of Los Angeles, 2003).

Most polychaetes feed by engulfing soft sediments and detritus and digesting the entrained microorganisms, while others filter feed on bits of organic detritus in the water, or prey on other infauna. Other common infaunal groups include crustaceans, such as amphipods, mollusks, and echinoderms. The abundance and distribution of infauna has been shown to vary both spatially and temporally (City of Los Angeles, 2003).

4.1.2.2 Epifauna

Epibenthic invertebrates (animals that live on the surface of the substrate) of Santa Monica Bay include sea stars, sea cucumbers, sand dollars, sea urchins, crabs, shrimp, snails, tube worms, nudibranchs, and sea slugs. During quarterly trawls at nine stations in Santa Monica Bay in 2001, a total of 15,820 individuals representing 53 species were captured. In 2002, the quarterly trawls yielded a total of 8,780 individuals representing 55 species. The most abundant species were echinoderms in terms of both numbers and biomass. The white urchin *Lytechinus pictus* and the spiny sea star *Astropecten verrilli* were the most abundant species throughout the Bay. The third most abundant invertebrate was the California sea cucumber *Parastichopus californicus* followed by the ridgeback prawn *Sicyonia ingentis*, sea slug *Philine auriformis*, sandstar *Luidia foliolata*, the serpent star *Ophiura lutkeni*, and the spiny brittle star *Ophiothrix spiculata* (City of Los Angeles, 2003).

4.1.3 Sandy Shoreline

Sandy shorelines in the Southern California Bight typically consist of exposed medium- to coarse-grain sand beaches. Santa Monica Bay has approximately 26 miles of sandy shoreline, extending from Malibu Point to Flat Rock Point, located near the Palos Verdes Peninsula. Sandy shoreline can be relatively dynamic in nature since it is subjected to tidal extremes, nearshore currents, storm surge, and wave activity that can move sand within the littoral cell and re-contour beach profiles.

The intertidal community of Santa Monica Bay consists largely of infaunal organisms such as polychaetes, bivalves and crustaceans. Blood worms (*Glycera dibranchiate*) are an infaunal polychaete that is often found in the sandy shoreline habitat, feeding on bacteria, microalgae, and small invertebrates beneath the sand. Though their populations have declined, bivalves that typically inhabit sandy shoreline habitat include the pismo clam (*Tivela stultorum*), Pacific littleneck (*Leukoma staminea*), and Gould bean clam (*Donax gouldi*).

The sand crab (*Emerita analoga*) is one of the most identifiable sandy intertidal crustaceans. Individuals can be found burrowing into the sand in the wave swash zone of beaches with moderate- to high-energy wave activity. Sand crabs are prey for shorebirds and several species of fish that include the California corbina (*Mentichirrhus undulatus*), barred surfperch (*Amphisticus argenteus*) and black croaker (*Cheiliotrema saturnum*). Consequently, the sand crab is often used as bait for recreational anglers fishing from the shoreline.

The California grunion (*Leuresthes tenuis*) is another species of interest that inhabits sandy shorelines. California grunion are small slender fish that average in length between 5 and 6 inches. They have bluish-green backs with silvery sides and bellies. This species of fish is endemic to the Bight and common in Santa Monica Bay. Grunion are unique in that they spawn on sandy beaches during large tidal swings that occur during full moons between the months of March and September. Eggs are deposited and fertilized in sandy reaches of the beach located within the intertidal zone. The eggs hatch in the sand and grunion larvae re-enters the ocean environment from the beach on subsequent high tides. While grunion can be taken from the beach during spawning, this fishery is regulated by California Department of Fish and Game (CDFG). “No take” periods generally occur during grunion runs between April and May. Protection during these months also extends to other beach activities (e.g. sand replenishment, construction) that may directly or indirectly impact grunion spawning. Grunion spawning has been documented in Santa Monica Bay, occurring at locations such as Hermosa Beach and Santa Monica Beach.

4.1.4 Rocky Shoreline

Rocky shorelines comprise a small part of Santa Monica Bay's shoreline habitats. Natural rocky shorelines are located primarily in the north between Point Dume and Malibu and in the south along the Palos Verdes Peninsula. Human-made rocky shoreline habitats exist within the Bay as well, primarily in the form of jetties and groins. Both types of rocky shorelines provide habitat within the intertidal zone for diverse assemblages of algae, invertebrates, and fish. Both diversity and abundance of intertidal species can vary according to tidal elevation, as location can affect competition, desiccation, and predation.

Plants in the rocky shoreline areas of Santa Monica Bay typically display vertical zonation. Species assemblages tend to be distinct at different tidal levels unless disturbed by marine animals. Lichens dominate the highest zone, identified as the splash zone. Located below the splash zone, the upper intertidal zone includes green algae (Subphylum Clorophyta), brown algae (Subphylum Phaeophyta) and various red algae (Subphylum Rhodophyta). The middle intertidal zone includes more diverse algal assemblage of red and brown algae. The lower intertidal consists of red and brown algae, along with surfgrass (*Phyllospadix* spp.).

Invertebrates living in the highest intertidal zones are typically shelled species that are able to tolerate extended periods of exposure to air. These species include barnacles (*Balanus* and *Chthamalus* spp.), periwinkels (*Littornia* spp.), limpets, and rock lice (*Ligia* spp.). In the upper tidal zone, species diversity tends to increase with the addition other snails (Class Gastropoda), bivalves (Class Bivalvia), chitons (Class Polyplacophora), hermit crabs (*Tribe Paguridea*), and striped shore crabs (*Pachygrapsus crassipes*). The middle intertidal usually supports a diverse assemblage of invertebrates that can include filter feeders, like the California mussel (*Mytilus californicus*) and gooseneck barnacles (*Lepas* spp.), as well as sea anemones, snails, sea slugs, octopus, polychaetes, barnacles, isopods, crab, and shrimp. Similar to the rocky subtidal habitat, the lower intertidal supports a wide range of invertebrates that include sponges, sea anemones, polychaetes, snails, sea slugs, shrimp, crab, bivalves, octopus, sea stars, sea cucumbers, sea urchins, isopods, tunicates, and brittle stars.

4.1.5 Pelagic Habitat

Pelagic habitat is by far the most extensive of any of the coastal and marine habitats in Santa Monica Bay. Phytoplankton and zooplankton communities form the base of the marine food web, supporting the Bay's extensive populations of invertebrates, fish, seabirds, and marine mammals. Within the Bight, over 40% of the total fish species are pelagic in nature (Santa Monica Bay Restoration Commission, 2010). Pelagic species commonly observed in Santa Monica Bay include: blue whales, long and short-beaked common dolphin, purple-striped jellyfish (*Pelagia colorata*), California sea lions, blue sharks (*Prionace glauca*), brown pelicans (*Pelecanus occidentalis*), *least terns* (*Sterna antillarum*), short-fin mako sharks (*Isurus oxyrinchus*), white sharks (*Carcharodon carcharias)*, krill, pacific sardines (*Sardinops sagax*), pacific bonito (*Sarda chiliensis*), and fish larvae.

El Niño and La Niña events can affect productivity within the plankton community. Harmful algal blooms occurring within the pelagic zone can indicate shifts in oceanographic conditions and can lead to sickness and sometimes death for marine species such as sea lions, otters, cetaceans, and humans. Currently, there is no validated modeling tool that is predictive of algal blooms based on oceanographic data (Bay Restoration Commission, 2011).

4.1.6 Marine Protected Areas

Currently the State is in the process of establishing a network of Marine Protected Areas (MPAs) in an attempt to protect marine habitats, ecosystems and species. Activities allowed within MPAs vary according to its classification within the MPA system. MPA classifications include State Marine Reserves (SMR), State Marine Parks (SMP) and State Marine Conservation Areas (SMCA). The only MPAs within Santa Monica Bay are located off of Point Dume and the Palos Verdes Peninsula. As of 2010, no additional MPAs have been proposed for Santa Monica Bay.

4.1.7 Areas of Special Biological Significance

Areas of Special Biological Significance (ASBS) are coastal areas with special status under the California Ocean Plan. Discharges of any waste into the ASBS are prohibited in order to maintain natural water quality and protect the uniqueness of these areas, their habitats and species. The only ASBS in Santa Monica Bay is the Mugu Lagoon to Latigo Point ASBS. As the name implies, this ASBS stretches from Mugu Lagoon in the north to Latigo Point in the south, which is located in Santa Monica Bay, between Point Dume and Malibu, approximately three miles north of the study area.

4.2 Marine Species

Santa Monica Bay is home to numerous sensitive and special status marine species ranging from marine mammals and sea turtles to marine birds, mollusks, and bony and cartilaginous fishes. Although some of these species may only rarely enter Santa Monica Bay, others spend a significant portion of their lives within the Bay's diverse marine habitats. For the purposes of this document, species that have been observed within Santa Monica Bay's waters in the past are assumed to have the potential to occur in the study area.

4.2.1 Marine Mammals

Over 40 different species of marine mammals are known to occur within the Southern California Bight (from Point Conception to the U.S.-Mexican border), including cetaceans (whales, dolphins, and porpoise), pinnipeds (seals and sea lions), and sea otters (Carretta el al., 2005). Special protections for each of these species fall under the Marine Mammal Protection Act (MMPA). Of these, five cetacean species that may be expected to occur within the nearshore waters of the study area are listed as federally endangered under the Endangered Species Act (ESA). These include the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*) (U.S. Navy Southern California Range Complex EIS). Stocks of all species listed as endangered under the ESA are automatically considered to be "depleted" and "strategic" under the MMPA. The California/Oregon/Washington Stock of the short-finned pilot whale (*Globicephala macrorhynchus*) is also considered to be strategic (Carreta et al., 2004).

Seven cetacean species are commonly observed in nearshore waters in significant numbers and are likely to occur in the study area either seasonally or on a year-round basis. These species include bottlenose dolphin, short-beaked common dolphin, Risso's dolphin, Dall's porpoise, Pacific white-sided dolphin, long-beaked common dolphin, and gray whale. Each of the dolphin and porpoise species live in the region year-round, while a significant portion of the gray whale population (currently estimated to be approximately 22,000 animals) migrates through the area from December through April. Blue whales, fin whales, humpback whales, killer whales, and northern right whale dolphins have the possibility of entering the study area. Blue whales and fin whales are typically observed further offshore than the study area, but are known to feed close to shore during times when krill or bait fish are overly abundant. Similarly, killer whales are occasionally observed in this area during winter months as they hunt gray whale calves during the gray whale migration to and from Mexican breeding grounds. Northern right whale dolphins and humpback whales are also periodically observed in nearshore waters but generally prefer to frequent deeper offshore locations. Other cetacean species listed in Table 4-2 are less likely to occur within the study area due to their limited population size in Southern California, their preference for deeper offshore waters, or because Santa Monica Bay is considered to be outside of their existing range.

Table 4-2. Status, Abundance, and Likelihood of Occurrence of Cetacean Species in the Study Area

Cetaceans Common Name Species Name	Southern California Abundance	Occurrence	Status	Likelihood of Occurrence in Study Area
Blue Whale *Balaenoptera musculus*	842	Seasonal- late spring to fall	Endangered; MMPA	Possible
Fin Whale *Balaenoptera physalus*	359	Small year round population	Endangered; MMPA	Possible
Humpback Whale *Megaptera*	36	Seasonal- late spring to fall	Endangered; MMPA	Possible
Sei Whale *Balaenoptera borealis*	Unknown (7 Brydes or Sei whales observed)	Rare- only 3 sightings in last 30 years	Endangered; MMPA	Unlikely
Sperm Whale *Physeter macrocephalus*	607	Common year round- typically found in waters greater than 1000 m in depth	Endangered; MMPA	Unlikely
Bryde's whale *Balaenoptera edeni*	Unknown (7 Brydes or Sei whales observed)	Rare	MMPA	Unknown
Gray whale *Eschrichtius robustus*	Population migrates through California	Common from December through April	MMPA	Likely
Minke Whale *Balaenoptera acutrorostrata*	226	Less common in summer	MMPA	Possible
Baird's Beaked Whale *Berardius bairdii*	127	Rare	MMPA	Unlikely
Bottlenose Dolphin *Tursiops truncatus*	323	Common	MMPA	Likely
Cuvier's Beaked Whale *Ziphius cavirostris*	911	Uncommon- typically observed in water greater than 1000 m in depth	MMPA	Unlikely

Table 4-2. Status, Abundance, and Likelihood of Occurrence of Cetacean Species in the Study Area

Cetaceans Common Name Species Name	Southern California Abundance	Occurrence	Status	Likelihood of Occurrence in Study Area
Dall's porpoise *Phocoenoides dalli*	727	Common year round	MMPA	Likely
Dwarf Sperm Whale *Kogia sima*	0	Possible visitor- observed only in deep water in Southern California	MMPA	Unlikely
False Killer Whale *Pseudorca crassidens*	Unknown	Unknown- strandings have occurred in Channel Islands	MMPA	Unlikely
Killer Whale *Orcinus orca*	30	Uncommon- typically observed during winter months	MMPA, southern resident population is Endangered	Possible
Long-beaked Common Dolphin	17,530	Common year round	MMPA	Likely
Melon-headed Whale *Peponocephala electra*	Unknown	May occasionally visit California waters	MMPA	Unlikely
Mesoplodont Beaked Whales *Five species*	132	Rare- typically observed only in deep water (>1000 m)	MMPA	Unlikely
Northern Right Whale Dolphin *Lissodelphis borealis*	1,172	Common during fall through early spring	MMPA	Possible
Pacific White-sided Dolphin *Lagenorhynchus obliquidens*	2,196	Common	MMPA	Likely
Pygmy Sperm Whale *Kogia breviceps*	0	May occasionally visit California waters	MMPA	Unlikely
Risso's Dolphin *Grampus griseus*	3,418	Common	MMPA	Likely
Short-beaked Common Dolphin *Delphinius delphis*	165,400	Common year round	MMPA	Likely
Short-finned Pilot Whale *Globicephala macrorhynchus*	118	Unknown	MMPA	Unlikely
Striped Dolphin *Stenella coreruleoalba*	12,529	Occasional visitor- generally observed during winter months	MMPA	Unlikely

Sources: Carretta et al., 2005; Carretta et al., 2007; California Fish and Game Code Section 4500

The occurrence, spatial distribution, and behavior of different cetacean species were investigated in Santa Monica Bay from 1997 and 2001. The three species of cetaceans that were found to inhabit the Bay year-round included the bottlenose dolphin, the long-beaked common dolphin, and the short-beaked common dolphin. Seven other species of cetaceans were found to occur only occasionally in Santa Monica Bay. These included Pacific white-sided dolphin, Risso's dolphin, Dall's porpoise, gray whale, minke whale, blue whale, and humpback whale. Bottlenose dolphins were found in waters within 0.5 km from shore in 80.0% of the sightings but were also found in deeper waters further offshore. All other species were generally seen in areas greater than 0.5 km from shore and showed a preference for bathymetric features such as escarpments and submarine canyons where they were observed traveling, foraging, and feeding (Bearzi, 2005).

Three species of pinnipeds are abundant in nearshore waters of Southern California and are likely to occur in the study area (Table 4-3). These include harbor seals, California sea lions, and northern elephant seals. One fissiped species, the southern sea otter *Enhydra lutris*, is typically found in nearshore waters north of Point Conception. As their population continues to increase, it is possible that their range could extend into Santa Monica Bay in the near future.

California sea lions (*Zalophus californianus*) northern elephant seals (*Mirounga angustirostris*) and harbor seals (*Phoca vitulina*) each maintain breeding colonies in the nearby Channel Islands. Sea lions have the ability to climb onto surface buoys, jetties, docks, and rock riprap to rest during the day when they are not actively feeding. Because harbor seals and elephant seals lack the large front flippers possessed by sea lions, they cannot climb onto structures and must haul out onto sandy beaches to seek refuge from the water. Each species of pinniped listed in Table 4-3 frequently dives to depths greater than 300 ft in search of food. Major predators for pinnipeds in Southern California include white sharks and occasionally killer whales.

Table 4-3. Status, Abundance, and Likelihood of Occurrence of Pinniped and Fissiped Species in the Study Area

Pinnepeds and Fissipeds Common Name Species Name	Southern California Abundance	Occurrence	Status	Likelihood of Occurrence in the Study Area
Harbor Seal *Phoca vitulina*	5,271	Common	MMPA	Likely
Northern Elephant Seal *Mirounga angustirostris*	9,794	Occasional	MMPA	Likely
California Sea Lion *Zalophus californianus*	50,750	Common	MMPA	Likely
Southern Sea Otter *Enhydra lutris*	29	Uncommon below Point Conception	Threatened, MMPA	Possible

Sources: Carretta et al., 2005; California Fish and Game Code Section 4500; Carretta et al., 2007.

4.2.2 Sea Turtles

Four of the five species of sea turtles that have been observed along the west coast of the United States, have the potential to occur within the study area. Olive Ridley (*Lepidochelys olivacea)*, green (*Chelonia mydas*), and loggerhead (*Caretta Caretta*) sea turtles are listed as federally threatened species, while the leatherback sea turtle (*Dermochelys coriacea*) is listed as a federally endangered species (Table 4-4). Each sea turtle species listed in Table 4-4 has been observed along the coast of Southern California.

Table 4-4. Status and Likelihood of Occurrence of Sea Turtle Species in the Study Area

Sea Turtles Common Name Species Name	Occurrence in Southern California	Status	Likelihood of Occurrence in Study Area
Loggerhead Sea Turtle *Caretta Caretta*	Uncommon	Federally Endangered (north pacific population); State of CA Endangered	Possible
Green Sea Turtle *Chelonia mydas*	Uncommon	Federally Threatened; State of CA Endangered	Possible
Olive Ridley Sea Turtle *Lepidochelys olivacea*	Rare	Federally Threatened	Unlikely
Leatherback Sea Turtle *Dermochelys coriacea*	Uncommon	Federally Endangered; State of CA Endangered	Unlikely

Source: California Herps.com

There are no known nesting sites on the west coast of the United States for any of the sea turtles listed in Table 4-4 (National Oceanographic and Atmospheric Administration [NOAA] Fisheries, 2011). NMFS and USFWS have joint jurisdiction over sea turtles within the U.S. NOAA maintains jurisdiction over the aquatic marine environment while USFWS has jurisdiction over nesting beaches, which occur only on the southeastern seaboard within the U.S. Sea turtles spend the vast majority of their lives swimming in the open water of the ocean and are known to migrate great distances from the nesting beaches where they were hatched. Although there have been recorded sea turtle sightings in waters as far north as Alaska, they most commonly occur along the west coast in more tropical waters from Mexico to South America. Additionally, there is a small resident population of green sea turtles in south San Diego Bay near the warm water discharge of the formerly operating South Bay Power Plant in Chula Vista, CA.

Loggerhead Sea Turtle

Loggerhead sea turtles are circumglobal, and are found in both temperate and tropical waters in the Pacific Ocean. Along the U.S. coastline, loggerheads are occasionally sighted off the coasts of Washington and Oregon and are most commonly sighted off the coast of California. The Baja Peninsula of Mexico provides critical habitat for juvenile loggerheads. As with other sea turtles, they are known to migrate across oceans and have been tracked thousands of miles away from their nesting beaches. The only known breeding grounds in the North Pacific for these sea turtles are in southern Japan (NOAA Fisheries, 2011). In 2002, NMFS issued an interim final rule to protect loggerhead sea turtles that follow warmer El Niño currents into drift gillnet fishing areas off of Southern California. The north Pacific population of loggerheads is currently listed as both a federally endangered species and a State of California endangered species.

Green Sea Turtle

Green sea turtles are the only sea turtle species that is completely herbivorous and are the most commonly observed sea turtle along the California coastline. Sightings of green sea turtles in Southern California have occurred year round, but are more frequent during the late summer when water temperatures are typically their warmest. They are currently listed as a federally threatened species and a state endangered species (NOAA Fisheries, 2011).

Olive Ridley Sea Turtle

Olive Ridley sea turtles are considered to be mainly pelagic turtles but have been known to inhabit coastal areas (NOAA Fisheries, 2011). These turtles are omnivorous and are known to eat lobster, crabs, algae, shrimp, fish, and benthic invertebrates. Olive Ridleys spend the vast majority of their lives in the open ocean and have been observed from trans-oceanic ships over 2,400 miles (4,000 km) from shore. Along the west coast of the U.S., the primary threats to the Olive Ridley appear to be incidental take in fisheries and boat collisions. No known nesting areas are located on the Pacific coast of the U.S. Olive Ridley sea turtles are currently listed as federally threatened, with breeding populations in Mexico currently listed as endangered.

Leatherback Sea Turtle

Leatherback sea turtles are the most migratory and wide-ranging of all the sea turtle species. They are known to be primarily pelagic, preferring the open ocean to nearshore waters but have been observed foraging along the coastline in search of jellyfish and other soft-bodied invertebrates (NOAA Fisheries, 2011). Leatherbacks are considered to be seasonal visitors to the central California coast, arriving in late summer and fall to forage on large aggregations of brown sea nettles (*Chrysaora fuscescens*) before migrating to waters off Hawaii. They then return to California the following summer, and may repeat this journey two or three times before swimming back to nesting beaches in Indonesia (Benson et al., 2011). Leatherback sea turtles are currently listed as both federally and state endangered species (NOAA Fisheries, 2011).

4.2.3 Fish

Santa Monica Bay has a rich diversity of migratory and resident species of fish. Table 4-5 provides a list of fish species that have been observed within the Santa Monica Bay or are identified for this portion of the Southern California Bight. In the following section, fish will be described according to:

- Internal support structure (bone or cartilage); and
- Assemblages by habitats; and

Fish are generally divided into two major groups based on whether they have a bony skeleton (Class Osteichthyes) or an internal support structure comprised of cartilage (Class Chondrichthyes). The dominant pelagic bony fish species in Santa Monica Bay are:

- Pacific (Chub) mackerel (*Scomber japonicas*);
- Jack mackerel (*Trachurus symmetricus*);
- Northern anchovy (*Engraulis mordax*); and

- Pacific sardine (*Sardinops sagax caerulea*).

The dominant cartilaginous fish in Santa Monica Bay tend to be sharks, although their abundance has declined. Sharks species found in the Bay and common to the region include:

- Basking sharks (*Cetorhinus maximus*);
- Blue sharks (*Prionace glauca*);
- Gray Smoothhound sharks (*Mustelus californicus*);
- Great white sharks (*Carcharodon carcharias*);
- Leopard sharks (*Triakis seimfasciata);*
- Mako sharks (*Isurus oxyrinchus*); and
- Thresher sharks (*Alopias vulpinus*).

Table 4-5. Fish Species in Santa Monica Bay

Common Name	Species	Habitat	Commercially (COM) or Recreationally (REC) Fished	Status
Anchovy, Northern	*Engraulis mordax*	pelagic	Yes (REC), Yes (COM)	
Sea bass, Giant (Black)	*Stereolepis gigas*	hard bottom	No (Moratorium)	Listed
Grunion, California	*Leuresthes tenuis*	surf area, soft bottom	Yes (REC)	Protected during (April - May)
Damselfish, Garibaldi	*Hypsypops rubicundus*	kelp, hard bottom	No	Protected, State Fish
Barracuda, California	*Sphyraena argentea*	pelagic	Yes (REC)	
Bass, Barred Sand	*Paralabrax nebulifer*	soft bottom	Yes (REC)	
Bass, Kelp	*Paralabrax clathratus*	kelp, hard bottom	Yes (REC)	
Bass, Spotted Sand	*Paralabrax maculatofasciatus*	bay environment	Yes (REC)	
Bass, Striped	*Roccus saxatilis (or Morone saxatilis)*	bay environment	Yes (REC)	
Bonito, Pacific	*Sarda chiliensis*	pelagic (seasonal)	Yes (REC)	
Cod, Ling	*Ophiodon elongatus*	hard bottom (deep)	Yes (REC)	
Cod, Rock	*Lotella rhacina*	hard bottom (deep)	Yes (REC)	
Corbina, California	*Menticirrhus undulatus*	surf area, soft bottom	Yes (REC)	
Croaker, Black	*Cheilotrema saturnum*	hard bottom, soft bottom, structures	Yes (REC)	
Croaker, Spotfin	*Roncador sternsii*	soft bottom	Yes (REC)	
Croaker, White	*Genyonemus lineatus*	soft bottom, structures	Yes (REC)	
Croaker, Yellowfin	*Umbrina roncador*	soft bottom	Yes (REC)	
Damselfish, Blacksmith	*Chromis punctipinnis*	kelp, hard bottom	No	
Dogfish, Spiny	*Squalus acanthias*	soft bottom	Yes (REC)	
Dorado (Dolphinfish)	*Coryphaena hippurus*	pelagic	Yes (REC)	
Giant Kelpfish	*Heterostichus rostratus*	kelp, hard bottom	Yes (REC)	
Goby, Black Eye	*Coryphopterus nicholsi*	hard bottom, soft bottom	No	
Goby, Bluebanded	*Catalina gobies*	hard bottom	No	

Table 4-5. Fish Species in Santa Monica Bay

Common Name	Species	Habitat	Commercially (COM) or Recreationally (REC) Fished	Status
Hake, Pacific (Pacific Whiting)	*Merluccius productus*	soft bottom	Yes (REC), usually incidentally	
Halfmoon	*Medialuna californiensis*	kelp, hard bottom	Yes (REC)	
Halibut, California	*Paralichthys californicus*	soft bottom	Yes (REC)	
Jacksmelt	*Atherinopsis californiensis*	bay environment, surf area, structures	Yes (REC)	
Lizardfish, California	*Synodus lucioceps*	soft bottom	Yes (REC), usually incidentally	
Mackerel, Jack	*Trachurus symmetricus*	pelagic	Yes (REC)	
Mackerel, Pacific (Chub)	*Scomber japonicus*	pelagic	Yes (REC)	
Opaleye	*Girella nigricans*	hard bottom	Yes (REC)	
Perch, Black	*Embiotoca jacksoni*	kelp, hard bottom, structures	Yes (REC)	
Perch, Pile	*Rhacochilus vacca*	kelp, hard bottom, structures	Yes (REC)	
Perch, Zebra	*Hermosilla azurea*	kelp, hard bottom, structures	Yes (REC)	
Queenfish	*Seriphus politus*	soft bottom, structures	Yes (REC)	
Ray, Bat	*Myliobatis californicus*	soft bottom	Yes (REC)	
Rockfish	*Sebastes* spp.	hard bottom, soft bottom near rocky reef	Yes (REC)	
Rockfish, Brown	*Sebastes auriculatus*	hard bottom, soft bottom near rocky reef	Yes (REC)	
Rockfish, Vermillion	*Sebastes miniatus*	hard bottom, soft bottom near rocky reef	Yes (REC)	
Sablefish	*Anoplopoma*	soft bottom	Yes (REC)	
Sanddab, California	*Citharichthys sordidus*	soft bottom	Yes (REC)	
Sanddab, Longfin	*Citharichthys xanthostigma*	soft bottom	Yes (REC)	
Sanddab, Speckled	*Citharichthys stigmaeus*	soft bottom	Yes (REC)	
Sardine, Pacific	*Sardinops sagax caerulea*	pelagic	Yes (COM)	
Sargo	*Anisotremus davidsonii*	hard bottom	Yes (REC), usually incidentally	
Sculpin, Cabezon	*Scorpaenichthys marmoratus*	hard bottom	Yes (REC)	
Sculpin, Pacific Staghorn	*Leptocottus armatus*	bay environment, soft bottom, hard bottom	Yes (REC)	
Sea bass, White	*Atractoscion nobilis (Cynoscion nobilis)*	hard bottom	Yes (REC)	
Señorita	*Oxyjulis californica*	kelp, hard bottom	No	
Shark, Basking	*Cetorhinus maximus*	pelagic	No	
Shark, Blue	*Prionace glauca*	pelagic	Yes (REC), usually incidentally	
Shark, Gray Smoothhound	*Mustelus californicus*	soft bottom	Yes (REC)	
Shark, Great White	*Carcharodon carharias*	pelagic	No	
Shark, Leopard	*Triakis seimfasciata*	bay environment, soft bottom	Yes (REC)	
Shark, Mako (Bonito)	*Isurus oxyrinchus*	pelagic	Yes (REC)	
Shark, Thresher	*Alopias vulpinus*	pelagic	Yes (REC)	
Sheephead, California	*Semicossyphus pulcher*	kelp, hard bottom	Yes (REC)	

Table 4-5. Fish Species in Santa Monica Bay

Common Name	Species	Habitat	Commercially (COM) or Recreationally (REC) Fished	Status
Shovelnose Guitarfish	*Rhinobatos productus*	soft bottom	Yes (REC)	
Sole, Petrale	*Eopsetta jordani*	soft bottom (usually near hard bottom)	Yes (REC)	
Stingray, Round	*Urolophus halleri*	soft bottom	Yes (REC), usually incidentally	
Surfperch, Pile	*Damalichthys vacca*	kelp, hard bottom, structures	Yes (REC)	
Surfperch, Rainbow	*Hypsurus caryi*	hard bottom	Yes (REC)	
Surfperch, Rubberlip	*Rhacochilus toxotes*	kelp, hard bottom	Yes (REC)	
Surfperch, Surf	*Embiotoca jacksoni*	kelp, hard bottom, soft bottom, structures	Yes (REC)	
Surfperch, Walleye	*Hyperprosopon argenteum*	bay environment, soft bottom, hard bottom	Yes (REC)	
Surfperch, White	*Phanerodon furcatus*	structures, hard bottom	Yes (REC)	
Topsmelt	*Atherinops affinis*	pelagic, bay environment, kelp	Yes (REC)	
Trigger Fish, Finescale	*Balistes polyepis*	hard bottom	Yes (REC)	
Turbot, Curlfin	*Pleuronichthys decurrens*	soft bottom	Yes (REC)	
Wrasse, Rock	*Halichoeres semicinctus*	soft bottom, hard bottoms	No	
Yellowtail, California	*Seriola lalandi (or S. dorsalis)*	pelagic	Yes (REC)	

4.2.3.1 Soft-Bottom Fish Species

The extensive soft-bottom habitat within Santa Monica Bay supports an abundant and diverse assemblage of over 100 species of demersal fish. For the most part, soft-bottom species derive much of their food from benthic infauna. Flatfish, rockfish, sculpins, combfishes and eelpouts comprise the majority of the soft-bottom fish found in the Bay (MBC, 1993). Quarterly trawls in 2001 and 2002 yielded a total of 15,122 individuals consisting of 58 species and 13,693 individuals representing 51 species respectively (City of Los Angeles, 2003). The number of fish species, abundance and biomass generally increase with water depth. Nearshore areas usually support a high abundance of species such as flatfish, surfperch and croakers. Middle and outer shelf species include numerous kinds of flatfish, sculpin, and rockfish.

4.2.3.2 Hard-Bottom Fish Species

Hard-bottom habitats (e.g., rocky reef) also support an abundant and diverse assemblage of fish, with community composition often varying according to depth. Areas of hard-bottom substrate may also have kelp of varying density and height. Within kelp beds, assemblages of fish and their composition will often vary according to the depth from under the canopy to the bottom. Common shallow-water fish include sea basses, rockfishes, kelpfishes, sculpins, damselfishes, and wrasses. Dominant deeper water species include vermillion rockfish, bocaccio, cowcod, and flag rockfish. Natural hard-bottom habitats and kelp beds in Santa Monica Bay are limited mostly to areas adjacent to rocky headlands located at the north and south of the Bay. Man-made hard-bottom habitats in Santa Monica Bay include pipeline systems, vaults and artificial reefs.

Monitoring studies conducted at three artificial reefs in Santa Monica Bay (i.e., SMAR, SMBAR and TAR) found several species of fish indicative of rocky reef habitats. Results from these surveys are provided in Table 4-6. Similar to the artificial reefs, the concrete vaults that house the electrodes provide habitat for algae, invertebrates, and fishes that commonly inhabit hard-bottom habitats of the Bay.

Table 4-6. Fish Species Observed During Artificial Reef Monitoring*

Common Name	Species	Location (Depth)	Reef	Abundance (1995)*
Bass, Barred Sand	*Paralabrax nebulifer*	28 - 72 feet	SMBAR/TAR	C
Bass, Kelp	*Paralabrax clathratus*	28 - 72 feet	SMBAR/TAR	C
Croaker, Black	*Cheilotrema saturnum*	28 - 57 feet	SMBAR/TAR	C
Croaker, White	*Genyonemus lineatus*	28 feet	TAR	R
Curlfin Turbot, Curlfin	*Pleuronichthys decurrens*	72 feet	SMBAR	R
Damselfish, Blacksmith	*Chromis punctipinnis*	28 - 72 feet	SMBAR/TAR	A
Damselfish, Garibaldi	*Hypsypops rubicundus*	28 feet	TAR	O
Goby, Black Eye	*Coryphopterus nicholsi*	72 feet	SMBAR	C
Goby, Bluebanded	*Catalina gobies*	72 feet	SMBAR	O
Halfmoon	*Medialuna californiensis*	28 - 57 feet	SMBAR/TAR	C
Opaleye	*Girella nigricans*	42 - 72 feet	SMBAR	O
Rockfish, Brown	*Sebastes auriculatus*	28 - 42 feet	SMBAR/TAR	R
Sargo	*Anisotremus davidsonii*	42 feet	SMBAR	C
Sculpin	*Scorpaena guttata*	42 - 72 feet	SMBAR	O
Señorita	*Oxyjulis californica*	28 feet, 57 feet	SMBAR/TAR	A
Sheephead, California	*Semicossyphus pulcher*	42 - 57 feet	SMBAR	C
Surfperch, Black	*Embiotoca jacksoni*	28 - 57 feet	SMBAR/TAR	C
Surfperch, Pile	*Damalichthys vacca*	28 - 72 feet	SMBAR/TAR	C
Surfperch, Rainbow	*Hypsurus caryi*	57 feet	SMBAR	O
Surfperch, Rubberlip	*Rhacochilus toxotes*	42 - 72 feet	SMBAR	O
Surfperch, White	*Phanerodon furcatus*	28 - 57 feet	SMBAR/TAR	O
Trigger Fish, Finescale	*Balistes polyepis*	42 feet	SMBAR	O
Wrasse, Rock	*Halichoeres semicinctus*	28 - 57 feet	SMBAR/TAR	O

* Abundance varied by reef and depth. The highest frequency of observed species is listed here.

A = Abundant	O = Occasional
C = Common	R = Rare

Table adapted from - Bedford et al 1996

4.2.3.3 Protected Fish and Invertebrate Species

Species that have prohibited take status with CDFG
Several species of fish are prohibited to target, catch, or possess according to California Fish and Game regulations. These species include the giant black sea bass (*Stereolepis gigas*), white shark (*Carcharodon carcharias*), steelhead (*Oncorhynchus mykiss*), broomtail grouper (*Mycteroperca xenarcha*), Garibaldi (*Hypsypops rubicundus*), silver salmon (*Oncorhynchus kisutch*), bronzespotted rockfish (*Sebastes gilli*), canary rockfish (*Sebastes pinniger*), yelloweye rockfish (*Sebastes ruberrimus*), and cowcod rockfish (*Sebastes levis*).

Two of these species (cowcod rockfish and steelhead) are also listed as species of concern by NMFS. Other species of concern that may occur in Santa Monica Bay include the basking shark (*Cetorhinus maximus*), and the bocaccio rockfish (*Sebastes paucispinis*).

Giant (Black) Sea Bass
Giant sea bass (*Stereolepis gigas*), also referred to as black sea bass, is a native to the Bight. Reaching sizes of between six- to eight-feet and a weight over 400 pounds; these fish prefer relatively shallow waters near kelp forests, drop offs, or rocky bottoms. Once a relatively common inhabitant of Southern California waters, the giant sea bass faced the threat of local extinction in the 1980s due to overfishing. In 1982 a moratorium was placed on catching and keeping giant sea bass that remains in place today. Giant sea bass cannot be actively sought and must be released if caught incidentally. The giant sea bass reproduces slowly with a population doubling time of more than 14 years, and is still listed as critically endangered by CDFG.

White Shark
Although a definitive population size has not yet been established for the white shark (*Carcharodon carcharias*), they are thought to be low in number along the west coast of the U.S. and worldwide. White sharks feed primarily on fish until they reach approximately 10 ft in length, whereupon they begin to feed predominantly on marine mammals. CDFG prohibits the possession or take of white sharks in California. White sharks are not uncommon along the Southern California coastline and are occasionally spotted by surfers and paddle boarders in the nearshore waters of Santa Monica Bay. The Monterey Bay Aquarium has tagged and tracked several small white sharks and has observed that that they like to remain in the waters off Will Rogers State Beach and Malibu before migrating to Baja California (Monterey Bay Aquarium Foundation, 2011).

Steelhead
Steelhead (*Oncorhynchus mykiss*) are anadromous salmonids that typically return to freshwater to spawn after spending two to three years at sea. The recovery of steelhead in Malibu Creek and the Bay watershed is threatened by reduced access to spawning and rearing habitat. It has been estimated that more than 80% of the spawning habitat, and 60% of the rearing habitat has been made inaccessible to steelhead in Malibu Creek as a result of passage barriers such as Rindge Dam, culverts, and Arizona crossings" (SMBRC, 2010). Southern steelhead are considered a "Distinct Population Segment (DPS)" of steelhead by the NMFS and as a Species of Special Concern within the State of California.

Broomtail Grouper

Broomtail grouper (*Mycteroperca xenarcha*) range from San Francisco Bay to Peru. They grow up to four ft in length and over 100 lbs. This species is typically found in Mexican waters and is illegal to possess or take within the State of California (Eschmeyer et al., 1983).

Garibaldi

The Garibaldi or Garibaldi damselfish (*Hypsypops rubicundus*) grow up to 15 inches in length and are identified by their bright orange color as adults. Juvenile Garibaldi are not as bright in color, having iridescent blue spots which fade as they become adult. The Garibaldi is the California state fish, and is protected in state waters. They may not be actively fished and must be released if caught incidentally.

Silver Salmon

Silver, or “coho” salmon (*Oncorhynchus kisutch*) are anadromous fish, hatching in freshwater and spending their lives at sea. They range from Alaska to northern Baja California and typically live in saltwater for 1-3 years before migrating to the freshwater stream of their birth. The silver salmon population is estimated to be less than 6% of what it was in the 1940s. The SMBRC is currently providing money through Proposition 84 for projects that protect Santa Monica Bay beaches and coastal waters, including projects to prevent contamination and degradation of coastal waters and watersheds, so that species such as silver salmon and steelhead trout populations in coastal streams can be restored.

Bronzespotted Rockfish

Bronzespotted rockfish (*Sebastes gilli*) range from Monterey Bay to northern Baja California. Bronzespotted rockfish are typically found along rocky substrates in 250 ft-750 ft of water. Historically, bronzespotted rockfish were relatively common in deeper waters off Southern California, but have since declined in numbers (CDFG, 2011). They are currently are protected under a “no possession, no take” rule by CDFG.

Canary Rockfish

Canary rockfish (*Sebastes pinniger*) range from the western Gulf of Alaska to Baja California. They are a densely aggregating fish that is usually associated with rock pinnacles or sharp drop-offs. Typically, they are near, but usually not on the bottom, and often associate with yellowtail, and widow and silvergray rockfishes. These rockfish grow to over 30 inches in length and live for longer than 75 years. Adults eat demersal invertebrates and small fishes, including other species of rockfish (Love, 1996). The CDFG prohibits the take or possession of canary rockfish.

Yelloweye Rockfish

Yelloweye rockfish (*Sebastes ruberrimus*) range from the Allutian Islands of Alaska to Baja California. They more commonly occur in Central California to Alaska. They are a typically caught in 450-600 ft depths and are mostly solidary, living on or just above reefs. Yelloweye rockfish grow to over 36 inches in length and live for longer than 114 years. Adults eat fish, crabs, shrimps and snails and spanwn between February and September (Love, 1996). The CDFT prohibits the take or possession of canary rockfish.

Cowcod Rockfish

Cowcod rockfish (*Sebastes levis*) range from Oregon to Baja California and are typically caught in water ranging from 100 ft to 800 ft. As with all rockfish species, cowcods inhabit rocky bottom substrates and prefer to live in crevices or caves. Cowcods are one of the biggest rockfish in the world, and grow to over 35 inches and 20 pounds (Love, 1996).

Basking Shark

Basking sharks (*Cetorhinus maximus*) grow to over 30 ft in length and feed on plankton. Basking sharks are most commonly seen in Southern California waters between spring and summer. Basking shark populations have declined dramatically since the 1900s and they are now are considered a Species of Special Concern in California and are protected under the Highly Migratory Species Fishery Management Plan (NMFS, 2011).

Bocaccio Rockfish

Boccacio rockfish (*Sebastes paucispinis*) range from Alaska to Baja California and predominantly occur in waters that range from 150 to 1,000 ft in depth, but occasionally come into depths as shallow as 60 ft as adults. Juvenile bocaccio stay in shallow waters (30 to 90 ft) but swim into deeper waters as they grow. Predators include harbor seals, elephant seals, and California sea lions (Love, 1996). Boccacio are currently listed as a Species of Special Concern by NMFS.

California Grunion

California grunion (*Leuresthes tenuis*) are a small slender fish with bluish-green backs, silvery sides and bellies that average in length between 5 and 6 inches. This species of fish is endemic to the SCB and has been observed in Santa Monica Bay. Grunion are unique in that they spawn on sandy beaches during large tidal swings that occur in the early morning hours between the months of March and September. Eggs are deposited and fertilized in sandy reaches of the beach located within the intertidal zone. Grunion larvae re-enters the ocean environment from the beach on subsequent high tides. While grunion can be taken from the beach during spawning, this fishery is regulated by CDFG. “No take” periods generally occur during grunion runs between April and May. Protection during these months also extends to other beach activities (e.g., sand replenishment and construction) that may directly or indirectly impact grunion spawning. Grunion spawning has been documented in Santa Monica Bay, occurring at locations such as Hermosa Beach and Santa Monica Beach.

5.0 SEABIRDS

5.1 Background

The Southern California Bight, including Santa Monica Bay, supports an abundant and diverse population of both resident and migratory seabirds (Baird, 1993), also referred to as marine birds. Seabirds have adapted to life within the marine environments and generally live longer, breed later, and have fewer young than other birds. Most seabird species nest in colonies and rely on habitats within the Bay for nesting, foraging, and refuge.

Santa Monica Bay is located within the Pacific Flyway, a major north-south avian migratory route that extends from Alaska to South America. Every spring and fall, migratory birds travel some of all of the Flyway to follow food sources, head to breeding grounds or travel to overwintering sites. Each bird species tends to follow the same route with regard to both distance and timing. Therefore, distribution of seabird species within the Bay will likely exhibit both seasonal and spatial variation to some degree (Pierson et al., 2000).

Seabirds can be primarily characterized as being coastal or pelagic. Coastal seabirds may feed in the pelagic realm, but tend to remain in the proximity of the mainland shore (i.e., approximately within 5 miles). Common coastal seabirds found in Santa Monica Bay include:

- Western grebes (*Aechmophorus occidentalis*);
- Clark’s grebes (*Aechmophorus clarkii*);
- Surf scooters (*Melanitta perspicillata*);
- Cormorants (*Phalacrocorax* spp.);
- Loons* (*Gavia* spp.);
- California brown pelicans (*Pelecanus occidentalis californicus*); and
- Gulls (Subfamily Laridae) (CLSC, 2010).

Highest densities of coastal seabirds in the Bay tend to occur in winter, although the California brown pelican populations generally peak in the summer months when they migrate northward from Mexico. Monitoring of shorebirds in wetlands indicates that fall is the dominate season for shorebirds in Santa Monica Bay, followed by winter, with wetlands serving as the key coastal areas used by these birds (Page et al., 1992). Shorebirds appearing in abundance (i.e., over 1,000 birds) during the fall in Santa Monica Bay’s lagoons include:

- Black-bellied Plover (*Pluvialis squatarola*);
- Semipalmated Plover (*Charadrius semipalmatus*);
- Black-necked Stilt (*Himantopus mexicanus*);
- American Avocet (*Recurvirostra americana*);
- Yellowlegs (*Tringa* spp.);
- Willet (*Tringa semipalmata*);
- Whimbrel (*Numenius phaeopus*);
- Long-billed Curlew (*Numenius americanus*);
- Marbled Gowit (*Limosa fedoa*);

- Red Knot (*Calidris canutus*);
- Sanderling (*Calidris alba*);
- Western Sandpiper (*Calidris mauri*);
- Least Sandpiper (*Calidris minutilla*);
- Dowitcheers *(Limnodromus* spp.);
- Wilson's Phalarope (*Phalaropus tricolor*); and
- Red-necked Phalarope (*Phalaropus lobatus*) (Page et al 1992).

In contrast to shorebirds, pelagic seabirds spend most of their time farther from the coast. Unlike shorebird populations, pelagic seabird populations are comparatively stable (Minerals Management Service, 2001). Most seabird rookeries in the region are located on offshore islands, to the north of Santa Monica Bay. These rookeries occur predominately in the northern Channel Islands while few, if any, nest on the mainland along the Bight (Carter et al., 1992). Common pelagic, or offshore, seabirds in the region include:

- Shearwaters (*Puffinus* spp.);
- Northern fulmars (*Fulamarus glacialis*);
- Jaegers (*Stercorarius* spp.);
- Common murres (*Uria aalge*);
- Storm-petrels (*Ocenaodroma* spp.);
- Puffins (*Fratercula* spp.); and
- Auklets (Family Alcidae).

5.2 Feeding Strategies

Seabirds have evolved in both behavior and physiology to exploit food resources in the marine environment, both on and below the surface. Several species (e.g., gulls, petrels, frigatebirds) implement multiple strategies to capture prey in the marine environment, while other species depend primarily on a single strategy (e.g., cormorants). The four basic strategies that seabirds use for feeding are described as follows.

5.2.1 Surface Feeding

Many seabirds feed by dipping their head in the ocean surface where ocean currents can concentrate food types such as krill, small fish, and squid. Surface feeding itself can be separated into two distinct types: flying or swimming. Surface feeding using flight include snatching food in flight, "walking" (i.e. pattering and hovering on the water's surface) (Withers, 1979) and skimming. Many seabirds that utilize this method of feeding do not ever land in the water, since some species (e.g., frigatebirds) have difficulty in getting airborne again (Metz, 2002). Seabirds that use flight surface feeding include petrels, frigatebirds, and skimmers. Much like surface feeders that fly, surface feeders that swim often have unique bill types that help them catch prey on the water surface. Fulmars, shearwaters, gulls and petrels utilize swimming to surface feed, though some of these species also use the flight technique for surface feeding.

5.2.2 Pursuit Diving

Pursuit diving seabirds propel themselves under water using their wings (e.g., auks and petrels) or feet (e.g., cormorants, grebes, and loons) to chase after prey below the surface. While this strategy tends to be more successful in acquiring prey than surface feeding, bird species that are well adapted to use this strategy generally have poor flying abilities (Gaston, 1998) and are more limited in their foraging range.

5.2.3 Plunge Diving

Plunge diving consists of using the energy from the momentum of an aerial dive to momentarily offset a seabird’s natural buoyancy (Robert-Coudert, 2004), allowing it to capture fish below the surface using less energy than needed for pursuit diving. In general this is the most specialized form of feeding strategy, with some of the more successful species, such as the California brown pelican, taking years to fully develop it in order to maximum diving height while minimizing bodily injury (Elliot, 1992). While water clarity can play a role in the success and overall foraging range of seabirds that rely on plunge diving, it has not been determined to be a conclusive factor (Haney, 1988). Seabirds that commonly use the plunge diving strategy include: gannets, some terns, gulls and California brown pelicans.

5.2.4 Stealing, Predation, and Scavenging

This group of feeding strategies involves stealing food from other seabirds, preying upon other seabirds (e.g. eggs and chicks), or scavenging on carrion or trash. Kleptoparasites are seabirds that make a part of their feeding behavior on stealing food from other seabirds. This group includes frigatebirds, gulls, terns, and other species that will steal opportunistically. It is believed that stealing is used to supplement food usually obtained through hunting (Schreiber, 2001). Some species, including gulls and some petrels, will actively feed on other seabirds by taking eggs, chicks or small adults from nesting colonies (Punta, 1995). Gulls and some petrels also rely on scavenging to augment their food supply.

5.3 Special Status Seabirds

Special status seabirds that occur in Santa Monica Bay (i.e., are protected or were recently de-listed under state or federal ESAs) are presented in Table 5-1.

Table 5-1. Special Status Seabirds of the Southern California Bight

Common Name	Species	Status
Bald eagle	*Haliaeetus leucocephalus*	Delisted in 2007
California brown pelican	*Pelecanus occidentalis californicus*	Delisted in 2009
California least tern	*Sterna antillarum browni*	Federally listed
Western snowy plover	*Charadrius alexandrinus nivosus*	Federally listed
Marbled murrelet	*Brachyramphus marmoratus*	State Endangered
Xantus's murrelet	*Synthliboramphus hypoleucus*	State Threatened
Ashy storm petrel	*Oceanodroma homchroa*	SCC
Black storm petrel	*Oceanodroma melania*	SCC
Rhinoceros auklet	*Cerorhinca monocerata*	SSC

SSC = State Species of Special Concern

Bald Eagle

The bald eagle is a type of sea eagle found only in North America and is an active predator in the Channel Islands. Once numbering around 50,000 with over 30 different nesting areas on the Channel Islands from 1800 through 1950, bald eagles disappeared from the Channel Islands in the early 1960s due primarily to the effects of pesticides (e.g., DDT) that impacted the eagles reproductive success (CSLC, 2010). Since that time, bald eagle populations have rebounded due largely to the restriction of the use of DDT by the federal government in 1972. In 1995, the USFWS reclassified the bald eagle from "endangered" to "threatened." It was eventually delisted in 2007, although the bald eagle is still protected under the Migratory Bird Treaty Act and Bald Eagle and Golden Eagle Protection Act.

The bald eagle is a key species in the ecosystem of the Channel Islands. During its decline, it was replaced by the non-native golden eagles, which led to the sharp decline in the native island fox due to predation. Bald eagles have been successfully reproducing in the Channel Islands since 2006, with Catalina Island producing the most eaglets in 2008 (National Park Service, 2008).

California Brown Pelican

California brown pelicans are large, fish-eating birds commonly seen plunge diving off the coast of Santa Monica Bay. Populations of this bird species seriously declined due to bioaccumulation of chlorinated hydrocarbon pesticides (i.e., DDT) that led to both state and federal listing in the early 1970s (CLCS, 2010). Habitat loss, human disturbance of nesting sites, excessive commercial fishing and food scarcity also contributed to the species decline (Keith et al., 1971). Following the delisting of the California brown pelican in 2009, the primary regulatory authority for protection of this species became the Migratory Bird Treaty Act; therefore, harming or killing a brown pelican remains illegal.

Pelicans often glide up and down the coastline in a "v" formation, sometimes just above the water's surface. They forage by plunge diving for small schooling fish. They generally roost on offshore rocks and coastal habitats such as rocky shores, sandy beaches, piers and wetlands, sometimes preferring freshwater for bathing. They generally return to specific roosts, isolated from human disturbance or predation, and do not remain at sea overnight. Most nesting activity takes place in the Channel Islands and in Mexico (USFWS, 2008). Breeding season extends from March through early August with the numbers of California brown pelicans generally highest in the summer and lowest in the late winter and early spring (Lehman, 1994).

California Least Tern

The California least tern is a sub-species of the least tern that breeds primarily in the bay systems of the Bight. It is a federally listed endangered species due to its limited breeding range, small and declining population, and vulnerability to threats that include predation, human disturbance, and loss of habitat. While numbers have gradually increased since 1974, the species is still considered endangered (USFWS, 2006, 2005).

California least terns nesting season extends from May to June, with the preferred nesting habitat being sandy or gravely substrates, and sometimes salt flats. Breeding colonies are not as dense as other seabirds and generally occur along marine or estuarine habitats. Presently, there is only one California least tern colony in Santa Monica Bay, located near Venice Beach (USFWS, 2006).

California least terns hunt primarily in shallow estuaries and lagoons, preying on smaller fish species found in these habitats. Prey for this seabird include northern anchovy, smelt, surfperch, silversides, and small crustaceans. California least terns also forage in the nearshore, especially in proximity to lagoons or river mouths.

Western Snowy Plover

The western snowy plover was listed as a federally threatened species in 1993. The plover is a small shorebird that is approximately the size of a sparrow. It is listed as threatened due to its limited breeding range, small and declining global population, and vulnerability to threats that include predation, loss of habitat, and human disturbance (USFWS, 2007). The western snowy plover nesting period is between March through September. Preferring to nest in small indentions or scrapes within sandy areas, the western snowy plover will also use kelp, driftwood, and rocks for nesting habitat. Western snowy plovers are believed to be extremely sensitive to both direct and indirect disturbance during nesting periods and will easily abandon their nests. The western snowy plover forages in the intertidal areas and sandy beaches, feeding primarily on invertebrates.

Marbled Murrelet

The marbled murrelet is a small Pacific seabird belonging to the family Alcidae that is currently listed as a threatened species in the states of Oregon, Washington, and California. They are long-lived seabirds that spend most of their lives in the marine environment but tend to use old growth forests for nesting. Marbled murrelets feed primarily on fish and invertebrates in nearshore marine waters, although they have also been observed foraging in rivers and inland lakes. Threats to these birds include loss of habitat, predation, gill-net fishing operations, oil spills, marine pollution, and disease. Recent reviews have concluded that the risk of predation may be a larger threat than was previously considered (USFWS, 2011).

Xantus’ Murrelet

The Xantus’ murrelet is a small diving bird of the family Alcidae. It is listed as threatened by CDFG and is currently a candidate for federal listing due to its limited breeding range, small and declining global population and vulnerability to threats that include predation, oil spills, loss of habitat, and artificial light pollution from boats operating near nesting colonies (Wolf et al., 2005). The murrelet is thought to breed primarily on 13 islands between the Point Conception and Punta Abreojos, in Baja California Mexico. Santa Barbara Island is one the key breeding areas near Santa Monica Bay.

Murrelets feed on zooplankton and small fish that include the northern anchovy, sardines and rockfish. They are pelagic seabirds, spending most of their lives at sea and returning to shore only to breed. Their nesting period extends from February to July, but may vary depending on food supplies. During nesting season, they generally forage near their colony. In the non-breeding season, the majority of the murrelet population winters in the waters of the California Current, from 20 to 60 miles offshore.

California Gull

California gulls are considered a State Species of Special Concern due to the decline in breeding populations in California caused by anthropogenic impacts that have affected interior colonies. California gulls nest primarily inland on islands and lakes, visiting the coast during the non-breeding season that occurs from late summer through March. Along the coast, this gull prefers sandy beaches, mudflats, rocky intertidal, and pelagic areas of marine and estuarine habitats. California gulls are omnivorous and feed opportunistically on garbage, carrion, fish, insects, and shrimp.

Double-Crested Cormorant

The double-crested cormorant is a large, heavy-bodied water bird that can be found within both marine and freshwater habitats of the Bay. When found in marine environments, the double-crested cormorant tends to feed in relatively shallow, open coastal and estuarine waters, although they have can be observed in waters with depths up to 70 feet. Skilled swimmers, they use pursuit diving to feed primarily on subsurface schooling fish. Nesting colonies and roost sites are generally located near large estuaries, rocky shorelines, and offshore rocks. Unlike other water bird species, cormorants do not have well-developed oil glands to protect their feathers from getting saturated by water and, therefore, must visit perches to periodically dry out their plumage so that they can fly. Similar to the California brown pelican, the cormorant suffered substantial declines to its population in California due to pesticide bioaccumulation and habitat loss. It was listed as a California Species of Concern with approximately 364,000 nesting pairs in North America (Hatch, 1995).

Double-crested cormorants are found throughout the Bight, with breeding populations in Southern California localized predominantly in the Channel Islands (Carter et al., 1992). Breeding season for marine colonies generally occurs between April and August.

Storm Petrels and Auklets

Similar to murrelets, ashy and black storm petrels and rhinoceros auklets are pelagic and come ashore primarily for breeding, with colonies generally found along rocky shorelines and cliffs of offshore islands. Both storm petrels and auklets are considered Species of Special Concern in California, due to their declining population sizes and threats to breeding habitats. These species are generally found far from shore, well beyond the shelf, as well as in areas adjacent to submarine canyons and other deep water features, or around islands where they breed.

5.3.1 Invertebrates

5.3.1.1 Plankton

Plankton are invertebrate aquatic organisms that drift or float with ocean currents. Though many species are microscopic, plankton include organisms that cover a wide range of sizes, including larger organisms such as jellyfish. Plankton play important roles in marine environments that include breaking down organic matter, producing oxygen through photosynthesis and providing the base food source for many organisms endemic to the Southern California Bight that range in size from microscopic invertebrates to 100-foot blue whales. Plankton are primarily divided into three broad trophic level groups: bacterioplankton, phytoplankton, and zooplankton.

Bacterioplankton

Bacterioplankton are comprised of the bacterial component of plankton that drifts in the water column. Bacterioplankton consist of species that are saprothrophic, obtaining energy by consuming organic material produced by other organisms, as well as autotrophic, deriving energy from either photosynthesis or chemosynthesis. Bacterioplankton occupy a range of ecological niches in aquatic systems and play roles in nitrogen fixation, nitrification, denitrification, reminieralisation, and methanogenesis. Bacterioplankton are the most important decomposers of organic matter, balancing phytoplankton and other primary producers that create new organic matter.

Phytoplankton

Phytoplankton are comprised of primary producers that form the base of the marine food web through photosynthesis. Comprised primarily of unicellular or colonial algae, phytoplankton provides a food source for zooplankton, fish and marine bacteria. The primary phytoplankton species located within Santa Monica Bay are: dinoflagellates (Order Dinoflagellata), diatoms (Class Bacillariophyceae) and blue-green algae (Class Myxophyceae). Dinoflagellates tend to dominate the water column. However, during periods of upwelling or storm runoff, diatoms can dominate the phytoplankton community in the water column due to the increased levels of nutrients in the photic zone.

Zooplankton

Zooplankton are comprised of animals that consume other organisms or organic material. Zooplankton forms the primary link between phytoplankton and larger organisms and represents a wide array of organisms that may spend all or only a portion of their life cycle as plankton. Protozoan, gelatinous animals and small crustaceans are examples of holoplankton, organisms that remain plankton throughout their lives. On the other hand, meroplankton only spend part of their lives as plankton, usually during the larval stage, before they become nektonic or benthic in their juvenile and adult stages.

While not invertebrates, the planktonic larvae of bony fish are an example of meroplankton, comprising a large portion of the zooplankton collectively referred to as ichthyoplankton. Ichthyoplankton serve as an important indicator of the strength of a fish stock as the abundance of fish larvae is typically an indication of abundance of adult species. Ichthyoplankton common to the nearshore waters of the Bight include northern anchovy (*Engraulis mordax*), white croaker (*Genyonemus lineatus*), Pacific sardine (*Sardinops sagax*), queenfish (*Seriphus politus*), California halibut (*Paralichthys californicus*), and sea basses (*Paralabrax* ssp.) (Watson et al., 2002). Fish larvae previously collected in Santa Monica Bay include northern anchovy, white croaker, unidentified gobies, queenfish, spotted kelpfish (*Gibboisa elegans*), black croaker (*Cheilotrema saturnum*), California clingfish (*Gobiesox rhessodon*), giant kelpfish (*Heterostichus rostratus*) and slender sole (*Lyopsetta exilis*) (CSLC, 2010).

Generally, plankton distribution, abundance and productivity are dependent on light, nutrients, water quality, runoff from land sources and upwelling. Bacterioplankton are found throughout the water column. Phytoplankton are generally restricted to the photic zone since they rely on photosynthesis. Zooplankton tend to be found throughout the water column with species distribution varying according to depth. Plankton distribution within Santa Monica Bay tends to be patchy and characterized by high seasonality and inter-annual variability (CSLC, 2010). Most plankton blooms in Santa Monica Bay occur in response to local conditions that increase nutrient levels. These conditions include runoff, wastewater discharges, and upwelling often caused by nearshore winds and/or coastal eddies. Spring and summer months usually produce more plankton blooms due to longer periods of sunlight. However, blooms can still take place in the fall when stratification breaks down and nutrients from below enter the photic zone. El Niño/La Niña events affect plankton abundance through changes in water temperature, salinity and transport. El Niño events are usually characterized by low zooplankton biomass, while La Niña Events show increases in zooplankton biomass.

5.3.1.2 Infaunal and Epibenthic Invertebrates

The soft-bottom and hard-bottom habitats of Santa Monica Bay support a diverse and abundant assemblage of both infauna and epibenthic invertebrates. Some of these species are listed in Table 5-2.

Table 5-2. Infaunal and Epibenthic Invertebrates in Santa Monica Bay

Common Name	Species	Habitat Type
Anemones	several species	hard bottom
Barnacles	several species	hard bottom
Clams	several species	hard bottom
Cockles	several species	soft bottom
Corals, Brown Cup	*Paracyathus stearnsi*	hard bottom
Corals, Orange Cup	*Balanophyllia elegans*	hard bottom
Crab, Pelagic Red (squat lobster)	*Pleruon planipes*	pelagic
Crab, Red	*Cancer productus*	hard bottom
Crab, Rock	*Cancer antennarius*	kelp, hard bottom
Crab, Sheep	*Loxorhynchus grandis*	soft bottoms
Crab, Yellow	*Cancer anthonyi*	hard bottom
Ectoproct	several species	hard bottom
Gorgonian	several species	hard bottom
Hydroids	several species	hard bottom
Leafy Hornmouth	*Ceratostoma foliatum*	hard bottom
Limpet, Giant Keyhole	*Megathura crenulate*	hard bottom
Limpets	several species	hard bottom
Lobster, California Spiny	*Panulirus interruptus*	kelp, hard bottom
Mussels	several species	hard bottom
Nudibranch	several species	hard bottom
Octopus	several species	kelp, hard bottom, soft bottom
Polychaetes	several species	soft bottoms
Prawn, Ridgeback	*Sicyonia ingentis*	soft bottoms
Prawn, Spot	*Pandalus platyceros*	hard and soft bottom
Rock Scallop	*Crassedoma giganteum*	hard bottom
Sea Cucumber, California	*Sicyonia igentis*	hard and soft bottom
Sea Hare, California	*Aplysia californica*	hard and soft bottom
Sea Slug	*Philine auriformis*	hard bottom, soft bottom
Shrimp, Bay	*Crangon franciscorum*	soft bottom

Table 5-2. Infaunal and Epibenthic Invertebrates in Santa Monica Bay

Common Name	Species	Habitat Type
Snail, Moon	several species	soft bottom
Snail, Top	several species	kelp, hard bottom
Snail, Turban	several species	kelp, hard bottom
Sponges	several species	hard bottom
Squid, California market	*Loligo ssp.*	soft bottom
Star, Serpent	*Ophiura lutkeni*	hard and soft bottom
Star, Spiny brittle	*Ophiothrix spiculata*	hard and soft bottom
Star, Spiny Sandstar	*Astropecten verrilli*	hard and soft bottom
Stars	several species	hard and soft bottom
Urchin, Purple	*Strongylocentrotus purpuratus*	hard bottom
Urchin, White	*Lytechinus picuts*	hard and soft bottom
Whelk, Kellet's	*Kelletia kelletii*	hard bottom

Residing within sediments of the seafloor, abundance and distribution of infauna typically varies seasonally and inter-annually. However, in Santa Monica Bay the dominant infaunal organism is polychaete worms. Polychaete worms for the most part feed by ingesting sediments and digesting the attached bacteria, filter feed on bits of organic detritus in the water or prey upon other infauna. Polychaetes play an important role in the marine benthos by reworking sediments, while serving as a food source for many demersal fish.

Santa Monica Bay has diverse and abundant assemblage of epibenthic invertebrates that reside on the seafloor. These species are larger than infauna and are generally less common. While single species tend to be dispersed spatially from each other, sand dollars and sea urchins tend to occur in dense, single-species patches. Epibenthic invertebrates can be motile (mobile) or sessile (non-mobile). Motile epibenthic invertebrates include: sea stars, sea cucumbers, sand dollars, sea urchins, crabs, lobster, snails, octopus, shrimp and sea slugs. Sessile species often inhabit hard-bottom substrate and include mussels, rock scallops, barnacles, sponges, sea anemones, sea fans, feather duster worms, worm snails, and sea squirts. Most of these sessile invertebrates feed by filtering plankton and detritus from the water column.

Trawls conducted within Santa Monica Bay in 2001 and 2002 indicated that echinoderms were the most abundant group in terms of both numbers and biomass (City of Los Angeles, 2003). Epibenthic species trawl-caught included:

- White urchin (*Lytechinus pictus*)
- Spiny sandstar (*Astropecten verrilli*)
- California sea cucumber (*Parastichopus californicus*)
- Ridgeback prawn (*Sicyonia ingentis*)
- Sea slug (*Philine auriformis*)
- Sand star (*Luidia foliolata*)
- Serpent star (*Ophiura lutkeni*)
- Spiny brittle star (*Ophiothrix spiculata*)

5.3.1.3 Protected Invertebrate Species

Abalone

Abalone are large marine snails historically found in rocky intertidal and subtidal areas, clinging to rocks and feeding off kelp and other algae. Abalone species used to comprise a highly valuable fishery in Southern California; however, their numbers have greatly dropped due to factors that include overharvesting, illegal harvesting, predation, disease, and El Niño events. Of the seven abalone species historically found in the Bight and Santa Monica Bay, four are federally listed as either endangered or as a species of concern and one (flat abalone) is no longer found south of Point Conception (Table 5-3).

Table 5-3. Abalone Species of the Santa Monica Bay

Common Name	Species Name	Protected Status	Preferred Depth (Feet)
Black Abalone	*Haliotis cracheirodii*	Federal Endangered	Intertidal to 20’
Green Abalone	*Haliotis fulgens*	Federal Species of Concern	Intertidal to > 30’
Pink Abalone	*Haliotis corrugate*	Federal Species of Concern	20’ to >120’
White Abalone	*Haliotis sorenseni*	Federal Endangered	Subtidal to >200’
Red Abalone	*Haliotis refescens*	None	Subtidal to >100’
Threaded Abalone	*Haliotis assimilis*	None	20’ to >80’

Source: CSLC, 2010

6.0 HUMAN USES

This section describes the marine infrastructure and human activities within the study area that may be impacted by construction, operation, and maintenance activities associated with the undersea ground electrode system.

6.1 Infrastructure

Based on a review of marine charts of Santa Monica Bay, no existing outfall pipes, bridges, ramps, or other corrodible metallic structures occur within a 5-km radius of the existing marine electrode location. Several piers and large outfall pipes are located in Santa Monica Bay; however, all reside outside of the study area (Figure 6-1). The Santa Monica Pier is the closest infrastructure to the existing electrode location and is just outside of the 5-km study area. Other major infrastructure along the coastline such as the Hyperion WWTP, Chevron El Segundo Refinery, and Joint WPCP are each located well south of the study area, while the Malibu Pier is located well to the north.

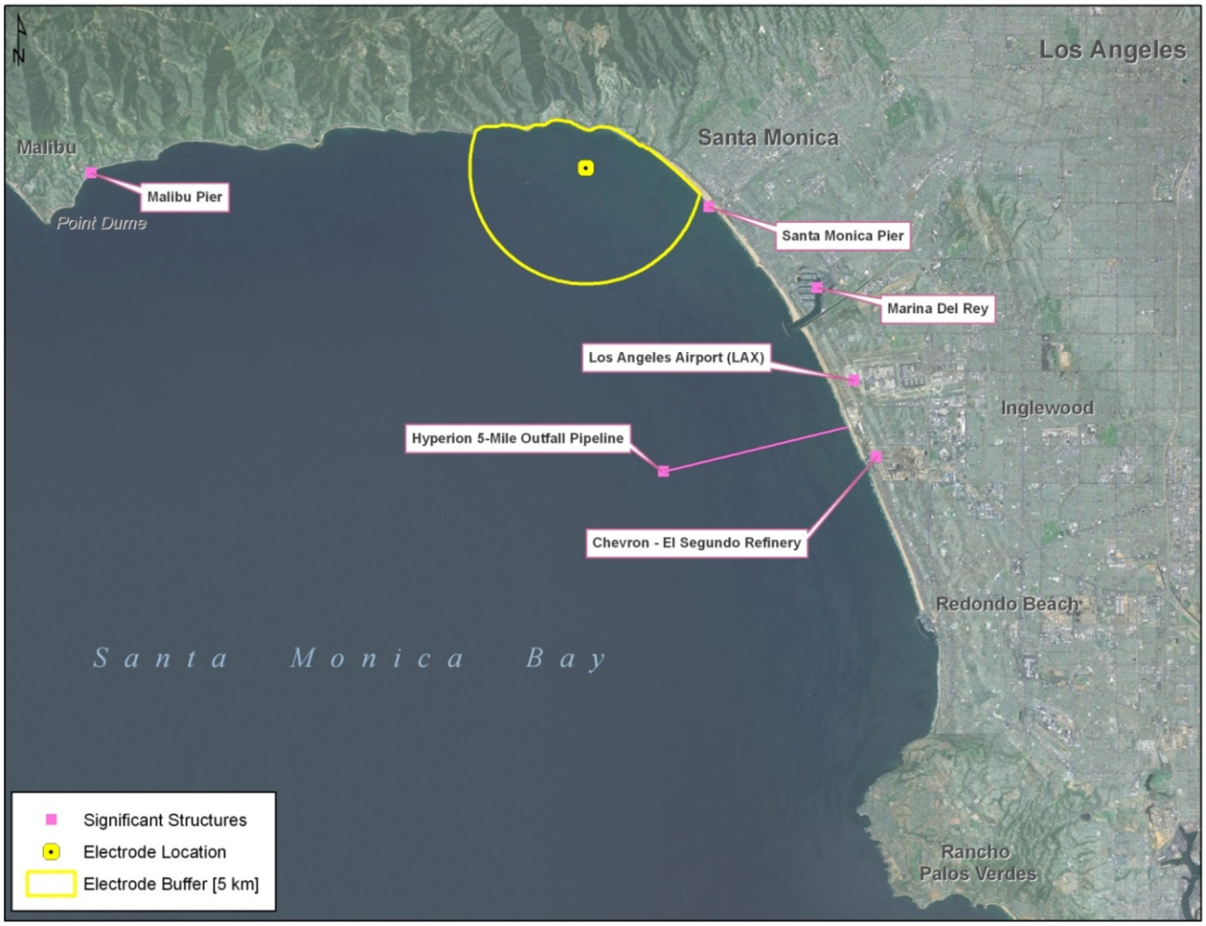


Figure 6-1. Existing Infrastructure in the Vicinity of the Study Area

6.2 Commercial and Recreational Uses

The coastal and offshore portions of the study area support a myriad of commercial and recreational uses. The location is a popular recreational and leisure area located between Topanga State Beach to the west by approximately 1.5 miles and Will Rogers State Beach to the south and east by approximately 0.75 miles.

Santa Monica Bay is one of the world's most populous urban areas. Nearly 1.9 million people live in the Santa Monica Bay watershed, which comprises 22 public beaches, 22 miles of bike path, and 55 miles of shoreline (Heal the Bay, 2011). Each year, approximately 50 million people visit Santa Monica Bay beaches to enjoy recreational sports, such as fishing, surfing, swimming, kayaking, offshore canoeing, windsurfing, paddle boarding, kite boarding, beach combing, boating, parasailing, and diving. Much of California's coastal economy, which is valued at $43 billion, and the Los Angeles area's economy, depend upon tourism and recreation (Heal the Bay, 2011). Jobs depend on tourist dollars and also on the fishing opportunities, surf lessons, and surf stores, and over 7,200 private boats at two harbors within the area. The nearest harbors to the study area include Marina Del Rey and Redondo Beach.

6.2.1 Commercial Uses

Commercial uses within the study area predominantly involve commercial fishing, but also include tourism-related businesses such as surfing instruction, whale watching, parasailing, party boat fishing, scuba diving, photography, and movie production. Although kelp harvesting occurs along the California coast, the study area is in Administrative Kelp Bed Area 15, which is closed to harvesting. A similar environmental impact study was recently conducted in Santa Monica Bay for the Chevron El Segundo Marine Terminal Lease Renewal Project and was used as source information for this discussion (CSLC, 2010).

6.2.1.1 Commercial Fishing

The study area lies within CDFG statistical fish-block unit 679 and is adjacent to blocks 680 to the west and 701, 702, and 703 to the south (Figure 6-2). Fish-block data specific to the study area block can be obtained through written requests to the CDFG Field Office in Los Alamitos, CA but was beyond the scope of this initial investigation. Because the recent data was not readily available, the data provided in the CSLC, 2010 report were used to provide an overview of commercial fishing activities found in the area. Rankings of the commercial landings of the 16 block area of Santa Monica Bay are provided in Table 6-1 by weight and by dollar value. Sardine, squid, mackerel, anchovy, and urchin comprised the largest mass of commercial fish landings in the area. By dollar value, squid, sardine, and urchin comprised the top three landings.

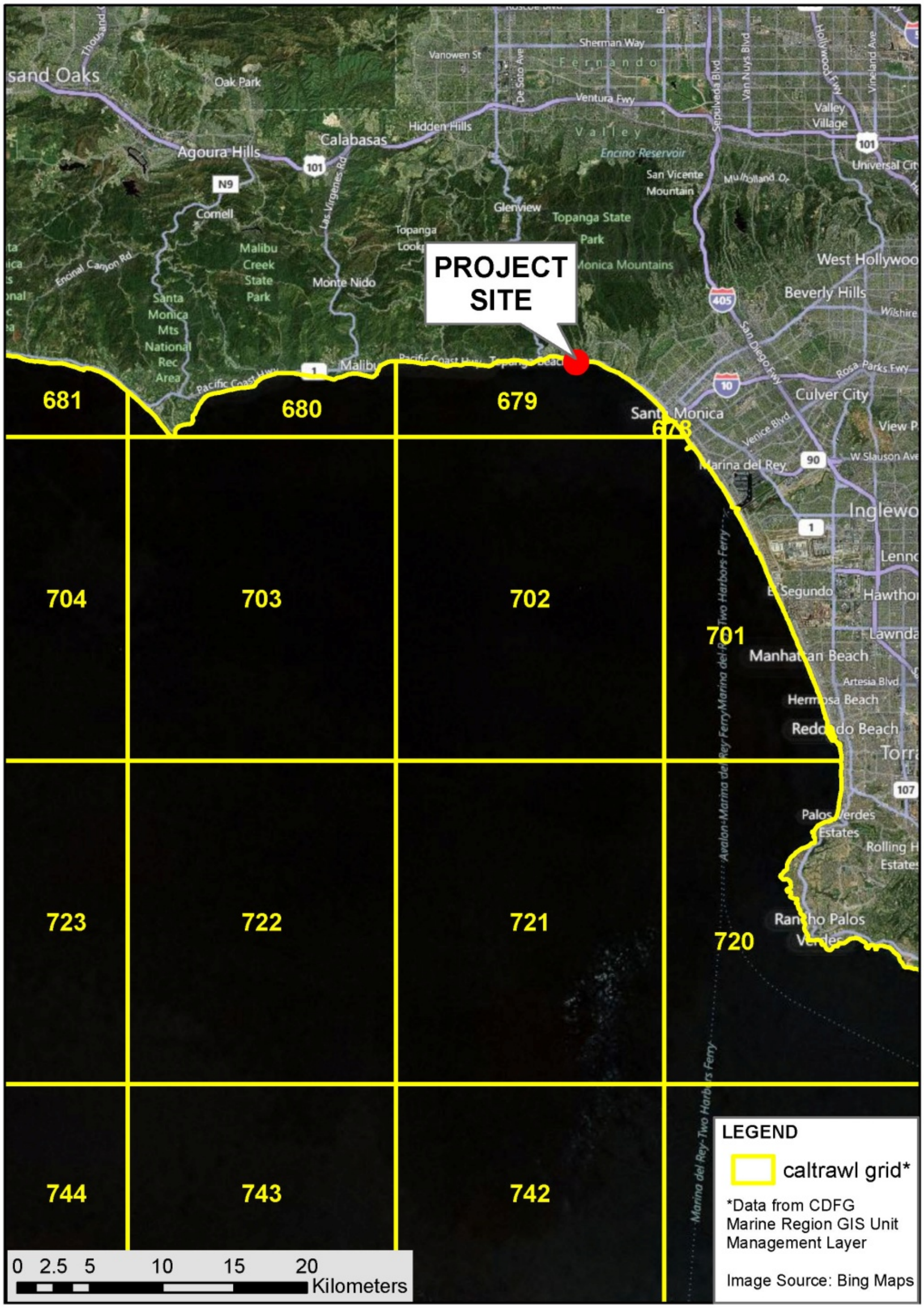


Figure 6-2. Location of California Department of Fish and Game Fish Blocks in the Project Vicinity

Table 6-1. Ranking of Commercial Fisheries in the Santa Monica Bay 16-Block Survey Area

Fishery	Total Pounds (Tons)		Fishery	Dollar Value (M)	
	Weight	Percent		$ Value	Percent
Sardine	98,132.30	58.10%	Squid	13.83	34.40%
Squid	45,426.30	26.90%	Sardine	8.12	20.20%
Mackerel	15,171.10	9.00%	Urchin	4.51	11.20%
Anchovy	4,577.90	2.70%	Lobster	3.95	9.80%
Urchin	2,551.80	1.50%	Rockfish	2.43	6.00%
Tuna	653.1	0.40%	Mackerel	1.96	4.90%
Rockfish	550.7	0.30%	Crab	1.23	3.10%
Crab	450.2	0.30%	Sablefish	0.55	1.40%
Lobster	251.9	0.10%	Shrimp	0.49	1.20%
Sablefish	245.5	0.10%	Halibut	0.45	1.10%
Barracuda	163	0.10%	Anchovy	0.38	0.90%
Sea Cucumber	163	0.10%	Tuna	0.38	0.90%
Shark	116.5	0.10%	Shark	0.29	0.70%
Shrimp	80.2	0.00%	Sea Cucumber	0.28	0.70%
Other fish	77.8	0.00%	Seabass	0.26	0.60%
Halibut	69.4	0.00%	Sheephead	0.24	0.60%
Sheephead	66.4	0.00%	Other invertebrate	0.2	0.50%
Seabass	50	0.00%	Swordfish	0.18	0.50%
Herring	44.3	0.00%	Barracuda	0.14	0.40%
Snail	27.9	0.00%	Other fish	0.14	0.40%
Other taxa	148.5	0.10%	Other taxa	0.17	0.50%
Grand Total	**169,017.90**	**100.00%**	**Grand Total**	**40.19**	**100.00%**

Notes: 1 ton = 0.9 metric ton; M= millions of dollars.
Source: CSLC, 2010; CDFG, 2007.

Although data was not readily available (at the time of this report) for Block 679, the study area is directly adjacent to Block 701, which is readily available and provides insight into Block 679. Block 701 represents only 0.5% of the overall landings value and mass in comparison to the entire Santa Monica Bay wide 16-Block Area (Table 6-2).

Commercial Fishing Gear

Commercial fishers utilize fishing gear capable of targeting multiple species, including:

- Seines for coastal pelagics such as sardine, northern anchovy, mackerel, and market squid;
- Trawls for shrimp, sole, flounder, and halibut;
- Hook and line/longlines for rockfish and other rocky outcrop fish;
- Traps for crab and lobster;
- Drift/set gillnets for shark and swordfish; and
- Trawls for albacore and salmon (CSLC, 2010).

Table 6-2. Ranking of Top 15 Commercial Fisheries Operating in Fish Block 701

Fishery	Weight (Tons)	Fishery	Value ($M)
Squid	728.5	Squid	0.2
Sardine	166.5	Halibut	0.03
Urchin	12.3	Sardine	0.02
Shark	9.3	Shark	0.02
Halibut	4.7	Urchin	0.02
Anchovy	3.6	Lobster	0.01
Sea Cucumber	1.6	Crab	<0.01
Mackerel	1.5	Rockfish	<0.01
Crab	1.3	Seabass	<0.01
Barracuda	1	Sea Cucumber	<0.01
Rockfish	0.9	Barracuda	<0.01
Seabass	0.6	Other invertebrates	<0.01
Lobster	0.5	Sheephead	<0.01
Surfperch	0.5	Anchovy	<0.01
Mussel	0.5	Surfperch	<0.01
Total	**933.2**	**Total**	**0.32**

Source: CLSC, 2010, CDFG 2007.

Comparisons of gear type in Block 701 are provided in Table 6-3. Seiners targeting squid were responsible for landing the largest biomass within the 16-block study area, and accounted for the largest catch within the Block 701, which is directly adjacent to the project location (CSLC, 2010). Trawls and traps were listed as the predominantly used method in Block 701 to catch the non-finfish, such as urchin, shrimp, lobster, and crab that have historically been the most profitable catch at that site over the past decade (CLSC, 2010).

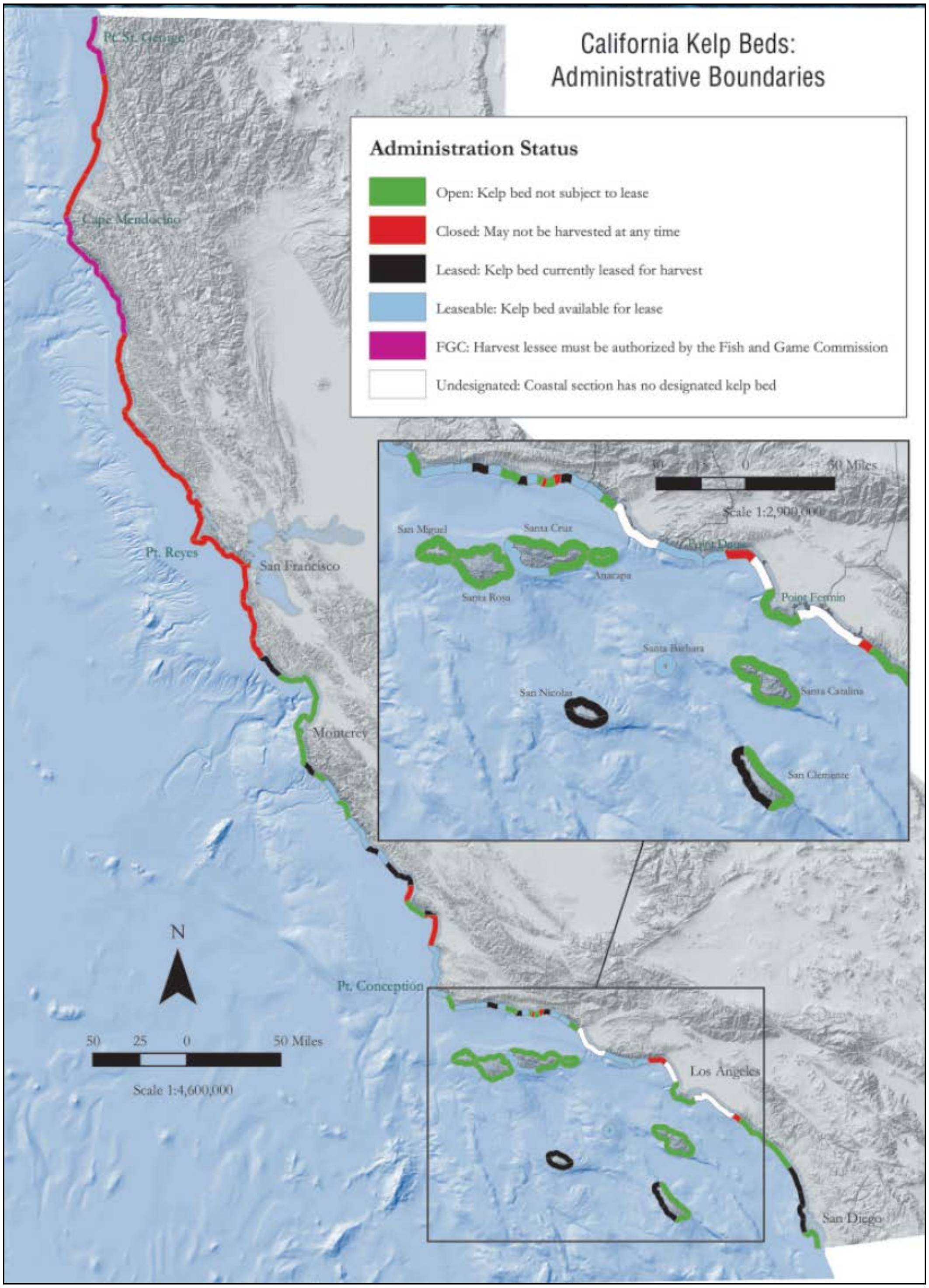
Table 6-3. Comparison of Commercial Fish Landings as a Function of Gear Type

Gear	Weight (Tons)		Gear	Value ($M)	
	Region	Block 701		Region	Block 701
Seine	160,432.50	616.1	Seine	23.37	0.12
Net	3,066.40	282.7	Trap	6	0.01
Diving	2,668.30	14	Diving	4.87	0.03
Hook & Line	932.4	16	Hook & Line	3.19	0.06
Trap	883.6	2.1	Net	1.23	0.1
Gill Net	415.5	3.1	Gill Net	1	0.01
Other	251.8	0.7	Trawl	0.34	0
Trawl	154	0.1	Harpoon	0.14	0
Troll	92.6	0	Troll	0.03	0
Harpoon	55.4	0	Other	0.03	0
Grand Total	**169,017.90**	**934.6**	**Grand Total**	**40.19**	**0.33**

Notes: data from 1996-2007
Source: CDFG, 2007

6.2.1.2 Kelp Harvesting

Although kelp harvesting occurs along the California coast, the study area is in Administrative Kelp Bed Area 15, which is closed harvesting at any time (Figure 6-3).



Source: CDFG, 2001

Figure 6-3. California's Administrative Kelp Beds

6.2.2 Recreational Uses

Recreational uses include sports like fishing, surfing, swimming, kayaking, paddle boarding, kite boarding, beach combing, boating, parasailing, and diving. Additionally, whale watching is also enjoyed by many visitors who board party boat fishing charter vessels from December through April of each year.

6.2.2.1 Fishing

Recreational fishing includes fishing from the shore, from boats originating from the two local harbors (Marina Del Rey and Redondo Beach), from kayaks launching from local shores, and by divers. Within the vicinity of the study area, two artificial reef locations exist. The TAR and SMBAR complexes were both constructed of 20,000 and 10,000 tons of quarry rock, respectively (Table 4-1). Both reef complexes provide rock structure desirable for recreational boaters to visit and lie in water depths ranging from 28 ft for TAR to 78 ft for SMBAR, making them readily accessible for diving and recreational fishing.

Primary species targeted by recreational fishermen include California halibut, kelp bass (*Paralabrax clathratus*), barred sand bass (*Paralabrax nebulifer*), rockfishes, chub mackerel, Pacific bonito (*Sarda chiliensis*), white seabass (*Atractoscion nobilis*), and Pacific barracuda (*Sphyraena argentea*). The sandy shelf areas are fished mainly for pelagic species such as bonito and barracuda, and bottom dwelling species, such as California halibut (*Hippoglossus stenolepis*). In contrast, vermilion rockfish (*Sebastes miniatus*), bocaccio (*Sebastodes paucispinus*), and chilipepper rockfish (*Sebastes goodei*) are taken along the Redondo and Santa Monica Submarine Canyons and along the shelf off Hermosa Beach. Vermilion rockfish, olive rockfish, and bocaccio are caught in the rocky substrates off Point Dume (Squire and Smith, 1977) (CSLC, 2010).

Due to the lack of reliable recreational fish landing data specific to the study area, recreational fishing effort was analyzed for the region comprising the coastlines of San Diego, Orange, and Los Angeles Counties. Table 6-4 provides a summary of the top 10 fish species caught in nearshore (less than 3 nautical miles) coastal waters throughout this region from 2004-2009. The numbers provided in the table are conservative estimates of catch landings because reporting is voluntary, and many catches go unreported (CSLC, 2010).

Table 6-4. Top 10 Individual Fish Species Recreationally Harvested Within 3 Nautical Miles of Shore in Southern California from 2004 to 2009

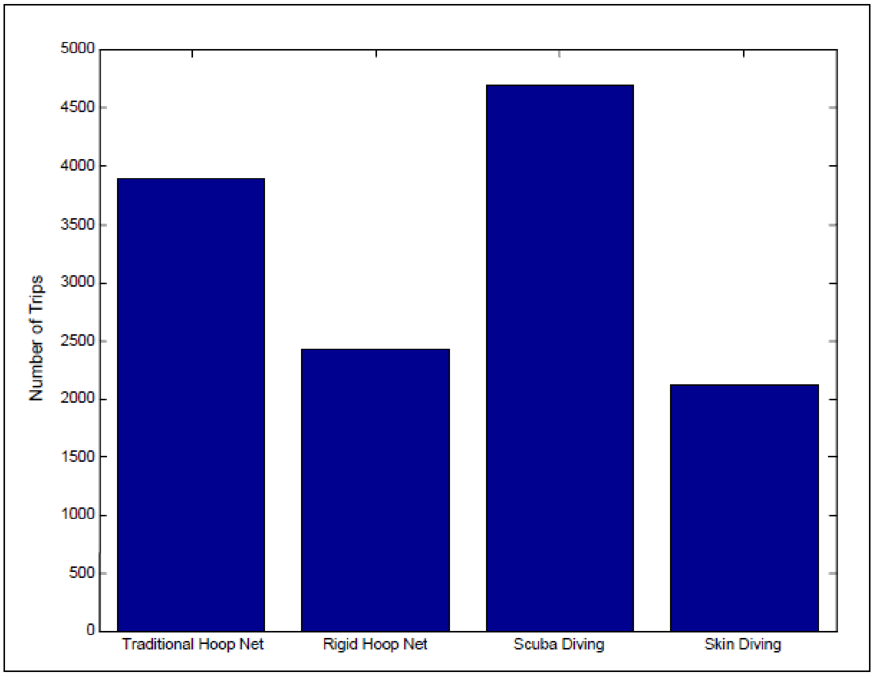
Taxon	Reported Catch[3] (# of fish)	
	2004-2009	2009
Pacific Mackerel (*Scomber japonicas*)	3955	475
Pacific Sardine (*Sardinops sagax caerulea*)	1877	361
Barred Sand Bass (*Paralabrax nebulifer*)	1218	66
Kelp Bass (*Paralabrax clathratus*)	1098	108
Pacific Bonito (*Sarda chiliensis lineolata)*	888	20
Barred Surfperch (*Amphistichus argenteus*)	837	72
Queenfish (*Seriphus politus*)	701	61
Jacksmelt (*Atherinopsis californiensis*)	583	78
Yellowfin Croaker (*Umbrina roncador*)	402	73
California Scorpionfish (*Scorpaena guttata*)	328	33

Notes: 3 Total fish counts for San Diego to Los Angeles areas as defined by RecFIN database.

Source: CSLC, 2010 and Pacific States Marine Fisheries Commission, 2010.

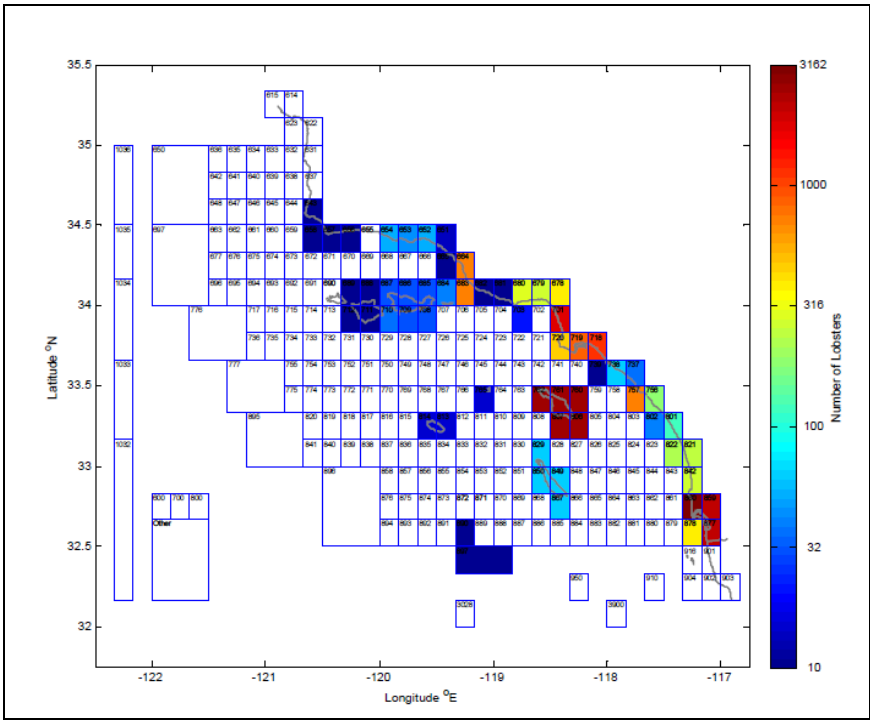
Several nearshore fishes are targeted in the surf zone in the Santa Monica Bay, where they are commonly caught from piers or the beach. These include California corbina (*Menticirrhus undulates*), barred surfperch (*Amphistichus argenteus*), and shovelnose guitarfish (*Rhinobatos productus*). California halibut are frequently caught from shore as well, particularly when they move inshore to feed on California grunion (*Leuresthes tenuis*), which come ashore to spawn on the sandy beaches within the Santa Monica Bay (CSLC, 2010).

Lobster fishing is also a popular recreational activity. The legal season occurs primarily from October 1 through mid-March of each year and specified annually by CDFG. The California spiny lobster (*Panulirus interruptus*) is taken primarily by diving (scuba or skin) or hoop netting. CDFG conducted a study during the first half of the 2008-2009 Lobster Season and included surveys of data taken from Block 679 (study area) and adjacent blocks up and down the California coast. The area from Santa Monica to Malibu Point ranked in the top 12 (at #9) of all California locations during the 2008-2009 Season and the 2009 Season and represented 2.8% of the overall recreational catch in California (CDFG, 2011). The total number of trips within LA County was estimated upwards of 3,000 trips (at 20% estimated reporting). Scuba diving was the single most common method used to collect lobsters (Figure 6-4). Specific catch data via hoop netting for the 6-block area adjacent to the study area ranged from as low as 10 lobsters in Block 703 to over 1,000 lobsters in Block 701. Block 679 was approximated between 100 and 300 lobsters (Figure 6-5). In contrast, specific catch data via diving for the 6-block area adjacent to the study area ranged from approximately 300 lobsters in Block 679 to over 1,000 lobsters in Blocks 680 and 701 (Figure 6-6).



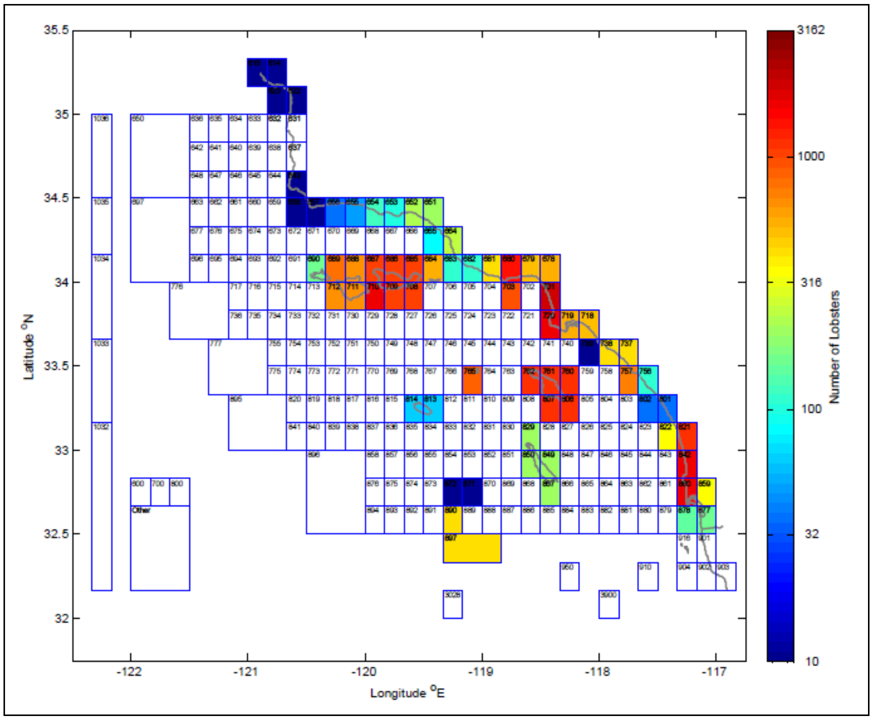
Source: CDFG, 2010.

Figure 6-4. Lobster Catch Methods and Trip Counts during the First Half of the 2008-2009 Lobster Season



Source: CDFG, 2010.

Figure 6-5. Geographic Block Data Showing Estimated Lobster Catches via Hoop Netting during the First Half of the 2008-2009 Lobster Season.



Source: CDFG, 2010.

Figure 6-6. Geographic Block Data Showing Estimated Lobster Catches via Diving during the First Half of the 2008-2009 Lobster Season.

6.2.2.2 Surfing

A popular surf destination is located at Topanga State Beach and the Rocky Point and cove at Sunset Blvd. Topanga point is an intermediate surfing location where the waves break over a rocky point. Topanga becomes more crowded during strong south and west swells as many other popular beach breaks in Santa Monica and South Santa Monica Bay close out. Sunset Blvd (Sunset) is considered a novice/beginner spot that tends to break softly over a rocky/sand bottom. It is primarily a right point break but also has a short left break that approaches the project site. Similar to Topanga, Sunset also becomes more crowded with larger swells as the South Santa Monica Bay beach breaks begin to close out. These periods of larger swells can occur year round with large winter swells from Pacific storms and during summer from Mexican hurricane swells and southern hemisphere swells. Project construction has the potential to impact the Sunset surf break since the cable route to the Gladstone Vault is immediately adjacent to the location. Impacts that could occur include limited accessibility to parking, access to the beach, and potential for shifting sands. However, potential shifting sands and rock alignments also has the potential to cause short-term improvements in the surfing conditions as well.

6.2.2.3 Kayaking, Paddle Boarding, and Kite Boarding

Kayaking has recently gained popularity since the advent of the plastic molded kayak. Topanga is a popular launching location for near shore kayak fishing and surf kayaking. Although kayaks may traverse the area, construction activities or underground cabling is not expected to impact accessibility to local areas.

Paddle Boarding, which includes both stand up paddling and prone position paddling, is also a common water recreational activity. Paddle boarding includes stand up paddle surfing but is more commonly done for distance and sprint racing and for exercise. Although paddle boarders may traverse the area, construction activities or underground cabling is not expected to impact accessibility to local areas.

Kite surfing, one of the newer water sports, has become very popular at Topanga State Beach in the last few years. Kite surfers like Topanga State Beach because it's easy to get to, and because it's often windy. Kites vary in size from 20 square meters to 4 square meters. The stronger the winds are, the smaller the kite. Dangers involved with kite surfing include colliding with other people in the water, and getting tangled up in the taut lines of the kite (Topanga Messenger, 2003). Kite surfing has the potential to be impacted by construction activities and warning signs would be recommended at upwind locations such as Topanga if construction activities include cranes or other heavy equipment that pose a tangling potential with kiting activities.

7.0 REQUIRED REGULATORY PERMITS AND APPROVALS

Biological resources in the vicinity of the study area are regulated by a variety of federal, state, and local laws. This section discusses the relevance of these statutes to the proposed Project. In addition, quantitative guidelines, standards, limits, and restrictions promulgated in the regulations form the basis for many of the criteria used to evaluate the significance of the proposed Project's impacts to marine resources.

7.1 Federal

7.1.1 Regulatory Agencies

NMFS, USFWS, and USEPA are the federal agencies responsible for the protection of biological resources and water quality within Santa Monica Bay. The USCG is responsible for enforcing U.S. maritime laws, including the enforcement of environmental regulations. The mission and jurisdiction of each of these agencies is listed below:

National Marine Fisheries Service

The mission of the NMFS reads "Stewardship of living marine resources through science-based conservation and management and the promotion of healthy ecosystems." NMFS, which is also known as NOAA Fisheries, is responsible for the management, conservation and protection of living marine resources within the United States Exclusive Economic Zone. The agency also plays a supportive and advisory role in the management of living marine resources in coastal areas under state jurisdiction and provides scientific and policy leadership in international conservation and management (NOAA Fisheries, 2011).

U.S. Fish and Wildlife Service

The mission of the USFWS is "working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people." USFWS activities include, but are not limited to: enforcing the federal Endangered Species Act; acquiring wetlands, fishery habitats, and other lands for restoration and preservation; insuring compliance with the National Environmental Policy Act (NEPA); managing National Wildlife Refuges and National Fish Hatcheries; and reviewing and commenting on all water resource projects (California Environmental Resources Evaluation System, 2011).

U.S. Environmental Protection Agency

The mission of the USEPA is "to protect human health and the environment." The USEPA ensures that environmental laws are enforced fairly and effectively and that environmental protection is considered in policies of the United States (USEPA, 2011). USEPA, working in conjunction with state and local water boards regulates inputs of pollutants to receiving waters under the CWA.

U.S. Coast Guard

The mission of the USCG is "to protect the public, the environment, and U.S. economic interests — in the nation's ports and waterways, along the coast, on international waters, or in any maritime region as required to support national security." The USCG works together with military personnel to save lives, enforce laws, operate ports and waterways, and protect the environment (USCG, 2011). The USCG is responsible for the oversight of responses to hazardous material discharges, such as oil spills, and ensures that safe navigation is maintained.

7.1.2 Legislations and Regulations

Federal legislation covering the protection of biological resources in the Santa Monica Bay region includes:

- Bald and Golden Eagle Protection Act;
- Clean Water Act;
- Coastal Zone Management Act;
- Endangered Species Act;
- International Maritime Organization Resolution A.868(20);
- Magnuson-Stevens Fishery Conservation and Management Act;
- Marine Mammal Protection Act;
- Marine Protection, Research, and Sanctuary Act;
- Migratory Bird Treaty Act; and
- National Invasive Species Act.

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act of 1940 protects bald and golden eagles by prohibiting “anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles, including their parts, nests, or eggs. The Act provides criminal penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle ... [or any golden eagle], alive or dead, or any part, nest, or egg thereof." The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." Enforcement of the Bald and Golden Eagle Protection Act falls under the USFWS (USFWS, 2010).

Clean Water Act

The CWA of 1972 established the basic structure for regulating discharges of pollutants into the waters of the U.S. and established minimum water quality standards for surface waters. Enforcement of CWA falls under the USEPA and USCG. Compliance with the CWA is provided by approval of a NPDES permit from the California State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCBs) (USEPA, 2011).

Coastal Zone Management Act

The Coastal Zone Management Act is administered by NOAA's Office of Ocean and Coastal Resource Management and provides for management of the nation's coastal resources and balances economic development with environmental conservation. Specifically, the objectives of the Coastal Zone Management Act are to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone" (U.S. Department of Commerce, 2011).

Endangered Species Act

The Endangered Species Act (ESA) of 1973 protects and conserves threatened and endangered species of plants and animals and their ecosystems. The law "requires federal agencies to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat of such species." The "taking" of any listed species of endangered fish or wildlife is prohibited under this act. Similarly, the import, export, interstate, and foreign commerce of listed species are all generally prohibited. Enforcement of ESA falls under USFWS and NMFS jurisdiction (USEPA, 2011b).

International Maritime Organization Resolution A.868(20)

The International Maritime Organization adopted Resolution A.868(20) entitled "Guidelines for the Control and Management of Ship's Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens." This resolution regulated the development and maintenance of ballast water management plans for international shipping and transport and is aimed at minimizing the transfer and dispersal of nonindigenous aquatic organisms.

Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act of 1976 established U.S. jurisdiction over the ocean area from 3 to 200 miles offshore (the Fishery Conservation Zone) and it established a new system of government for managing fishery resources in the form of eight regional fishery management councils. Additionally, the Magnuson-Stevens Act established new goals and criteria for fisheries management and put in place new procedures for managing fisheries (NOAA/ NMFS, 1996).

Marine Mammal Protection Act

MMPA was enacted by Congress in 1972 to prohibit the taking of marine mammals in U.S. waters and to prohibit the taking of marine mammals by U.S. citizens on the high seas. It also prohibits the importation of marine mammals and marine mammal products into the U.S. MMPA was substantially amended in 1994 to provide for certain exceptions to the take prohibitions. It defines "take" to mean "to hunt harass, capture, or kill" any marine mammal or attempt to do so. The inclusion of harassment in the definition was a groundbreaking action by Congress. Exceptions to the moratorium can be made through permitting actions for take incidental to commercial fishing and other nonfishing activities; for scientific research; and for public display at licensed institutions such as aquaria and science centers. NMFS is charged with protecting whales, dolphins, porpoises, seals, and sea lions, while USFWS is charged with protecting walrus, manatees, otters, and polar bears (NOAA Fisheries, 2011).

Marine Protection, Research, and Sanctuary Act

Titles I and II of the Marine Protection, Research, and Sanctuaries Act, prohibit the transportation of material from the U.S. for the purpose of ocean dumping; the transportation of material from anywhere for the purpose of ocean dumping by U.S. agencies or U.S.-flagged vessels; and the dumping of material transported from outside the U.S. into the U.S. territorial sea. Deviation from any of these statutes requires a permit issued by NOAA (USEPA, 2011c).

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) prohibits the "take" of migratory birds, their eggs, feathers or nests without a permit. "Take is defined in the MBTA to include by any means or in any manner, any attempt at hunting, pursuing, wounding, killing, possessing or transporting any migratory bird, nest, egg, or part thereof." In total, 836 bird species are protected by the MBTA, 58 of which are currently legally hunted as game birds. A migratory bird is defined as any species or family of birds that live, reproduce or migrate within or across international borders at some point during their annual life cycle. The responsibilities of federal agencies to protect migratory birds are set forth in Executive Order 13186. USFWS is the lead agency for migratory birds (USFWS, 2011b).

National Invasive Species Act

The National Invasive Species Act was originally passed by Congress in 1990 in response to a zebra mussel invasion that impacted the Great Lakes. The Act has since been reauthorized in 1996 and 2007 and expanded to include salt water flushing of ballast water. Under the National Invasive Species Act, ships arriving from outside the US Exclusive Economic Zone (a 200-mile boundary around the US) are required to exchange their ballast water at sea (National Environmental Coalition on Invasive Species, 2011).

7.2 State

Biological resource protection for waters within the State of California is primarily the responsibility of CDFG. CDFG regulates both fishing and hunting within the state's boundaries and is also responsible for the protection of all state-listed threatened and endangered species, as well as candidates for listing as threatened or endangered. Additionally, habitat protection of biological resources and protection of California Species of Special Concern falls under the responsibility of the CDFG.

Water quality standards within the State of California are set forth and enforced by SWRCB and regionally by the LARWQCB. Water quality standards for Santa Monica Bay and other coastal water bodies within the state are prescribed in the California Ocean Plan.

State legislation that applies to the protection of biological resources within Santa Monica Bay and its surrounding waters includes:

- California Coastal Act of 1976;
- California ESA;
- California Fish and Game Code;
- California Environmental Quality Act of 1970;
- California Marine Invasive Species Act of 2004;
- California Ocean Plan of 2005
- Water Quality Control Plan: Los Angeles Region Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties
- Marine Life Protection Act of 1999;
- California Marine Managed Areas Improvement Act of 2000; and
- Porter-Cologne Water Quality Control Act.

California Coastal Act

The California Coastal Act was enacted in 1976 to regulate development within the "coastal zone," a zone extending three miles seaward and generally 1,000 yards inland. Almost all development within the coastal zone, and its wetlands, requires a coastal development permit from either the Coastal Commission or a local government that has a certified Local Coastal Program (California Environmental Resources Evaluation System, 2011). The California Coastal Act was designed to guide local and state decision-makers in the management of coastal and marine resources, and mandates that coastal development shall not interfere with the public's right to access the beach. Priority is placed on public and private recreation over residential development and limitations are placed on coastal armoring and land alteration. The California Coastal Act includes protections for environmentally sensitive habitat, water quality, and wetlands, stating that "Marine resources shall be maintained, enhanced, and, where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes."

California Endangered Species Act

The California Endangered Species Act (CESA) provides for the protection of all native endangered or threatened species of plants, and their habitats, within the State of California (CDFG, 2011b). It also provides protection for those species experiencing a significant decline which, if not halted, would lead to a threatened or endangered designation. The CDFG is responsible for enforcing the CESA and for establishing criteria for determining the threatened or endangered status of a given species. State agencies are required to consult with the CDFG to ensure that any actions they undertake will not adversely impact essential habitat or jeopardize the existence of threatened or endangered species.

California Fish and Game Code

The California Fish and Game Code places restrictions on the take of protected species, defines sport fishing and hunting regulations and seasons, defines refuge boundaries and addresses other licensure requirements for particular varieties of fish and game (Justia.com, 2011).

California Environmental Quality Act

The California Environmental Quality Act (CEQA) is a state statute passed in 1970 that institutes a statewide policy for environmental protection. This passing of this act followed the federal government's ratification of NEPA. CEQA requires state and local agencies within California to follow a protocol of analysis, provide public disclosure of environmental impacts for proposed projects, and adopt feasible measures to mitigate any perceived impacts to the environment from said project (CDFG, 2011)

Water Quality Control Plan: Los Angeles Region
Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties

The Water Quality Control Plan for the Santa Clara River and Los Angeles River Basins (Basin Plan) for the Los Angeles Region is "designed to preserve and enhance water quality and protect the beneficial uses of all regional waters." Beneficial uses and water quality objectives are specified within this plan for surface and ground waters within Los Angeles and Ventura Counties. The Basin Plan incorporates all applicable State and Regional Board plans and policies and other pertinent water quality policies and regulations for the region and is the main policy document that guides the LARWQCB. The Basin Plan is the primary policy document that guides the LARWQCB. The Basin plan is reviewed and updated regularly and following adoption by the RWQCB is subject to review by the SWRCB and the USEPA (SWRCB, 2011).

Marine Life Protection Act

MLPA directs the state of California to reevaluate and redesign California's network of MPAs to more effectively protect the state's biological marine resources and to improve recreational, scientific, and educational opportunities provided by minimally disturbed marine ecosystems. The redesigned network of MPAs is to be done using the best available science and based upon recommendations from stakeholders, the general public, scientists, and resource managers. The six goals of the MLPA are as follows:

- Protect the natural diversity and abundance of marine life, and the structure, function and integrity of marine ecosystems;
- Help sustain, conserve and protect marine life populations, including those of economic value, and rebuild those that are depleted;
- Improve recreational, educational and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, and to manage these uses in a manner consistent with protecting biodiversity;
- Protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic values;
- Ensure California's MPAs have clearly defined objectives, effective management measures and adequate enforcement and are based on sound scientific guidelines; and
- Ensure the State's MPAs are designed and managed, to the extent possible, as a network.

New regulations for the South Coast Region (Point Conception to the Mexican Border) go into effect beginning January 2012 (CDFG, 2011d). No MLPAs occur within the study area but do occur at Point Dume (Point Dume State Marine Conservation Area [SMCA] and Point Dume State Marine Reserve [SMR]) and off Palos Verdes (Point Vicente SMCA and Abalone Cove SMCA).

California Marine Managed Areas Improvement Act of 2000

The California Department of Parks and Recreation (DPR) was designated as the Principal State Agency for marine managed areas by Executive Order in 2000. The California Marine Managed Areas Improvement Act of 2000 extends the DPR management jurisdiction into the marine environment and gives priority to MPAs adjacent to protected terrestrial lands. The act also established the California Marine Managed Areas System, a system that designates three classification levels of marine life protection, as well as one classification level each for water quality protection, cultural heritage protection and recreation use. These designations are State Marine Reserve, State Marine Park, State Marine Conservation Area, State Marine Cultural Preservation Area, State Marine Recreational Management Area and State Marine Water Quality Protection Area. The DPR is the only state agency that has delegated management authority over all State Marine Managed Areas designations (CDFG, 2011e).

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act established nine regional water quality control boards to oversee water quality at a local and regional level. The creation and maintenance of each region's Basin Plan is one the main duties of the RWQCBs. The Basin Plan establishes beneficial uses, water quality objectives, and actions necessary to maintain beneficial uses and control point and non-point sources of pollution for water bodies. Under the auspices of the USEPA, the SWRCB, and nine RWQCBs also have the responsibility of granting CWA NPDES permits for point-source discharges. It should be noted that RWQCB decisions must ultimately be approved by the SWRCB, which has final authority over State water rights and water quality policy (California Environmental Resources Evaluation System, 2011b).

California Ocean Plan

The Water Quality Control Plan, Ocean Waters of California 2005 (California Ocean Plan), is the policy document that guides the SWRCB. The California Ocean Plan provides for the "protection of the quality of the ocean waters for use and enjoyment by the people of the State" by setting forth provisions for the discharge of waste to ocean waters. Essentially, the California Ocean Plan specifies water quality criteria for the protection of beneficial uses of ocean waters of California such as water contact recreation, navigation, sport and commercial fishing, preservation and enhancement of ASBS, marine habitat, and endangered species habitat. The SWRCB reviews the plan at least every three years to guarantee that the current standards are adequate and are not allowing degradation to marine species or posing a threat to public health (SWRCB, 2011).

7.3 Local

Local legislation applicable to the protection of biological resources in the study area includes:

- County of Los Angeles Local Coastal Plan; and
- The Santa Monica Bay Restoration Plan.

The County of Los Angeles and City of Malibu Local Coastal Plans

Both the City of Malibu and the County of Los Angeles have Local Coastal Plans that have been certified by the California Coastal Commission. Certification of these plans indicates that they are consistent with the goals and directives of the California Coastal Act, and thus allow the local governments to directly apply the development, conservation, environmental, and public access protection goals of the Coastal Act to development within their jurisdictions (Coastal California website, 2011).

The Santa Monica Bay Restoration Plan

The Bay Restoration Plan was originally adopted in 1994 and identified almost 250 actions that were needed to address critical problems such as storm water and urban runoff pollution, habitat loss and degradation, and public health risks associated with seafood consumption and swimming near storm drain outlets. The Plan both outlined specific programs to address the environmental problems facing the Bay and identified implementers, timelines, and funding needs. In 2008 the Bay Restoration Plan was updated to acknowledge completed actions and progress made in restoration efforts since its adoption in 1994. The 2008 Bay Restoration Plan consists of 14 goals, 67 objectives, and 170 milestones to fulfill its mission to "improve water quality, conserve and rehabilitate natural resources, and protect the Bay's benefits and values" (Santa Monica Bay Restoration Commission, 2010).

8.0 BIGHT ‘08 DATA RESULTS

The Sylmar Electrode Array lies just offshore of Sunset Blvd. within Santa Monica Bay and within the Southern California Bight (Bight). The Southern California Coastal Water Research Project (SCCWRP) has conducted a regional Bight-wide survey of the health of the waters and sediment in the Bight since 1994. The program is conducted approximately every five years with the most recent survey being conducted during Summer 2008 (Bight ‘08). These surveys included the analysis of sediment chemistry, toxicity, and benthos from stations within relevant proximity to the Sylmar Electrode Array. These results are presented for the purpose of comparing to the baseline samples collected from the Proposed Primary and Secondary cable routes. The Bight ’08 sample locations within proximity to the project include 11 stations ranging from Inner Shelf samples (7517 and 7474) to Upper Slope samples (7428 and 7479). The remaining sample locations occurred on the mid to lower shelf. For the purposes of comparing to the Project Area, the most relevant locations are the two Inner Shelf samples (7517 and 7474), however, all sample results are provided for this discussion.

8.1 Bight ’08 Sediment Chemistry

Sediments collected during Bight ’08 were tested for general chemistry, particle size, trace metals, chlorinated pesticides, PCB congeners, and polynuclear aromatic hydrocarbons (PAHs). Sample results from the area of Santa Monica Bay in proximity to the Sylmar Project are provided in Appendix A. Samples consisted of primarily silts ranging from 7.9% to 55.0% and sands ranging from 36.0% to 90.7% with some clays <8.9%.

Results of chemical analyses (metals, PCBs, chlorinated pesticides, and PAHs were compared to Effects Range-Low (ER-L) and Effects Range-Median (ER-M) values developed by Long et al. (1995). The effects range values are helpful in assessing the potential significance of elevated sediment-associated contaminants of concern, in conjunction with biological analyses. Briefly, these values were developed from a large data set where results of both benthic organism effects (e.g., amphipod toxicity tests) and chemical analysis were available for individual samples. The ER-L was then calculated as the lower 10th percentile of the observed effects concentrations and the ER-M as the 50th percentile of the observed effects concentrations. Therefore, results less than the ER-L do not suggest any effect would occur, results between the ER-L and ER-M may suggest a potential for an effect, and results above the ER-M have a likely potential to cause an effect. While these values are useful for identifying elevated sediment-associated contaminants, they should not be used to infer causality because of the inherent variability and uncertainty of the approach. The ER-L and ER-M sediment quality values are included for comparative purposes only.

8.1.1 Trace Metals

While several trace metals were detected in all samples, no sample results were above the ER-M. Several metals results were detected above the ER-L but below the ER-M and include arsenic, cadmium, chromium, mercury, nickel, and silver. However, all results detected between the ER-L and ER-M occurred in samples collected from the mid shelf (7410 and 7461), outer shelf

(7477), or upper slope (7428 and 7479). All samples collected from the inner shelf had metals detected below the ER-L.

8.1.2 Chlorinated Pesticides

Chlorinated pesticides were detected in all samples within Santa Monica Bay. Several samples had results above the ER-M for Total Detectable DDT primarily related to the legacy breakdown isomers of 4-4' DDD and 4-4' DDE. The sample location closest to the Project Site (7571) had trace level detections of 4-4' DDE and Total Detectable DDT above the ER-L but below the ER-M.

8.1.3 Total PCBs

Trace levels of PCB congeners were detected in all samples collected. However, all Total PCB results were below the ER-L.

8.1.4 Total PCBs

Trace levels of PAHs were detected only in samples 7417, 7458, and 7517. However, all Total PAH results were below the ER-L.

8.2 Bight '08 Sediment Toxicity

Sediment toxicity testing was conducted on a subset of samples (7417, 7517, and 7461) from the project area using the marine amphipod *Eohaustorius estuarius.* Toxicity test results are provided in Appendix A. No toxicity was observed from any samples collected from the project area.

8.3 Bight '08 Benthic Community Measures

Benthic community measures from offshore sites from Bight '08 were also available. The Mainland Shelf Benthic Response Index (BRI; Smith et al., 2001) was used for evaluation purposes and condition assessments were based on those developed by the Bight '08 Program. Response Levels related to the condition assessment are provided in Table 8-1. Other metrics provided include the abundance, number of taxa, Shannon-Wiener Diversity Index (Shannon), Evenness (Pielou, 1969) and Dominance (Swartz et al., 2001). Summary results are shown in Table 8-2 while the benthic invertebrate taxonomy and infaunal taxonomy data are provided in Appendix A.

Sample results for Inner Shelf stations 7474 and 7517 near the project area, had BRI scores of 26.1 and 27.2, respectively and Response Levels of 1, indicating marginal deviation from reference conditions. The remaining stations had BRI scores less than 25 classifying them as reference conditions.

Table 8-1. Response Level Condition Assessment Categories

Response Level	Characterization	Definition	BRI Threshold
Reference	Reference		< 25
Response Level 1	Marginal deviation	> 90% tolerance interval for reference index values	25-34
Response Level 2	Biodiversity loss	> 25% of reference species lost	34-< 44
Response Level 3	Community function loss	> 90% of echinoderm and 75% arthropod species lost	44-72
Response Level 4	Defaunation	> 90% of reference species lost	> 72

Table 8-2. Benthic Community Summary Results

Site	Stratum	Abundance (0.1 m2)	No. of Taxa (0.1 m2)	Shannon-Weiner Index (nats)	Evenness	Dominance	Shelf BRI	Condition
7474	Inner Shelf	194	66	3.63	0.87	26	26.1	RL 1
7517	Inner Shelf	782	137	4.00	0.81	35	27.2	RL 1
7410	Mid Shelf	257	95	4.11	0.90	38	11.1	Reference
7415	Mid Shelf	448	118	4.10	0.86	37	14.5	Reference
7417	Mid Shelf	277	90	4.00	0.89	35	16.6	Reference
7426	Mid Shelf	281	105	4.32	0.93	47	8.4	Reference
7458	Mid Shelf	309	106	4.20	0.90	42	18.4	Reference
7461	Mid Shelf	508	117	4.09	0.86	36	17.4	Reference
7477	Outer Shelf	121	55	3.56	0.89	25	21.1	Reference
7428	Upper Slope	258	47	3.09	0.80	12	NA	NA
7479	Upper Slope	86	26	2.72	0.83	10	NA	NA

NA-Not applicable; No validated condition evaluation tool available.
Source: Appendix E Bight ’08 Community Measures.

9.0 POTENTIAL ELECTROMAGNETIC IMPACTS

The purpose of this discussion is to provide a review of potential effects from electromagnetic fields (EMF) and is based on a literature review of approximately 20 applicable scientific articles reviewing the effects of EMF on marine organisms. A review of existing literature related to the effects of EMF, focusing on direct current (DC) applications was conducted. DC is characterized by a constant flow of electrical charge in one direction from high to low potential (as opposed to alternating current (AC), which is characterized by current that oscillates from high to low magnitude and reverses direction many times per second). Magnetic fields are created by the flow of electric current. The Sylmar Electrode System is a high voltage DC (HVDC) system. Within all the literature cited in this document, researches generally described the potential for varied effects from EMF and were primarily associated with elasmobranch species (cartilaginous fishes, such as sharks, skates, and rays). Many of the papers reviewed called for a need to address the potential effects on the behavior and or navigation issues of marine organisms associated with weak electric and magnetic fields (Gradient Corporation, 2006).

Gill et al., (2005) indicated that high voltage AC and DC cables that transmit power between devices such as undersea electrodes and the mainland have the potential to interact with aquatic animals that are sensitive to electric and magnetic fields. These fields primarily affect fish and mainly the elasomobranchs (skates, rays, and sharks), and potentially marine mammals that use the earth's magnetic field for navigation. Only the elasmobranchs are able to detect electrical impulses through the ampullae of Lorenzini (subdermal electroreceptor sensory organs). This system detects weak extrinsic voltage gradients that occur across the body and encodes information about the direction, polarity, and intensity of the source (Tricas and New, 1997). Few other marine animals possess this ability.

In all the papers reviewed, elasmobranchs were suggested to have a higher potential for sensitivity to EMFs resulting in either attraction or avoidance within near proximity to the source of the EMF. Some elasmobranchs have been shown to be attracted to undersea cables and in some cases have attacked the cable itself (Kalmijn, 2000). Kalmijn (2000) described that electrical excitability is an inherent property of animal life and electric fields abound in natural waters. Additional documentation of shark attacks on undersea cables were reported for dogfish (*Mustelus canis*), stingray (*Urolophus halleri*), blue shark (*Prionace glauca*), and bonnet head sharks (*Sphyrna tiburo*) (Cameron Fischer, Ecology & Environment, Inc., 2010).

Extensive studies have been conducted by several researchers to better understand the science behind electrosensory ability in marine animals. In most cases, the researchers concluded that navigation and prey detection were the two primary uses of detecting electromagnetic fields. Of the majority of literature reviewed, reported detection thresholds for steady DC electric fields ranged from 10^{-6} to 10^{-3} volts/meter (V/m) (Gradient Corporation, 2006). Further, the numerical threshold levels were limited largely to elasmobranchs. Of 380 shark species, only nine have been tested for electroreceptive response (Kajiura and Holland, 2002). Fisher and Slater (2010) reported that some elasmobranchs are capable of detecting electric fields as weak as 1 nV/m (10^{-9} V/m). Similarly, round stingrays were shown to have behavioral responses to uniform electrical fields of 5 x 10^{-7} V/mr (Tricas and New, 1997). Evidence of shark bites on submarine optical telecommunications cables were associated with electromagnetic fields between 1 x 10^{-6} and 6.3 x 10^{-6} V/m (Gill, 2005). Additionally, Gill described studies demonstrating attraction by

European eels (*Anguilla anguilla*) and the prawn (*Crangon crangon*). In laboratory studies, two nurse sharks were trained to respond to dipole fields in the ranges of 1 x 10^{-6} and 4 x 10^{-6} V/m with and without a background electric field (Johnson, et al., 1984). Meyer, et al., 2005 also performed captive studies using conditioned sharks and showed that sharks converged on electrically generated artificial targets when no food was presented. Sessile stingrays have also demonstrated orientation responses to electromagnetic fields similar to those generated by ocean currents (Kalmijn, 1982). At certain amplifications, elasmobranchs generally practiced avoidance of the cable. However, no other effects were noted.

Gill, 2005 suggested that electric fields emanating from undersea cables have the potential to be detected by electrosensitive species. At levels that approximate the bioelectric fields of natural prey there is the potential for these species to be attracted to them. However, Gill further stated that whether the species would be attracted or repelled is unknown at this time. Magnetosensitive species do occur in coastal waters world-wide (e.g., migratory fish, elasmobrachs, mammals, and crustaceans) and these species are thought to be sensitive to the Earth’s magnetic field (Gill, 2005). However, whether these species would be affected by short term discharges associated with the Sylmar HVDC link is unknown at this time and is similar to most findings in the literature reviewed.

Other species have been described that have the potential for impacts. Cameron Fischer, Ecology & Environment, Inc., 2010 described changes in embryonic development and juvenile stages of life for numerous species including sea urchins, barnacles, and blue mussels (*Mytilus edulis*). However, they also described no negative impacts to the spiny lobster even under the influence of anthropogenic fields. No differences in survival were noted to the blue mussel (*Mytilus edulis*), North sea prawn (*Crangon crangon*), round crab (*Rhithropanopeus harrisii*), and the flounder (*Plathychthys flesus*) when exposed to static B-fields for several weeks (Bocher and Zettler, 2004). The marine mammals were described as using a magnetic map which allows them to travel in areas of low magnetic intensity and gradient such as valleys and peaks (Walker et al., 2003). Many whale and dolphin species are sensitive to stranding when Earth’s B-field has a total intensity variation of less than 0.5 mG (Cameron Fischer, Ecology & Environment, Inc., 2010). Significantly sensitive species included the common dolphin (*Delphinus delphis*), Risso’s dolphin (*Grampus griseus*), Atlantic white-sided dolphins (*Lagenorhynchus acutus*), finwhale (*Balaenoptera physalus*), and the long-finned pilot whale (*Globicephala malaena*) (Kischvink, et al., 1986).

Gill further described DC cables in the Baltic Sea and suggested that electromagnetic fields equal to that of the Earth’s magnetic field were detectable at distances of up to 6 meters. Such a field may also have the potential to affect a ships compass and has the potential to interact with the navigation and orientation of any animal relying on the Earth’s magnetic field for direction (Gill, 2005). This finding is similarly described by Elder and Whitney, 1968 in the discussion of the Los Angeles HVDC Ocean Electrode. The current in each electrode an in the cable produces magnetic fields that may deflect compass needles in passing ships or they may magnetize a ship’s hull in they are in the area during the discharge event, thereby throwing off calibration even after passing the area.

The conclusions for this study are similar to the findings of the majority of the literature reviewed. Undersea cables do produce electromagnetic fields to varying degrees. Marine organisms do have the potential for some local effects; however, there are no conclusive studies that suggest significant impacts are to be expected. In the case of the Sylmar HVDC discharge cable and array, the cable is limited to a proposed 6,000 to 15,000 feet offshore and does not impose a barrier to migratory pathways. In the case of other extensive long distance cables reviewed (e.g., those crossing the Baltic Sea), a higher potential for impacts were noted when the cable bridged a migratory pathway and if continuously operated. Avoidance or attraction may occur during short term discharge periods. Since the operational duration of the discharge is estimated to be only 20 hours per year, long term impacts to marine life are not expected. While elasmobranch species can detect and respond to electromagnetic fields in the range of undersea cables, no studies were found describing levels that affect elasmobranchs under field conditions. Although there is a lack of research for sea-turtles and marine mammals, sea-turtles do not appear as sensitive to electromagnetic fields. However, statistical evidence suggests that some marine mammals are susceptible to stranding as a result of increase levels of electromagnetic fields (Cameron Fischer, Ecology & Environment, Inc., 2010). The Sylmar HVDC Electrode has been in operation since 1969 and it is presently unknown if there have been any documented mammal strandings associated with grounding discharges over the history of the operations. This data gap may be useful for review to determine the potential for marine mammal impacts.

10.0 POTENTIAL CHEMICAL IMPACTS

The potential chemical effects of the Sylmar ground return associated with electrolysis are discussed in this section. Electrolysis occurs when a direct electric current (DC) is applied to drive a non-spontaneous chemical reaction that leads separation of elements from naturally occurring sources (such as seawater in this case). For example, chlorine gas, hydrogen gas, and sodium hydroxide solution (commonly called "caustic soda" or simply "caustic") can be produced by passing an electric current (electrolyzing) through an aqueous solution of sodium chloride. If the electrolyte is maintained at a pH of 6.5 or 10, one can form chlorate or hypochlorite from the electrogenerated chlorine and caustic. In industrial applications, this is the basis for the electrolytic production of sodium chlorate or sodium hypochlorite (commonly known as "bleach"). In addition, oxidizing compounds can be generated by the chlorination of sea water, such as hypobromous acid and bromamines when ammonia nitrogen is present. These compounds rapidly disappear from the water after its discharge in coastal waters (Allonier and Khalanski, 1998, Abarnou and Miossec, 1992, Burton and Fisher, 2001). Chlorine reactions quickly combine with other substances in water, typically forming inert compounds. However, if water contains large amounts of decaying materials, free chlorine can combine with them to form trihalomethanes (THMs). In high concentrations, THMs can persist in the environment and has been shown to be carcinogenic to some vertebrates. The amount of chloride evolution is complicated by the specific features of the electrodes, in particular by the pH dependence of the surface charging (Trasatti, 1986).

The copper submarine cables of the Sylmar Ground Return Undersea Electrode is a DC system that will be capable of operating at a maximum amperage of 3,650 A (with an overall current value of 4,867A) and is expected to operate for less than 50 hour per year. Electrolysis produced by the DC current in the seawater environment will have the potential to generate chemical by-products, such as chlorine gas, hydrogen gas, and sodium hydroxide solution, as discussed above. Operation of the existing electrode system has been reported to generate chlorine gas as a byproduct of the electrolysis process, and the proposed conceptual electrode array has been modeled to produce up to 140 kg of chlorine per year. However, there is very little information available on the resulting concentrations in the surrounding seawater, and the potential toxicity to native marine organisms.

Although the impacts of chlorine by-product production from undersea electrodes has not been well-studied, there is a large body of literature available on the effects of chlorine on marine organisms. A few of these studies are summarized below, with a focus on fish, invertebrate, and community level effects.

Alderson (1969) studied the response of the developmental stages of flatfish eggs under constant flow conditions using direct electrolysis of sea water as a source of chlorine. From LC_{50} determinations, the eggs of the American plaice (*Hipoglossoides platessoides*) were found to be more tolerant than the newly-hatched larvae, and for both plaice and Dover sole (*Microstomus pacificus*) the tolerance of the larvae increased as their development proceeded up to metamorphosis. Less change in tolerance was evident with increasing size of fish after metamorphosis. Determinations of time to kill 50% of a test population showed that at chlorine concentrations only slightly higher than LC_{50} level the time for survival was considerably reduced.

The differential effects of free chlorine and chloramine on three species of juvenile marine fish were investigated in continuous flow bioassay units (Capuzzo et al. 1976a). The toxicity of both chlorine forms to winter flounder, *Pseudopleuronectes americanus*, scup, *Stenotomus versicolor* and killifish, *Fundulus heteroclitus*, appeared to be a threshold effect: an abrupt increase in mortality was observed over a narrow range of toxicant concentrations. The three species were similar in their responses to free chlorine, the more toxic of the two chlorine forms. There was a difference in chloramine toxicity among the three species; killifish were more susceptible than either of the other two species, probably reflecting differences in metabolic regulation or uptake rates.

Dempsey (1986) studies postlarvae of *Clupea harengus* exposed to chlorinated sea water for 30 minutes, to simulate passage through a typical power station cooling water circuit, and 24-h, during which detectable chlorine decayed away, to simulate a 'worst case' exposure. Twenty-four hour LC_{50s} were 0.63 ppm initial concentration for 30 minutes exposure and 0.36 ppm initial concentration for 24-h exposure.

The viable hatch, survival, growth and lethal concentrations (LC_{50}) for early life stages of northern anchovy (*Engraulis mordax*) were examined after seawater chlorination (Rosales Casian, 1991). Varying life stages were exposed to replicated concentrations of 0.0 (controls), 0.05, 0.1, 0.2, 0.5, 0.8 and 1.0 mg/L chlorine. Egg bioassays were of 24-hr duration only in static technique, and up to 12 days after hatching for larval series in semistatic technique.

Rosales Casian et al. (1990) conducted a series of bioassays to determine the chlorine effect on the survival and growth of 1, 4 and 16 day old grunion (*Leuresthes tenuis*) larvae maintained under semistatic conditions. After chlorination, there was a decrease in survival with 0.2 mg/L Cl_2 and survival was zero in less than two hours with 1.0 mg/L. The lethal LC_{50s} after the first two hours for 1, 4 and 16 day larvae were 0.255, 0.15 and 0.119 mg/L Cl_2 respectively. The LC_{50} values at 24 h and 48 h were similar. Eggs and larvae of white perch (*Morone americana*), striped bass (*Morone saxatilis*) and blueback herring (*Alosa aestivalis*) and eggs of Atlantic silversides (*Menidia menidia*) and tidewater silversides (*M. beryllina*) were exposed to various residual chlorine levels for pre-established periods by larvae (Morgan and Prince, 1977). Almost all LC_{50} values fell between 0.20-0.40 ppm of total residual chlorine for eggs, and between 0.20-0.32 ppm for larvae. Age-related effects in sensitivity to chlorine were observed. Abnormal larvae issued from blueback herring eggs exposed to low chlorine concentrations.

Capuzzo (1977) studied the non-lethal effects of chlorine on larval lobsters (*Homarus americanus*). The length, dry weight and standard respiration rates were monitored for 19 days following a 60 minute exposure at 25°C to 1.0 mg/L applied free Cl and 1.0 mg/L applied chloramine. Compared to control organisms, significantly lower increases in dry weight ($P < 0.05$) and significant reductions in standard respiration rates ($P < 0.01$) were measured among exposed organisms; greater differences were detected among chloramine exposed organisms. They concluded that acute exposure to free chlorine or chloramine results in subsequent reductions in growth and metabolic activity of larval lobsters. The differential effects of free Cl and chloramine on stage I larvae of *H. americanus* were investigated in continuous flow bioassay units (Capuzzo et al., 1976b). Applied chloramines was more toxic than corresponding concentrations of applied free Cl to lobster larvae with estimated LC_{50} values at 25°C of 16.30 mg/L applied free Cl and 2.02 mg/L applied chloramine. The synergistic effect of temperature on the toxicity of both free Cl and chloramine was also demonstrated. Heinle and Beaven (1977) found LC_{50}'s of 0.175, 0.062, 0.028 mg/L of chlorine produced oxidants for adult and immature copepods (combined) of *A. tonsa* at 15°C and salinities of 10.4 to 11.8 ppt. Results with nauplii of *A. tonsa* suggest lower LC_{50}'s than those for adults at equivalent exposure times. The effects of different chlorine concentrations (0.1-1 mg/L total residual chlorine) on growth rate (k) of *Cordylophora. Caspia* (a brackish water hydroid) were studied in the laboratory Rajagopal et al., 2002c). The results show that chlorine is effective at relatively low concentrations (above 0.1 mg/L residual chlorine). The growth rate of *C. caspia* at different chlorine concentrations was dose-dependent. An average decrease of 23% in the growth rate was observed at 0.1 mg/L residual chlorine when compared to control experiments, over a period of 7 d. No growth was recorded at 1 mg/L residual chlorine, indicating threshold levels of residual chlorine on *C. caspia*.

Vanderhorst (1982) assessed the effects of chlorine on marine epibenthic communities. A single experiment provided for two years of exposure to target concentrations of 10 and 50 ppb of chlorine-produced oxidants (CPO) in sea water. Continuous and intermittent chlorination regimes were used at each of the concentrations. The experiment was conducted in triplicate and included triplicate controls not receiving chlorination. There was an increase in the number of species for communities receiving each of the treatments, but there were significant ($p = 0.05$) differences in the rate of increase between intermittent and continuous chlorination regimes and between the two target concentrations within each of the regimes. Continuously chlorinated communities increased less rapidly in the number of species than did intermittently chlorinated communities. Communities receiving 50 ppb CPO increased in the number of species less rapidly than did communities receiving 10 ppb CPO ($p = 0.05$). There were significant ($p = 0.05$) effects on community complexity attributable to the distance between microcosms and the central head tank supplying all microcosms. Experimental substrates placed closer to the in-flow end of microcosms exhibited more animal species and fewer plant species than did experimental substrates placed closer to the out-flow end of individual microcosms.

These studies reflect the high variability of lethal and non-lethal effects of exposure to chlorine in marine systems and some of the levels of exposure to chlorine and chlorinated products required to produce toxic effects. It is important to note that concentrations and exposures related in the review do not necessarily reflect those expected to be generated by the Sylmar ground return.

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Appenidx B. CTD Profiles and graphs 16 Stations

Station	Depth (3ft Average)	Temp (C)	Conductivity (mS/cm)	Salinity (PPT)	DO (mg/l)	Ph	Tranmissivity	Chlorophyll A (mg/m^3)	Density (Kg/m^3)
Trans-1	0	13.4	39.8	33.5	8.7	8.0	75.9	1.9	1025.2
Trans-1	3	13.3	39.7	33.5	8.9	8.0	80.4	1.9	1025.2
Trans-1	6	13.3	39.7	33.5	9.1	8.1	79.7	1.9	1025.2
Trans-1	9	13.1	39.6	33.5	9.1	8.1	78.1	1.9	1025.3
Trans-1	12	13.0	39.5	33.6	9.3	8.1	78.7	2.0	1025.3
Trans-1	15	12.9	39.4	33.6	9.4	8.1	82.4	2.0	1025.3
Trans-1	18	12.9	39.4	33.6	8.9	8.0	77.0	2.1	1025.3
Trans-2	0	13.6	40.0	33.5	6.7	8.1	81.7	2.0	1025.1
Trans-2	3	13.6	39.9	33.5	7.2	8.1	81.0	1.9	1025.2
Trans-2	6	13.5	39.9	33.5	8.6	8.1	81.2	1.9	1025.1
Trans-2	9	13.4	39.8	33.6	9.0	8.1	84.3	1.9	1025.3
Trans-2	12	13.3	39.7	33.6	8.5	8.1	86.0	1.9	1025.3
Trans-2	15	13.1	39.6	33.6	8.2	8.1	90.2	1.8	1025.3
Trans-2	18	13.0	39.5	33.6	8.8	8.1	91.9	1.6	1025.3
Trans-2	21	13.0	39.5	33.6	8.9	8.1	92.4	1.5	1025.3
Trans-2	24	13.0	39.4	33.6	8.9	8.1	92.7	1.6	1025.3
Trans-2	27	12.8	39.3	33.6	8.9	8.1	92.7	1.6	1025.4
Trans-2	30	12.5	39.1	33.6	8.6	8.0	89.9	1.7	1025.5
Trans-2	33	12.4	39.0	33.6	8.0	8.0	88.7	1.8	1025.5
Trans-2	36	12.4	38.9	33.6	7.1	8.0	87.6	1.9	1025.5
Trans-3	0	13.7	40.1	33.5	7.2	8.1	86.6	1.6	1025.1
Trans-3	3	13.7	40.1	33.5	7.4	8.1	86.8	1.7	1025.1
Trans-3	6	13.7	40.1	33.5	7.9	8.1	87.0	1.6	1025.1
Trans-3	9	13.7	40.0	33.5	8.9	8.1	87.1	1.6	1025.1
Trans-3	12	13.6	40.0	33.5	8.9	8.1	87.8	1.5	1025.1
Trans-3	15	13.6	40.0	33.5	8.1	8.1	88.6	1.5	1025.2
Trans-3	18	13.5	39.9	33.6	8.0	8.1	91.8	1.5	1025.2
Trans-3	21	13.4	39.8	33.5	8.6	8.1	92.6	1.4	1025.2
Trans-3	24	13.4	39.8	33.5	8.8	8.1	92.4	1.4	1025.2
Trans-3	27	13.3	39.7	33.5	8.9	8.0	94.6	1.3	1025.2
Trans-3	30	13.3	39.7	33.5	8.7	8.0	94.9	1.2	1025.2
Trans-3	33	13.2	39.6	33.5	8.6	8.0	95.6	1.3	1025.3
Trans-3	36	13.2	39.6	33.5	8.5	8.0	95.8	1.3	1025.3
Trans-3	39	13.1	39.5	33.5	8.5	8.0	96.0	1.3	1025.3
Trans-3	42	13.0	39.5	33.5	8.4	8.0	95.8	1.3	1025.3
Trans-3	45	13.0	39.5	33.5	8.3	8.0	95.5	1.3	1025.3
Trans-3	48	13.0	39.4	33.5	8.5	8.0	95.3	1.4	1025.3
Trans-3	51	12.9	39.3	33.6	8.5	8.0	94.7	1.4	1025.4
Trans-3	54	12.3	38.9	33.7	8.6	8.0	94.1	1.4	1025.6
Trans-3	57	12.2	38.8	33.6	7.7	7.9	86.7	1.8	1025.5
Trans-4	0	13.8	40.1	33.5	7.0	8.0	95.2	1.2	1025.1
Trans-4	3	13.7	40.1	33.5	7.5	8.0	95.3	1.2	1025.1
Trans-4	6	13.5	40.0	33.6	7.7	8.0	95.3	1.2	1025.3
Trans-4	9	13.4	39.8	33.6	8.1	8.0	95.4	1.2	1025.3
Trans-4	12	13.3	39.8	33.6	7.6	8.0	95.8	1.2	1025.2
Trans-4	15	13.3	39.7	33.5	7.7	8.0	95.6	1.1	1025.2

Appenidx B. CTD Profiles and graphs 16 Stations

Station	Depth (3ft Average)	Temp (C)	Conductivity (mS/cm)	Salinity (PPT)	DO (mg/l)	Ph	Tranmissivity	Chlorophyll A (mg/m^3)	Density (Kg/m^3)
Trans-4	18	13.3	39.7	33.5	8.1	8.0	95.6	1.2	1025.2
Trans-4	21	13.3	39.7	33.5	8.1	8.0	95.5	1.2	1025.2
Trans-4	24	13.3	39.6	33.5	8.1	8.0	95.3	1.2	1025.2
Trans-4	27	13.3	39.6	33.5	8.1	8.0	95.3	1.2	1025.2
Trans-4	30	13.3	39.6	33.5	8.2	8.0	95.3	1.2	1025.2
Trans-4	33	13.2	39.6	33.5	8.2	8.0	95.2	1.2	1025.2
Trans-4	36	13.2	39.6	33.5	8.2	8.0	95.0	1.2	1025.3
Trans-4	39	13.2	39.6	33.5	8.2	8.0	95.3	1.2	1025.3
Trans-4	42	13.2	39.6	33.5	8.3	8.0	95.5	1.2	1025.3
Trans-4	45	13.2	39.6	33.5	8.3	8.0	95.6	1.2	1025.3
Trans-4	48	13.2	39.6	33.5	8.4	8.0	95.6	1.2	1025.3
Trans-4	51	13.2	39.6	33.5	8.3	8.0	95.7	1.5	1025.3
Trans-4	54	13.2	39.6	33.5	8.4	8.0	95.5	1.2	1025.3
Trans-4	57	13.2	39.6	33.5	8.4	8.0	95.9	1.2	1025.3
Trans-4	60	13.1	39.5	33.5	8.4	8.0	95.4	1.2	1025.3
Trans-4	63	13.0	39.4	33.5	8.4	8.0	96.1	1.2	1025.4
Trans-4	66	12.8	39.3	33.5	8.3	8.0	95.5	1.3	1025.4
Trans-4	69	12.8	39.3	33.5	8.2	8.0	95.6	1.4	1025.4
Trans-4	72	12.8	39.3	33.6	8.1	8.0	95.4	1.4	1025.4
Trans-4	75	12.8	39.2	33.6	8.2	8.0	95.2	1.4	1025.4
Trans-4	78	12.7	39.2	33.6	8.2	8.0	95.1	1.5	1025.5
Trans-4	81	12.2	38.8	33.6	8.3	8.0	90.9	1.5	1025.6
Trans-4	84	12.1	38.7	33.6	6.8	7.9	84.7	2.0	1025.6
Trans-6	0	14.8	41.1	33.5	6.8	8.0	57.0	4.8	1024.8
Trans-6	3	14.8	41.0	33.5	7.3	8.0	61.9	4.8	1024.9
Trans-6	6	14.8	41.0	33.5	8.1	8.0	63.1	4.8	1024.9
Trans-6	9	14.8	41.0	33.5	8.3	8.0	63.9	4.8	1024.9
Trans-6	12	14.7	41.0	33.5	7.9	8.0	63.6	4.8	1024.9
Trans-6	15	14.1	41.0	34.0	7.8	8.0	61.3	3.1	1025.5
Trans-7	0	14.2	40.5	33.5	7.4	8.0	85.6	1.6	1025.0
Trans-7	3	14.2	40.5	33.5	7.2	8.0	85.6	1.6	1025.0
Trans-7	6	14.2	40.5	33.5	7.6	8.0	85.6	1.6	1025.0
Trans-7	9	14.2	40.5	33.5	8.1	8.0	85.7	1.6	1025.0
Trans-7	12	14.0	40.5	33.6	9.0	8.0	85.7	1.5	1025.1
Trans-7	15	13.7	40.2	33.7	8.7	8.0	86.6	1.5	1025.3
Trans-7	18	13.5	40.0	33.6	8.2	8.0	87.3	1.5	1025.2
Trans-7	21	13.4	39.9	33.6	8.4	8.0	87.6	1.5	1025.3
Trans-7	24	13.2	39.7	33.6	9.0	8.0	87.4	1.4	1025.3
Trans-7	27	13.0	39.5	33.6	9.2	8.0	88.0	1.6	1025.3
Trans-7	30	12.7	39.3	33.6	9.4	8.0	88.1	1.7	1025.5
Trans-7	33	12.6	39.1	33.6	8.9	8.0	85.1	1.9	1025.5
Trans-7	36	12.6	39.1	33.6	7.8	8.0	83.3	2.4	1025.4
Trans-8	0	14.2	40.5	33.4	7.4	8.0	86.0	1.4	1024.9
Trans-8	3	14.2	40.5	33.5	7.5	8.0	85.9	1.4	1025.0
Trans-8	6	14.1	40.4	33.6	7.9	8.0	85.9	1.4	1025.1
Trans-8	9	13.7	40.2	33.6	8.1	8.0	86.3	1.4	1025.2

Appenidx B. CTD Profiles and graphs 16 Stations

Station	Depth (3ft Average)	Temp (C)	Conductivity (mS/cm)	Salinity (PPT)	DO (mg/l)	Ph	Tranmissivity	Chlorophyll A (mg/m^3)	Density (Kg/m^3)
Trans-8	12	13.5	40.1	33.7	8.8	8.0	86.4	1.4	1025.3
Trans-8	15	13.4	39.9	33.6	8.4	8.0	86.3	1.4	1025.3
Trans-8	18	13.4	39.8	33.6	8.2	8.0	88.2	1.4	1025.3
Trans-8	21	13.3	39.8	33.6	8.9	8.0	88.7	1.4	1025.3
Trans-8	24	13.3	39.7	33.5	9.1	8.0	90.8	1.4	1025.3
Trans-8	27	13.2	39.7	33.6	9.1	8.0	91.9	1.4	1025.3
Trans-8	30	13.2	39.6	33.6	9.1	8.0	91.6	1.4	1025.3
Trans-8	33	13.1	39.5	33.6	9.1	8.0	91.5	1.4	1025.3
Trans-8	36	12.9	39.4	33.6	9.1	8.0	91.4	1.4	1025.4
Trans-8	39	12.8	39.3	33.6	8.9	8.0	89.2	1.7	1025.4
Trans-9	0	13.7	40.0	33.5	5.9	8.0	95.3	1.3	1025.0
Trans-9	3	13.8	40.1	33.5	6.4	8.0	95.4	1.3	1025.1
Trans-9	6	13.6	40.1	33.6	7.1	8.0	95.4	1.3	1025.2
Trans-9	9	13.3	39.8	33.7	7.8	8.0	95.4	1.3	1025.3
Trans-9	12	13.2	39.7	33.6	8.0	8.0	94.9	1.2	1025.2
Trans-9	15	13.2	39.7	33.6	8.1	8.0	94.9	1.3	1025.3
Trans-9	18	13.2	39.6	33.5	7.5	8.0	94.5	1.2	1025.2
Trans-9	21	13.2	39.6	33.5	7.6	8.0	94.3	1.2	1025.2
Trans-9	24	13.2	39.6	33.5	8.2	8.0	94.3	1.3	1025.2
Trans-9	27	13.2	39.6	33.5	8.3	8.0	94.6	1.3	1025.2
Trans-9	30	13.2	39.6	33.5	8.4	8.0	94.4	1.3	1025.2
Trans-9	33	13.2	39.6	33.5	8.4	8.0	94.6	1.3	1025.3
Trans-9	36	13.2	39.6	33.5	8.4	8.0	94.5	1.3	1025.3
Trans-9	39	13.2	39.6	33.5	8.5	8.0	94.1	1.4	1025.3
Trans-9	42	13.2	39.6	33.5	8.5	8.0	94.1	1.4	1025.3
Trans-9	45	13.2	39.6	33.5	8.4	8.0	94.0	1.4	1025.3
Trans-9	48	13.2	39.6	33.5	8.4	8.0	94.5	1.4	1025.3
Trans-9	51	13.1	39.6	33.5	8.5	8.0	94.6	1.4	1025.3
Trans-9	54	13.1	39.5	33.5	8.5	8.0	94.9	1.4	1025.3
Trans-9	57	13.1	39.5	33.5	8.5	8.0	95.0	1.4	1025.3
Trans-9	60	13.1	39.5	33.5	8.5	8.0	94.8	1.4	1025.3
Trans-9	63	13.0	39.4	33.5	8.5	8.0	94.8	1.4	1025.3
Trans-9	66	13.0	39.4	33.5	8.6	8.0	94.0	1.5	1025.4
Trans-9	69	12.8	39.3	33.6	8.8	8.0	93.5	1.6	1025.4
Trans-9	72	12.5	39.0	33.6	8.4	8.0	84.3	1.9	1025.5
Trans-10	0	13.4	39.5	33.3	6.4	8.0	95.7	2.7	1025.0
Trans-10	3	13.3	39.5	33.4	6.5	8.0	95.7	2.8	1025.1
Trans-10	6	13.2	39.6	33.5	7.3	8.0	95.9	2.8	1025.2
Trans-10	9	12.9	39.4	33.6	7.5	8.0	95.9	2.8	1025.4
Trans-10	12	12.8	39.3	33.6	8.1	7.9	95.8	2.7	1025.3
Trans-10	15	12.8	39.3	33.6	8.2	7.9	95.3	2.7	1025.4
Trans-10	18	12.7	39.2	33.6	7.9	7.9	95.4	2.7	1025.4
Trans-10	21	12.7	39.2	33.6	7.6	7.9	95.4	2.7	1025.4
Trans-10	24	12.7	39.2	33.6	7.9	7.9	95.2	2.7	1025.4
Trans-10	27	12.7	39.2	33.6	7.9	7.9	94.8	2.8	1025.4
Trans-10	30	12.7	39.1	33.6	7.9	7.9	94.8	2.8	1025.4
Trans-10	33	12.6	39.1	33.6	7.9	7.9	94.6	2.8	1025.4

Appenidx B. CTD Profiles and graphs 16 Stations

Station	Depth (3ft Average)	Temp (C)	Conductivity (mS/cm)	Salinity (PPT)	DO (mg/l)	Ph	Tranmissivity	Chlorophyll A (mg/m^3)	Density (Kg/m^3)
Trans-10	36	12.6	39.1	33.6	7.8	7.9	94.9	2.9	1025.4
Trans-10	39	12.5	39.0	33.6	7.8	7.9	94.8	2.5	1025.4
Trans-10	42	12.4	38.9	33.6	7.7	7.9	93.7	1.6	1025.5
Trans-10	45	12.3	38.9	33.6	7.5	7.9	94.2	1.6	1025.5
Trans-10	48	12.3	38.8	33.6	7.3	7.9	95.1	1.6	1025.5
Trans-10	51	12.3	38.8	33.6	7.2	7.9	95.2	1.7	1025.5
Trans-10	54	12.2	38.8	33.6	7.2	7.9	95.3	1.7	1025.5
Trans-10	57	12.2	38.7	33.6	7.1	7.9	95.4	1.7	1025.5
Trans-10	60	12.2	38.7	33.6	7.0	7.9	95.6	1.7	1025.5
Trans-10	63	12.1	38.6	33.6	7.0	7.8	95.5	1.7	1025.6
Trans-10	66	12.0	38.6	33.6	6.9	7.8	95.4	1.8	1025.6
Trans-10	69	12.0	38.6	33.6	6.8	7.8	95.4	1.9	1025.6
Trans-10	72	11.9	38.5	33.6	6.6	7.8	95.4	1.9	1025.6
Trans-10	75	11.8	38.4	33.6	6.5	7.8	95.8	1.9	1025.7
Trans-10	78	11.8	38.4	33.6	6.4	7.8	95.2	1.9	1025.7
Trans-10	81	11.7	38.3	33.6	6.3	7.8	94.9	2.0	1025.7
Trans-10	84	11.6	38.2	33.6	5.9	7.8	95.0	2.1	1025.7
Trans-10	87	11.5	38.2	33.7	5.8	7.8	94.7	2.1	1025.8
Trans-10	90	11.4	38.1	33.7	5.7	7.7	94.9	2.1	1025.8
Trans-10	93	11.3	38.0	33.7	5.6	7.7	95.6	2.2	1025.8
Trans-10	96	11.2	37.9	33.7	5.5	7.7	94.8	2.2	1025.8
Trans-10	99	11.2	37.9	33.7	5.2	7.7	93.4	2.3	1025.9
Trans-10	102	11.2	37.9	33.7	5.2	7.7	93.2	2.3	1025.9
Trans-10	105	11.2	37.9	33.7	5.2	7.7	92.7	2.3	1025.9
Trans-10	108	11.1	37.9	33.7	5.2	7.7	91.8	2.3	1025.9
Trans-10	111	11.1	37.8	33.7	5.0	7.7	91.3	2.3	1025.9
Trans-10	114	10.9	37.7	33.7	5.0	7.7	88.5	2.3	1026.0
Trans-10	117	10.9	37.7	33.7	4.5	7.6	85.7	2.4	1025.9
Trans-5	0	13.4	39.8	33.5	6.5	8.0	95.2	1.6	1025.1
Trans-5	3	13.4	39.8	33.5	6.5	8.0	95.1	1.6	1025.2
Trans-5	6	13.4	39.8	33.5	7.5	8.0	95.2	1.5	1025.1
Trans-5	9	13.4	39.8	33.5	8.0	8.0	95.1	1.4	1025.2
Trans-5	12	13.4	39.8	33.5	8.2	8.0	95.2	1.4	1025.2
Trans-5	15	13.4	39.7	33.5	8.3	8.0	95.4	1.3	1025.2
Trans-5	18	13.2	39.6	33.5	8.3	8.0	95.5	1.5	1025.3
Trans-5	21	13.1	39.5	33.5	8.3	8.0	95.3	1.3	1025.3
Trans-5	24	13.0	39.4	33.6	8.4	8.0	95.2	1.3	1025.3
Trans-5	27	12.9	39.3	33.6	8.4	8.0	95.3	1.3	1025.3
Trans-5	30	12.8	39.3	33.6	8.4	7.9	95.0	1.4	1025.4
Trans-5	33	12.7	39.2	33.6	8.3	7.9	95.2	1.4	1025.4
Trans-5	36	12.7	39.2	33.6	8.2	7.9	95.4	1.4	1025.4
Trans-5	39	12.7	39.1	33.6	8.1	7.9	95.5	1.5	1025.4
Trans-5	42	12.6	39.1	33.6	8.1	7.9	95.5	1.5	1025.4
Trans-5	45	12.5	39.0	33.6	8.0	7.9	95.4	1.5	1025.5
Trans-5	48	12.4	38.9	33.6	7.7	7.9	94.9	1.6	1025.5
Trans-5	51	12.4	38.9	33.6	7.7	7.9	94.4	1.7	1025.5
Trans-5	54	12.4	38.9	33.6	7.7	7.9	93.5	1.7	1025.5
Trans-5	57	12.3	38.8	33.6	7.6	7.9	94.1	1.7	1025.5

Appenidx B. CTD Profiles and graphs 16 Stations

Station	Depth (3ft Average)	Temp (C)	Conductivity (mS/cm)	Salinity (PPT)	DO (mg/l)	Ph	Tranmissivity	Chlorophyll A (mg/m^3)	Density (Kg/m^3)
Trans-5	60	12.3	38.8	33.6	7.4	7.9	93.8	1.7	1025.5
Trans-5	63	12.2	38.8	33.6	7.3	7.9	93.6	1.8	1025.5
Trans-5	66	12.2	38.7	33.6	7.2	7.9	93.9	1.8	1025.6
Trans-5	69	12.1	38.7	33.6	7.1	7.8	94.3	1.8	1025.6
Trans-5	72	12.0	38.6	33.6	7.0	7.8	94.4	1.8	1025.6
Trans-5	75	11.8	38.4	33.6	6.9	7.8	94.4	1.9	1025.7
Trans-5	78	11.7	38.3	33.6	6.4	7.8	94.2	2.0	1025.7
Trans-5	81	11.6	38.2	33.6	6.2	7.8	95.0	1.9	1025.7
Trans-5	84	11.5	38.1	33.6	6.1	7.8	94.8	2.0	1025.8
Trans-5	87	11.4	38.0	33.6	5.8	7.8	95.3	2.1	1025.8
Trans-5	90	11.3	38.0	33.7	5.7	7.7	95.2	2.1	1025.8
Trans-5	93	11.2	37.9	33.7	5.4	7.7	95.1	2.2	1025.8
Trans-5	96	11.2	37.9	33.7	5.3	7.7	95.3	2.2	1025.8
Trans-5	99	11.1	37.8	33.7	5.2	7.7	95.3	2.1	1025.9
Trans-5	102	11.1	37.8	33.7	5.1	7.7	95.6	2.1	1025.9
Trans-5	105	11.1	37.8	33.7	5.0	7.7	94.2	2.1	1025.9
Trans-5	108	11.1	37.8	33.7	5.0	7.7	93.2	2.2	1025.9
Trans-5	111	11.1	37.8	33.7	4.9	7.7	93.2	2.2	1025.9
Trans-5	114	10.9	37.6	33.7	4.8	7.7	91.9	2.2	1026.0
Trans-5	117	10.7	37.5	33.8	4.2	7.6	88.3	2.4	1026.0
Trans-5	120	10.7	37.5	33.7	3.7	7.6	85.7	2.5	1026.0
EA-1	0	13.2	39.6	33.5	6.4	8.0	93.3	1.5	1025.2
EA-1	3	13.2	39.6	33.5	6.5	8.0	93.4	1.4	1025.2
EA-1	6	13.2	39.6	33.5	7.2	8.0	94.2	1.4	1025.2
EA-1	9	13.2	39.6	33.6	7.9	8.0	94.1	1.4	1025.3
EA-1	12	13.2	39.6	33.6	8.3	8.0	94.2	1.4	1025.3
EA-1	15	13.1	39.6	33.6	8.4	8.0	94.2	1.3	1025.3
EA-1	18	13.0	39.5	33.6	8.4	8.0	94.4	1.3	1025.3
EA-1	21	13.0	39.4	33.6	8.3	8.0	95.0	1.3	1025.3
EA-1	24	12.8	39.3	33.6	8.5	8.0	95.2	1.3	1025.4
EA-1	27	12.7	39.2	33.6	8.4	8.0	95.2	1.3	1025.4
EA-1	30	12.6	39.1	33.6	8.3	7.9	95.6	1.2	1025.4
EA-1	33	12.6	39.1	33.6	8.4	7.9	95.7	1.3	1025.4
EA-1	36	12.6	39.1	33.6	8.4	7.9	95.9	1.3	1025.4
EA-1	39	12.5	39.1	33.6	8.4	7.9	96.1	1.3	1025.4
EA-1	42	12.4	39.0	33.6	8.4	7.9	96.3	1.3	1025.5
EA-1	45	12.3	38.9	33.6	8.3	7.9	96.4	1.3	1025.5
EA-1	48	12.3	38.8	33.6	8.0	7.9	96.1	1.3	1025.5
EA-1	51	12.3	38.8	33.6	7.9	7.9	96.4	1.4	1025.5
EA-1	54	12.3	38.8	33.6	7.8	7.9	96.4	1.4	1025.5
EA-1	57	12.3	38.8	33.6	7.8	7.9	96.4	1.4	1025.5
EA-1	60	12.2	38.7	33.6	7.7	7.9	96.5	1.5	1025.5
EA-1	63	12.1	38.6	33.6	7.6	7.9	96.4	1.5	1025.6
EA-1	66	12.0	38.6	33.6	7.5	7.9	95.7	1.5	1025.6
EA-1	69	12.0	38.5	33.6	7.2	7.9	95.2	1.5	1025.6
EA-1	72	11.8	38.4	33.6	7.1	7.9	94.5	1.5	1025.7
EA-1	75	11.7	38.3	33.6	6.7	7.8	94.4	1.7	1025.7
EA-1	78	11.7	38.3	33.6	6.3	7.8	95.4	1.8	1025.7

Appenidx B. CTD Profiles and graphs 16 Stations

Station	Depth (3ft Average)	Temp (C)	Conductivity (mS/cm)	Salinity (PPT)	DO (mg/l)	Ph	Tranmissivity	Chlorophyll A (mg/m^3)	Density (Kg/m^3)
EA-1	81	11.6	38.2	33.6	6.1	7.8	95.7	1.8	1025.7
EA-1	84	11.6	38.2	33.6	6.0	7.8	95.8	1.8	1025.7
EA-1	87	11.5	38.1	33.6	6.0	7.8	93.4	1.9	1025.7
EA-1	90	11.4	38.0	33.6	5.7	7.8	93.2	1.9	1025.7
EA-1	93	11.3	37.9	33.6	5.5	7.7	93.1	1.9	1025.7
EA-1	96	11.1	37.8	33.6	5.3	7.7	95.1	2.0	1025.8
EA-1	99	11.0	37.7	33.7	5.0	7.7	95.5	2.0	1025.9
EA-1	102	11.0	37.7	33.7	4.9	7.7	95.0	2.0	1025.9
EA-1	105	10.9	37.7	33.7	4.8	7.7	94.7	2.1	1025.9
EA-1	108	10.9	37.6	33.7	4.6	7.7	94.6	2.2	1025.9
EA-1	111	10.8	37.6	33.7	4.6	7.7	94.3	2.1	1025.9
EA-1	114	10.8	37.5	33.7	4.4	7.7	94.1	2.2	1026.0
EA-1	117	10.8	37.5	33.7	4.3	7.6	93.7	2.2	1026.0
EA-1	120	10.7	37.5	33.7	4.3	7.6	93.8	2.1	1026.0
EA-1	123	10.7	37.5	33.7	4.3	7.6	93.7	2.2	1026.0
EA-1	126	10.7	37.5	33.7	4.3	7.6	92.8	2.2	1026.0
EA-1	129	10.7	37.5	33.7	4.3	7.6	92.5	2.2	1026.0
EA-1	132	10.7	37.5	33.7	4.2	7.6	91.9	2.2	1026.0
EA-1	135	10.7	37.5	33.7	4.2	7.6	91.4	2.3	1026.0
EA-1	138	10.7	37.5	33.7	4.2	7.6	91.9	2.2	1026.0
EA-1	141	10.7	37.4	33.7	4.1	7.6	89.0	2.2	1026.0
EA-1	145	10.5	37.3	33.8	3.9	7.6	90.6	2.2	1026.1
EA-1	148	10.4	37.3	33.8	3.6	7.6	90.6	2.3	1026.1
EA-1	151	10.4	37.3	33.8	3.5	7.6	89.8	2.3	1026.2
EA-1	154	10.4	37.3	33.8	3.5	7.6	89.6	2.4	1026.2
EA-2	0	13.4	39.8	33.5	8.1	8.0	93.7	1.1	1025.2
EA-2	3	13.4	39.8	33.5	8.2	8.0	93.9	1.2	1025.2
EA-2	6	13.4	39.8	33.5	8.3	8.0	94.1	1.1	1025.2
EA-2	9	13.3	39.7	33.5	8.4	8.0	94.1	1.2	1025.2
EA-2	12	13.2	39.6	33.6	8.5	8.0	94.5	1.2	1025.3
EA-2	15	12.9	39.4	33.6	8.5	8.0	95.0	1.1	1025.3
EA-2	18	12.7	39.2	33.6	8.6	8.0	94.8	1.2	1025.4
EA-2	21	12.7	39.2	33.6	8.6	8.0	95.3	1.3	1025.4
EA-2	24	12.6	39.1	33.6	8.4	8.0	95.8	1.3	1025.4
EA-2	27	12.4	38.9	33.6	8.5	8.0	96.1	1.3	1025.5
EA-2	30	12.4	38.9	33.6	8.3	8.0	96.4	1.4	1025.5
EA-2	33	12.3	38.8	33.6	8.1	7.9	96.4	1.4	1025.5
EA-2	36	12.3	38.8	33.6	7.8	7.9	96.2	1.4	1025.5
EA-2	39	12.3	38.8	33.6	7.8	7.9	96.4	1.4	1025.5
EA-2	42	12.2	38.7	33.6	7.7	7.9	96.3	1.4	1025.5
EA-2	45	12.1	38.6	33.6	7.6	7.9	96.5	1.5	1025.5
EA-2	48	12.0	38.6	33.6	7.5	7.9	96.4	1.4	1025.6
EA-2	51	12.0	38.5	33.6	7.3	7.9	96.3	1.5	1025.6
EA-2	54	11.8	38.4	33.6	7.2	7.9	96.0	1.4	1025.6
EA-2	57	11.8	38.4	33.6	6.8	7.9	93.7	1.5	1025.6
EA-2	60	11.6	38.3	33.6	6.7	7.8	92.0	1.5	1025.7
EA-2	63	11.6	38.2	33.6	6.3	7.8	93.4	1.6	1025.7
EA-2	66	11.5	38.1	33.6	6.0	7.8	93.4	1.7	1025.7

Appenidx B. CTD Profiles and graphs 16 Stations

Station	Depth (3ft Average)	Temp (C)	Conductivity (mS/cm)	Salinity (PPT)	DO (mg/l)	Ph	Tranmissivity	Chlorophyll A (mg/m^3)	Density (Kg/m^3)
EA-2	69	11.5	38.1	33.6	5.9	7.8	91.2	1.7	1025.7
EA-2	72	11.5	38.1	33.6	5.8	7.8	91.4	1.7	1025.7
EA-2	75	11.5	38.1	33.6	5.8	7.8	91.9	1.7	1025.7
EA-2	78	11.4	38.0	33.6	5.7	7.8	92.2	1.7	1025.7
EA-2	81	11.2	37.9	33.6	5.7	7.8	93.0	1.8	1025.8
EA-2	84	11.1	37.8	33.7	5.4	7.7	93.9	1.9	1025.8
EA-2	87	11.0	37.8	33.7	5.1	7.7	95.5	2.0	1025.9
EA-2	90	11.0	37.7	33.7	5.0	7.7	95.9	2.0	1025.9
EA-2	93	11.0	37.7	33.7	4.8	7.7	95.0	2.1	1025.9
EA-2	96	10.9	37.7	33.7	4.8	7.7	94.5	2.1	1025.9
EA-2	99	10.8	37.6	33.7	4.6	7.7	94.7	2.1	1025.9
EA-2	102	10.8	37.6	33.7	4.6	7.7	95.3	2.1	1026.0
EA-2	105	10.8	37.6	33.7	4.4	7.7	94.5	2.2	1026.0
EA-2	108	10.8	37.5	33.7	4.4	7.7	93.4	2.2	1026.0
EA-2	111	10.8	37.5	33.7	4.4	7.7	92.7	2.1	1026.0
EA-2	114	10.7	37.5	33.7	4.3	7.7	92.7	2.2	1026.0
EA-2	117	10.7	37.5	33.7	4.3	7.6	92.5	2.2	1026.0
EA-2	120	10.7	37.5	33.7	4.3	7.6	92.2	2.2	1026.0
EA-2	123	10.7	37.5	33.7	4.2	7.6	92.3	2.2	1026.0
EA-2	126	10.7	37.5	33.7	4.2	7.6	91.4	2.2	1026.0
EA-2	129	10.7	37.5	33.7	4.1	7.6	91.6	2.2	1026.0
EA-2	132	10.7	37.5	33.7	4.1	7.6	91.4	2.2	1026.0
EA-2	135	10.6	37.5	33.7	4.1	7.6	91.5	2.2	1026.1
EA-2	138	10.5	37.4	33.8	3.9	7.6	91.8	2.3	1026.1
EA-2	141	10.4	37.3	33.8	3.7	7.6	91.2	2.2	1026.1
EA-2	145	10.4	37.3	33.8	3.6	7.6	90.9	2.4	1026.1
EA-2	148	10.4	37.3	33.8	3.5	7.6	90.7	2.3	1026.2
EA-2	151	10.4	37.3	33.8	3.5	7.6	89.8	2.2	1026.2
EA-2	154	10.4	37.3	33.8	3.4	7.6	89.7	2.2	1026.2
EA-3	0	13.4	39.8	33.5	6.9	8.0	93.5	1.2	1025.2
EA-3	3	13.4	39.8	33.5	6.9	8.0	93.6	1.2	1025.2
EA-3	6	13.4	39.8	33.5	7.7	8.0	93.7	1.2	1025.2
EA-3	9	13.4	39.8	33.5	8.4	8.0	93.8	1.2	1025.2
EA-3	12	13.3	39.7	33.6	8.5	8.0	94.0	1.1	1025.2
EA-3	15	13.0	39.5	33.6	8.5	8.0	94.4	1.2	1025.3
EA-3	18	12.8	39.3	33.6	8.5	8.0	94.8	1.2	1025.4
EA-3	21	12.7	39.2	33.6	8.5	8.0	95.4	1.2	1025.4
EA-3	24	12.7	39.1	33.6	8.5	8.0	95.3	1.3	1025.4
EA-3	27	12.6	39.1	33.6	8.5	8.0	95.6	1.3	1025.4
EA-3	30	12.4	38.9	33.6	8.4	8.0	95.4	1.3	1025.5
EA-3	33	12.3	38.8	33.6	8.2	8.0	96.0	1.3	1025.5
EA-3	36	12.2	38.8	33.6	7.8	7.9	96.1	1.4	1025.5
EA-3	39	12.2	38.7	33.6	7.7	7.9	96.2	1.4	1025.5
EA-3	42	12.2	38.7	33.6	7.7	7.9	96.4	1.4	1025.5
EA-3	45	12.2	38.7	33.6	7.8	7.9	96.4	1.4	1025.5
EA-3	48	12.1	38.7	33.6	7.7	7.9	96.3	1.4	1025.5
EA-3	51	12.1	38.7	33.6	7.6	7.9	96.5	1.4	1025.5
EA-3	54	12.1	38.6	33.6	7.6	7.9	96.3	1.4	1025.6

Appenidx B. CTD Profiles and graphs 16 Stations

Station	Depth (3ft Average)	Temp (C)	Conductivity (mS/cm)	Salinity (PPT)	DO (mg/l)	Ph	Tranmissivity	Chlorophyll A (mg/m^3)	Density (Kg/m^3)
EA-3	57	12.1	38.6	33.6	7.6	7.9	96.3	1.4	1025.6
EA-3	60	12.0	38.6	33.6	7.5	7.9	96.5	1.4	1025.6
EA-3	63	11.9	38.5	33.6	7.3	7.9	96.5	1.4	1025.6
EA-3	66	11.7	38.2	33.6	7.0	7.9	92.6	1.5	1025.7
EA-3	69	11.3	38.0	33.6	6.7	7.8	92.4	1.7	1025.7
EA-3	72	11.3	38.0	33.6	5.5	7.8	93.6	1.7	1025.8
EA-3	75	11.3	38.0	33.6	5.3	7.8	93.7	1.8	1025.8
EA-3	78	11.3	37.9	33.6	5.4	7.8	93.6	1.8	1025.8
EA-3	81	11.3	37.9	33.6	5.4	7.8	93.8	1.8	1025.8
EA-3	84	11.2	37.9	33.6	5.4	7.7	94.2	1.8	1025.8
EA-3	87	11.2	37.9	33.6	5.2	7.7	94.9	1.9	1025.8
EA-3	90	11.1	37.8	33.7	5.1	7.7	96.2	2.0	1025.9
EA-3	93	11.0	37.7	33.7	5.0	7.7	95.7	2.0	1025.9
EA-3	96	10.9	37.7	33.7	4.8	7.7	95.0	2.1	1025.9
EA-3	99	10.9	37.7	33.7	4.7	7.7	95.3	2.1	1025.9
EA-3	102	10.8	37.6	33.7	4.7	7.7	93.0	2.1	1026.0
EA-3	105	10.8	37.6	33.7	4.4	7.7	92.9	2.2	1026.0
EA-3	108	10.7	37.5	33.7	4.3	7.7	92.4	2.2	1026.0
EA-3	111	10.7	37.5	33.7	4.3	7.7	92.4	2.2	1026.0
EA-3	114	10.7	37.5	33.7	4.3	7.7	92.6	2.2	1026.0
EA-3	117	10.7	37.5	33.7	4.2	7.6	92.6	2.2	1026.0
EA-3	120	10.7	37.5	33.7	4.2	7.6	91.7	2.2	1026.0
EA-3	123	10.7	37.5	33.7	4.1	7.6	91.4	2.3	1026.0
EA-3	126	10.7	37.5	33.7	4.1	7.6	92.3	2.4	1026.0
EA-3	129	10.6	37.5	33.7	4.0	7.6	91.8	2.2	1026.0
EA-3	132	10.6	37.4	33.7	4.0	7.6	91.8	2.2	1026.0
EA-3	135	10.6	37.4	33.7	4.0	7.6	92.2	2.2	1026.1
EA-3	138	10.6	37.4	33.7	4.0	7.6	92.7	2.2	1026.1
EA-3	141	10.5	37.4	33.8	3.9	7.6	93.1	2.2	1026.1
EA-3	145	10.5	37.4	33.8	3.8	7.6	93.2	2.4	1026.1
EA-3	148	10.4	37.3	33.8	3.7	7.6	93.5	2.2	1026.2
EA-3	151	10.3	37.3	33.8	3.5	7.6	91.5	2.2	1026.2
EA-3	154	10.3	37.3	33.8	3.4	7.6	89.0	2.4	1026.2
REF-1	0	13.7	40.0	33.5	8.2	8.0	93.9	1.0	1025.1
REF-1	3	13.6	40.0	33.5	8.2	8.0	93.6	1.1	1025.1
REF-1	6	13.6	39.9	33.5	8.4	8.0	93.1	1.0	1025.2
REF-1	9	13.5	39.9	33.5	8.4	8.0	92.9	1.0	1025.2
REF-1	12	13.5	39.9	33.5	8.4	8.0	93.1	1.0	1025.2
REF-1	15	13.2	39.7	33.6	8.6	8.0	93.6	1.1	1025.3
REF-1	18	13.0	39.5	33.6	8.6	8.0	94.4	1.1	1025.3
REF-1	21	12.9	39.4	33.6	8.6	8.0	94.6	1.1	1025.4
REF-1	24	12.8	39.3	33.6	8.7	8.0	95.0	1.2	1025.4
REF-1	27	12.8	39.2	33.6	8.6	8.0	95.1	1.2	1025.4
REF-1	30	12.7	39.2	33.6	8.7	7.9	95.3	1.3	1025.4
REF-1	33	12.6	39.1	33.6	8.5	7.9	95.3	1.3	1025.4
REF-1	36	12.5	39.1	33.6	8.5	7.9	94.7	1.3	1025.4
REF-1	39	12.5	39.0	33.6	8.4	7.9	95.7	1.2	1025.5
REF-1	42	12.3	38.8	33.6	8.3	7.9	95.0	1.3	1025.5

Appenidx B. CTD Profiles and graphs 16 Stations

Station	Depth (3ft Average)	Temp (C)	Conductivity (mS/cm)	Salinity (PPT)	DO (mg/l)	Ph	Tranmissivity	Chlorophyll A (mg/m^3)	Density (Kg/m^3)
REF-1	45	12.2	38.7	33.6	8.0	7.9	96.0	1.3	1025.5
REF-1	48	12.2	38.7	33.6	7.9	7.9	95.9	1.3	1025.5
REF-1	51	12.2	38.7	33.6	7.6	7.9	95.9	1.4	1025.5
REF-1	54	12.1	38.7	33.6	7.7	7.9	95.6	1.4	1025.5
REF-1	57	12.1	38.7	33.6	7.7	7.9	95.8	1.4	1025.5
REF-1	60	12.1	38.6	33.6	7.6	7.9	95.9	1.4	1025.6
REF-1	63	12.0	38.5	33.6	7.5	7.9	96.1	1.4	1025.6
REF-1	66	11.8	38.4	33.6	7.4	7.9	94.5	1.4	1025.6
REF-1	69	11.8	38.3	33.6	7.1	7.9	93.4	1.5	1025.6
REF-1	72	11.7	38.3	33.6	6.9	7.8	92.0	1.5	1025.7
REF-1	75	11.7	38.3	33.6	6.9	7.8	91.2	1.6	1025.7
REF-1	78	11.7	38.3	33.6	6.8	7.8	91.6	1.5	1025.7
REF-1	81	11.4	38.1	33.6	6.6	7.8	91.9	1.5	1025.7
REF-1	84	11.3	38.0	33.6	6.4	7.8	92.9	1.6	1025.8
REF-1	87	11.2	37.9	33.6	5.5	7.7	93.9	1.8	1025.8
REF-1	90	11.2	37.9	33.6	5.3	7.7	94.5	1.8	1025.8
REF-1	93	11.2	37.9	33.6	5.3	7.7	94.7	1.9	1025.8
REF-1	96	11.2	37.9	33.6	5.3	7.7	94.9	1.9	1025.8
REF-1	99	11.2	37.9	33.6	5.2	7.7	95.1	1.9	1025.8
REF-1	102	11.2	37.9	33.7	5.2	7.7	95.3	1.9	1025.8
REF-1	105	11.1	37.8	33.7	5.3	7.7	95.2	2.0	1025.9
REF-1	108	11.0	37.8	33.7	5.1	7.7	95.2	2.1	1025.9
REF-1	111	10.9	37.7	33.7	5.0	7.7	94.9	2.1	1025.9
REF-1	114	10.9	37.7	33.7	4.8	7.7	95.0	2.1	1025.9
REF-1	117	10.8	37.6	33.7	4.7	7.7	92.9	2.1	1026.0
REF-1	120	10.7	37.5	33.7	4.5	7.7	92.6	2.2	1026.0
REF-1	123	10.7	37.5	33.7	4.2	7.6	92.4	2.2	1026.0
REF-1	126	10.7	37.5	33.7	4.2	7.6	92.4	2.2	1026.0
REF-1	129	10.7	37.5	33.7	4.1	7.6	92.7	2.2	1026.0
REF-1	132	10.6	37.5	33.7	4.1	7.6	92.0	2.2	1026.0
REF-1	135	10.6	37.4	33.8	4.1	7.6	92.9	2.3	1026.1
REF-1	138	10.5	37.4	33.8	3.9	7.6	93.1	2.2	1026.1
REF-1	141	10.3	37.3	33.8	3.8	7.6	94.0	2.2	1026.2
REF-1	145	10.3	37.3	33.8	3.6	7.6	91.4	2.3	1026.2
REF-1	148	10.3	37.3	33.8	3.5	7.6	90.8	2.4	1026.2
REF-1	151	10.3	37.2	33.8	3.4	7.6	90.3	2.4	1026.2
REF-2	0	14.0	40.4	33.5	8.3	7.9	94.6	1.0	1025.0
REF-2	3	13.6	40.0	33.5	8.5	8.0	94.9	1.0	1025.1
REF-2	6	13.6	40.0	33.5	8.4	8.0	93.7	1.0	1025.1
REF-2	9	13.6	39.9	33.5	8.4	8.0	93.3	1.0	1025.2
REF-2	12	13.5	39.9	33.5	8.5	8.0	92.6	1.0	1025.2
REF-2	15	13.4	39.8	33.6	8.5	8.0	92.8	1.0	1025.2
REF-2	18	13.1	39.6	33.6	8.6	8.0	93.5	1.0	1025.3
REF-2	21	13.0	39.5	33.6	8.7	8.0	93.8	1.1	1025.3
REF-2	24	12.9	39.4	33.6	8.7	7.9	94.4	1.2	1025.3
REF-2	27	12.9	39.3	33.6	8.6	7.9	94.6	1.2	1025.4
REF-2	30	12.8	39.2	33.6	8.7	7.9	94.9	1.2	1025.4
REF-2	33	12.7	39.2	33.6	8.6	7.9	94.9	1.2	1025.4

Appenidx B. CTD Profiles and graphs 16 Stations

Station	Depth (3ft Average)	Temp (C)	Conductivity (mS/cm)	Salinity (PPT)	DO (mg/l)	Ph	Tranmissivity	Chlorophyll A (mg/m^3)	Density (Kg/m^3)
REF-2	36	12.6	39.1	33.6	8.6	7.9	95.1	1.3	1025.4
REF-2	39	12.6	39.1	33.6	8.5	7.9	95.4	1.3	1025.4
REF-2	42	12.5	39.0	33.6	8.4	7.9	95.4	1.2	1025.5
REF-2	45	12.4	38.9	33.6	8.4	7.9	95.4	1.2	1025.5
REF-2	48	12.3	38.9	33.6	8.2	7.9	95.6	1.3	1025.5
REF-2	51	12.3	38.8	33.6	8.1	7.9	96.1	1.3	1025.5
REF-2	54	12.2	38.7	33.6	8.0	7.9	96.1	1.3	1025.5
REF-2	57	12.1	38.7	33.6	7.7	7.9	96.1	1.4	1025.6
REF-2	60	12.1	38.7	33.6	7.7	7.9	96.0	1.5	1025.6
REF-2	63	12.1	38.6	33.6	7.7	7.9	95.9	1.4	1025.6
REF-2	66	12.0	38.6	33.6	7.7	7.9	95.6	1.4	1025.6
REF-2	69	12.0	38.5	33.6	7.5	7.9	95.6	1.4	1025.6
REF-2	72	11.9	38.5	33.6	7.4	7.9	95.6	1.5	1025.6
REF-2	75	11.8	38.4	33.6	7.2	7.9	95.2	1.4	1025.6
REF-2	78	11.8	38.4	33.6	7.1	7.9	91.9	1.5	1025.6
REF-2	81	11.7	38.3	33.6	7.3	7.9	87.4	1.5	1025.7
REF-2	84	11.4	38.1	33.6	7.1	7.9	88.7	1.5	1025.8
REF-2	87	11.3	37.9	33.6	6.6	7.8	91.2	1.6	1025.8
REF-2	90	11.2	37.9	33.6	5.3	7.8	92.7	1.9	1025.8
REF-2	93	11.2	37.9	33.6	5.2	7.7	94.6	1.9	1025.8
REF-2	96	11.2	37.9	33.6	5.3	7.7	94.3	1.9	1025.8
REF-2	99	11.2	37.9	33.7	5.3	7.7	94.8	2.0	1025.9
REF-2	102	11.1	37.8	33.7	5.2	7.7	94.9	2.0	1025.9
REF-2	105	11.0	37.8	33.7	5.0	7.7	95.1	2.1	1025.9
REF-2	108	11.0	37.7	33.7	5.0	7.7	95.4	2.1	1025.9
REF-2	111	11.0	37.7	33.7	4.8	7.7	94.9	2.1	1025.9
REF-2	114	10.9	37.7	33.7	4.8	7.7	95.2	2.1	1025.9
REF-2	117	10.8	37.6	33.7	4.7	7.7	92.6	2.1	1026.0
REF-2	120	10.8	37.5	33.7	4.5	7.7	92.6	2.1	1026.0
REF-2	123	10.7	37.5	33.7	4.3	7.6	92.8	2.1	1026.0
REF-2	126	10.6	37.5	33.7	4.3	7.6	92.8	2.1	1026.0
REF-2	129	10.6	37.5	33.7	4.1	7.6	93.0	2.2	1026.1
REF-2	132	10.6	37.4	33.8	4.1	7.6	93.4	2.2	1026.1
REF-2	135	10.4	37.3	33.8	4.0	7.6	92.9	2.2	1026.1
REF-2	138	10.4	37.3	33.8	3.7	7.6	92.5	2.2	1026.2
REF-2	141	10.3	37.3	33.8	3.6	7.6	90.5	2.2	1026.2
REF-2	145	10.3	37.3	33.8	3.5	7.6	90.3	2.3	1026.2
REF-2	148	10.3	37.3	33.8	3.5	7.6	90.2	2.3	1026.2
REF-2	151	10.3	37.3	33.8	3.4	7.6	90.0	2.3	1026.2
REF-3	0	14.8	41.0	33.5	8.1	8.0	94.5	1.0	1024.9
REF-3	3	14.6	40.9	33.5	8.2	8.0	94.7	0.9	1024.9
REF-3	6	14.1	40.5	33.6	8.4	8.0	94.6	1.0	1025.1
REF-3	9	13.8	40.2	33.6	8.4	8.0	93.8	1.0	1025.1
REF-3	12	13.6	40.0	33.5	8.4	8.0	92.3	1.0	1025.2
REF-3	15	13.6	40.0	33.5	8.4	8.0	93.3	1.0	1025.2
REF-3	18	13.5	39.9	33.5	8.4	8.0	93.8	1.0	1025.2
REF-3	21	13.4	39.9	33.5	8.5	8.0	93.9	1.0	1025.2
REF-3	24	13.1	39.6	33.6	8.6	8.0	93.8	1.0	1025.3

Appenidx B. CTD Profiles and graphs 16 Stations

Station	Depth (3ft Average)	Temp (C)	Conductivity (mS/cm)	Salinity (PPT)	DO (mg/l)	Ph	Tranmissivity	Chlorophyll A (mg/m^3)	Density (Kg/m^3)
REF-3	27	13.0	39.5	33.6	8.7	8.0	94.3	1.1	1025.3
REF-3	30	12.9	39.4	33.6	8.7	8.0	94.7	1.2	1025.3
REF-3	33	12.9	39.4	33.6	8.7	8.0	94.8	1.2	1025.4
REF-3	36	12.8	39.3	33.6	8.7	8.0	94.8	1.2	1025.4
REF-3	39	12.7	39.2	33.6	8.7	8.0	95.0	1.2	1025.4
REF-3	42	12.7	39.2	33.6	8.7	8.0	94.8	1.2	1025.4
REF-3	45	12.6	39.1	33.6	8.6	8.0	94.5	1.2	1025.4
REF-3	48	12.5	39.0	33.6	8.5	8.0	94.6	1.2	1025.5
REF-3	51	12.3	38.9	33.6	8.4	8.0	95.6	1.2	1025.5
REF-3	54	12.3	38.8	33.6	8.1	7.9	95.5	1.3	1025.5
REF-3	57	12.2	38.8	33.6	8.1	7.9	95.9	1.3	1025.5
REF-3	60	12.2	38.7	33.6	7.9	7.9	96.0	1.3	1025.5
REF-3	63	12.1	38.7	33.6	7.9	7.9	95.8	1.4	1025.6
REF-3	66	12.1	38.7	33.6	7.8	7.9	95.7	1.4	1025.6
REF-3	69	12.1	38.6	33.6	7.7	7.9	95.6	1.5	1025.6
REF-3	72	12.1	38.6	33.6	7.7	7.9	95.6	1.4	1025.6
REF-3	75	12.0	38.6	33.6	7.6	7.9	95.4	1.4	1025.6
REF-3	78	12.0	38.6	33.6	7.6	7.9	95.0	1.4	1025.6
REF-3	81	11.9	38.5	33.6	7.5	7.9	92.0	1.4	1025.6
REF-3	84	11.9	38.5	33.6	7.4	7.9	91.8	1.5	1025.6
REF-3	87	11.9	38.5	33.6	7.1	7.9	93.5	1.5	1025.6
REF-3	90	11.8	38.4	33.6	7.1	7.9	93.5	1.5	1025.7
REF-3	93	11.5	38.1	33.6	7.0	7.8	93.3	1.5	1025.8
REF-3	96	11.3	38.0	33.6	6.3	7.8	92.5	1.6	1025.8
REF-3	99	11.3	37.9	33.6	5.6	7.8	93.9	1.8	1025.8
REF-3	102	11.3	37.9	33.6	5.4	7.7	94.2	1.9	1025.8
REF-3	105	11.2	37.9	33.7	5.3	7.7	94.9	2.0	1025.8
REF-3	108	11.2	37.9	33.7	5.3	7.7	94.7	2.0	1025.9
REF-3	111	11.1	37.8	33.7	5.2	7.7	94.9	2.1	1025.9
REF-3	114	11.1	37.8	33.7	5.0	7.7	95.2	2.1	1025.9
REF-3	117	11.0	37.8	33.7	4.9	7.7	95.4	2.2	1025.9
REF-3	120	11.0	37.7	33.7	4.9	7.7	95.0	2.1	1025.9
REF-3	123	10.9	37.7	33.7	4.8	7.7	94.9	2.1	1026.0
REF-3	126	10.8	37.6	33.7	4.7	7.7	92.2	2.2	1026.0
REF-3	129	10.7	37.5	33.7	4.3	7.7	93.0	2.2	1026.0
REF-3	132	10.6	37.5	33.7	4.3	7.6	91.9	2.2	1026.1
REF-3	135	10.6	37.4	33.8	4.1	7.6	92.0	2.2	1026.1
REF-3	138	10.5	37.4	33.8	4.0	7.6	92.9	2.2	1026.1
REF-3	141	10.5	37.3	33.8	3.8	7.6	92.4	2.2	1026.1
REF-3	145	10.4	37.3	33.8	3.8	7.6	92.1	2.2	1026.2
REF-3	148	10.4	37.3	33.8	3.5	7.6	91.8	2.5	1026.2
REF-3	151	10.3	37.3	33.8	3.5	7.6	90.2	2.2	1026.2
REF-3	154	10.3	37.3	33.8	3.4	7.6	89.9	2.2	1026.2

Appendix C. Water and Sediment Chemistry

Analyte	Units	Methods	Daily Maximum	Instantaneous Maximum	EA-1	EA-2	EA-3	EA-3-DUP	REFERENCE-	FIELD
					3/31/2012	3/31/2012	3/31/2012	3/31/2012	3/31/2012	3/31/2012
Trace Metals										
Aluminum	µg/L	EPA 1640			9.12	9.31	7.26	10.3	8.7	8.16
Antimony	µg/L	EPA 1640			0.198	0.212	0.193	0.206	0.192	0.00585J
Arsenic	µg/L	EPA 1640	32	80	1.78	1.7	1.61	1.75	1.59	<0.0133
Barium	µg/L	EPA 1640			7.5B	7.43B	7.45B	7.5B	7.71B	0.0402B,J
Beryllium	µg/L	EPA 1640			<0.0981	<0.0981	<0.0981	0.198B,J	<0.0981	0.185B,J
Cadmium	µg/L	EPA 1640	4	10	0.102	0.111	0.111	0.112	0.109	<0.00650
Chromium	µg/L	EPA 1640	8	20	0.194J	0.159J	0.157J	0.175J	0.183J	<0.0937
Cobalt	µg/L	EPA 1640			0.0486J	0.0527	0.0555	0.0637	0.0574	0.015J
Copper	µg/L	EPA 1640	12	30	0.327	0.245	0.249	0.53	0.22	0.106
Iron	µg/L	EPA 1640			17.6	20.8	13.3	21.4	19.5	11.5
Lead	µg/L	EPA 1640	8	20	0.115	0.0896	0.0817	0.0989	0.104	<0.0124
Manganese	µg/L	EPA 1640			0.445J	0.444J	0.386J	0.446J	0.401J	0.0533J
Mercury	µg/L	EPA 7470A	16	4	<0.0321	<0.0321	<0.0321	<0.0321	<0.0321	<0.0321
Molybdenum	µg/L	EPA 1640			13B	13.1B	13B	13B	13.2B	<0.0113
Nickel	µg/L	EPA 1640	20	50	1.41	1.51	1.73	1.92	1.74	0.0883
Selenium	µg/L	EPA 1640	60	150	0.0489J	0.0621	0.0479J	0.047J	0.0453J	<0.0112
Silver	µg/L	EPA 1640	28	7	0.139	0.143	0.137	0.139	0.141	<0.00655
Thallium	µg/L	EPA 1640			0.0148J	0.0156J	0.0157J	0.0151J	0.0154J	<0.00782
Vanadium	µg/L	EPA 1640			2.29	2.37	2.5	2.62	2.37	0.0374J
Zinc	µg/L	EPA 1640	80	200	1.73	1.49	1.87	1.74	1.03	0.479J
Chlorine										
Chlorine, Total Residual	mg/L	SM 4500-Cl F	8	60	<0.042	<0.042	<0.042	<0.042	<0.042	<0.042
Halogenated Organic Compounds (volatile and semi-volatile										
1,1,1-Trichloroethane	µg/L	EPA 624			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
1,1,2,2-Tetrachloroethane	µg/L	EPA 624			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,1,2-Trichloroethane	µg/L	EPA 624			<0.26	<0.26	<0.26	<0.26	<0.26	<0.26
1,1-Dichloroethane	µg/L	EPA 624			<0.13	<0.13	<0.13	<0.13	<0.13	<0.13
1,1-Dichloroethene	µg/L	EPA 624			<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,2,4-Trichlorobenzene	µg/L	EPA 625			<2.8	<2.8	<2.8	<2.8	<2.8	<2.8
1,2-Dibromoethane	µg/L	EPA 624			<0.11	<0.11	<0.11	<0.11	<0.11	<0.11
1,2-Dichlorobenzene	µg/L	EPA 624			<0.12	<0.12	<0.12	<0.12	<0.12	<0.12
1,2-Dichloroethane	µg/L	EPA 624			<0.077	<0.077	<0.077	<0.077	<0.077	<0.077
1,2-Dichloropropane	µg/L	EPA 624			<0.14	<0.14	<0.14	<0.14	<0.14	<0.14
1,3-Dichlorobenzene	µg/L	EPA 624			<0.12	<0.12	<0.12	<0.12	<0.12	<0.12
1,4-Dichlorobenzene	µg/L	EPA 624			<0.17	<0.17	<0.17	<0.17	<0.17	<0.17
2,4,6-Trichlorophenol	µg/L	EPA 625	4	10	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
2,4-Dichlorophenol	µg/L	EPA 625	4	10	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
2-Chloroethyl Vinyl Ether	µg/L	EPA 624			<0.51	<0.51	<0.51	<0.51	<0.51	<0.51
2-Chloronaphthalene	µg/L	EPA 625			<2.8	<2.8	<2.8	<2.8	<2.8	<2.8
2-Chlorophenol	µg/L	EPA 625	4	10	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3
3,3'-Dichlorobenzidine	µg/L	EPA 625			<2.6	<2.6	<2.6	<2.6	<2.6	<2.6
4-Bromophenyl-Phenyl Ether	µg/L	EPA 625			<2.7	<2.7	<2.7	<2.7	<2.7	<2.7
4-Chloro-3-Methylphenol	µg/L	EPA 625	4	10	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4

Appendix C. Water and Sediment Chemistry

Analyte	Units	Methods	Daily Maximum	Instantaneous Maximum	EA-1	EA-2	EA-3	EA-3-DUP	REFERENCE-	FIELD
					3/31/2012	3/31/2012	3/31/2012	3/31/2012	3/31/2012	3/31/2012
4-Chlorophenyl-Phenyl Ether	µg/L	EPA 625			<2.7	<2.7	<2.7	<2.7	<2.7	<2.7
Bis(2-Chloroethoxy) Methane	µg/L	EPA 625			<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Bis(2-Chloroethyl) Ether	µg/L	EPA 625			<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Bis(2-Chloroisopropyl) Ether	µg/L	EPA 625			<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
Bromodichloromethane	µg/L	EPA 624			<0.12	<0.12	<0.12	<0.12	<0.12	<0.12
Bromoform	µg/L	EPA 624			<0.37	<0.37	<0.37	<0.37	<0.37	<0.37
Bromomethane	µg/L	EPA 624			<0.81	<0.81	<0.81	<0.81	<0.81	<0.81
c-1,2-Dichloroethene	µg/L	EPA 624			<0.16	<0.16	<0.16	<0.16	<0.16	<0.16
c-1,3-Dichloropropene	µg/L	EPA 624			<0.082	<0.082	<0.082	<0.082	<0.082	<0.082
Carbon Tetrachloride	µg/L	EPA 624			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
Chlorobenzene	µg/L	EPA 624			<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
Chloroethane	µg/L	EPA 624			<0.26	<0.26	<0.26	<0.26	<0.26	<0.26
Chloroform	µg/L	EPA 624			<0.12	<0.12	<0.12	<0.12	<0.12	<0.12
Chloromethane	µg/L	EPA 624			<0.13	<0.13	<0.13	<0.13	<0.13	<0.13
Dibromochloromethane	µg/L	EPA 624			<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
Dichlorodifluoromethane	µg/L	EPA 624			<0.076	<0.076	<0.076	<0.076	<0.076	<0.076
Hexachloro-1,3-Butadiene	µg/L	EPA 625			<2.9	<2.9	<2.9	<2.9	<2.9	<2.9
Hexachlorobenzene	µg/L	EPA 625			<3.1	<3.1	<3.1	<3.1	<3.1	<3.1
Hexachlorocyclopentadiene	µg/L	EPA 625			<6.9	<6.9	<6.9	<6.9	<6.9	<6.9
Hexachloroethane	µg/L	EPA 625			<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Methylene Chloride	µg/L	EPA 624			<0.86	<0.86	<0.86	<0.86	<0.86	<0.86
t-1,2-Dichloroethene	µg/L	EPA 624			<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
t-1,3-Dichloropropene	µg/L	EPA 624			<0.14	<0.14	<0.14	<0.14	<0.14	<0.14
Tetrachloroethene	µg/L	EPA 624			<0.094	<0.094	<0.094	<0.094	<0.094	<0.094
Trichloroethene	µg/L	EPA 624			<0.14	<0.14	<0.14	<0.14	<0.14	<0.14
Trichlorofluoromethane	µg/L	EPA 624			<0.066	<0.066	<0.066	<0.066	<0.066	<0.066
Vinyl Chloride	µg/L	EPA 624			<0.086	<0.086	<0.086	<0.086	<0.086	<0.086

< - results less than the method detection limit.

B - Analyte was detected in the associated method blank.

J - results above the method detection limit but below the reporting limit. Result is estimated.

Appendix D - Species List and Abundance Table

Group	Species Name	Trans-1	Trans-2	Trans-3	Trans-4	Trans-5	Trans-6	Trans-7	Trans-8	Trans-9	Trans-10	EA-1	EA-2	EA-3	Ref-1	Ref-2	Ref-3
Polychaetes	Aglaophamus verrilli														1		
Polychaetes	Amaeana occidentalis					1					1						
Polychaetes	Ampharete finmarchica					1						5		1		3	
Polychaetes	Ampharete labrops			4	1			1		6			1				
Polychaetes	Ampharetidae							1						1			
Polychaetes	Amphicteis scaphobranchiata			1					1			1					
Polychaetes	Anobothrus gracilis											4	1	1		1	3
Polychaetes	Anotomastus gordiodes		7					1		1							
Polychaetes	Aphelochaeta glandaria Cmplx																1
Polychaetes	Aphelochaeta monilaris											2		1			
Polychaetes	Aphelochaeta petersenae									1				1			
Polychaetes	Aphelochaeta sp				1					1							
Polychaetes	Aphelochaeta sp HYP6													1			1
Polychaetes	Apoprionospio pygmaea					1											
Polychaetes	Aricidea (Acmira) catherinae				1	4									1	1	2
Polychaetes	Aricidea (Allia) antennata					1							1				
Polychaetes	Aricidea (Allia) hartleyi					4					1		1				
Polychaetes	Aricidea (Allia) sp A					1					2		2	3		1	3
Polychaetes	Artacama coniferi				1												
Polychaetes	Artacamella hancocki												1		1		2
Polychaetes	Autolytus sp										1				1		
Polychaetes	Axiothella rubrocincta					1											
Polychaetes	Bipalponephtys cornuta									1							
Polychaetes	Capitella capitata Cmplx													1			
Polychaetes	Carazziella sp A									2							
Polychaetes	Chaetozone columbiana		1														
Polychaetes	Chaetozone corona			1						2							
Polychaetes	Chaetozone hartmanae											1	1	1			
Polychaetes	Cossura candida														1	1	
Polychaetes	Cossura sp A					1							1				
Polychaetes	Dialychone albocincta			1							1						
Polychaetes	Dialychone veleronis			1	1												
Polychaetes	Diopatra ornata						1				1						
Polychaetes	Diopatra sp										2						
Polychaetes	Diopatra tridentata									2	2					1	
Polychaetes	Dipolydora socialis										2					1	1
Polychaetes	Drilonereis mexicana													1			
Polychaetes	Drilonereis sp			1	1	2				1	1						
Polychaetes	Eclysippe trilobata					1								2		1	1
Polychaetes	Eranno lagunae												1		1	1	
Polychaetes	Euclymeninae				1	1				2	2		3	2			
Polychaetes	Euclymeninae sp A			1	3	7					8	6	1	1	4		2
Polychaetes	Eulalia californiensis														1		
Polychaetes	Eunice americana					2									1		
Polychaetes	Eusyllis sp							2									
Polychaetes	Eusyllis transecta		1	1						1							
Polychaetes	Exogone dwisula			1						2	2						
Polychaetes	Glycera americana									1	2						
Polychaetes	Glycera macrobranchia		2				2										
Polychaetes	Glycera nana				2	2				1	6	1	2	4	3	2	
Polychaetes	Glycinde armigera			2	1				1				1				
Polychaetes	Goniada littorea	1	2	1			1	1		1							
Polychaetes	Goniada maculata			2	2	1			2	1	4	3		1	2	4	1
Polychaetes	Gymnonereis crosslandi					2					5						
Polychaetes	Hesperonoe laevis				1												1
Polychaetes	Isocirrus planiceps										1						
Polychaetes	Laonice cirrata		1	2							1	1					
Polychaetes	Laonice nuchala											1					
Polychaetes	Leitoscoloplos pugettensis	5		1		1								1			1
Polychaetes	Levinsenia gracilis											1					2
Polychaetes	Lumbrineris cruzensis				1	2					1	1	2	5	5	4	3
Polychaetes	Lumbrineris japonica				1									1			
Polychaetes	Lumbrineris latreilli				1												
Polychaetes	Lumbrineris ligulata			1		1									1		
Polychaetes	Lumbrineris sp			1													
Polychaetes	Lysippe sp A			1	3					4	2	1	1				
Polychaetes	Lysippe sp B													1			1
Polychaetes	Magelona berkeleyi					1											
Polychaetes	Maldane sarsi											2		1	1		
Polychaetes	Malmgreniella baschi				1										1		
Polychaetes	Malmgreniella macginitiei			2							1						
Polychaetes	Malmgreniella sp A					2					1	2	3	7	4	5	5
Polychaetes	Marphysa disjuncta				1	4					6			1	1		
Polychaetes	Mediomastus sp		4	3		6				5	2	1	2	3	2	3	2
Polychaetes	Melinna oculata			2	6					10		1			1		
Polychaetes	Metasychis disparidentatus			1													
Polychaetes	Monticellina cryptica		1		1	5				1	7		7	8	4	3	2
Polychaetes	Monticellina siblina		4	5	2					8							
Polychaetes	Monticellina tesselata													1			
Polychaetes	Mooreonuphis nebulosa			1		3				9							
Polychaetes	Mooresamytha bioculata											1					
Polychaetes	Neosabellaria cementarium										1						
Polychaetes	Nephtys caecoides									3	2	1			1		
Polychaetes	Nephtys ferruginea			1	3	3				1	4	1				2	2
Polychaetes	Nereis latescens		2					6									
Polychaetes	Nereis sp A		3	4	3	1		2			1			3			2
Polychaetes	Ninoe tridentata					1							2	2	4	1	3
Polychaetes	Notomastus sp A					1					1		1		1		
Polychaetes	Odontosyllis phosphorea			1													
Polychaetes	Onuphidae									1							
Polychaetes	Onuphis sp A			1		1		1						1			
Polychaetes	Ophelina acuminata										1						
Polychaetes	Owenia collaris						3	2									
Polychaetes	Paradialychone bimaculata									2							
Polychaetes	Paradialychone ecaudata					1					5						
Polychaetes	Paradialychone harrisae				2	7				1	2	1				1	1
Polychaetes	Paradialychone paramollis				2						3						
Polychaetes	Paradiopatra parva				1						1	1		1		1	1
Polychaetes	Paraexogone acutipalpa				2												
Polychaetes	Paramage scutata			2										1		2	1
Polychaetes	Paraprionospio alata		1	6	9	3				4	6	2	3	3	2	3	3
Polychaetes	Parasabella sp									1							
Polychaetes	Pectinaria californiensis												1	1	1	1	
Polychaetes	Petaloclymene pacifica				2					2			3	3	1	2	1
Polychaetes	Pherusa neopapillata			1													
Polychaetes	Phisidia sanctaemariae											2					1
Polychaetes	Pholoe glabra				1	1							6	3	5		3
Polychaetes	Phyllodoce longipes				3	1				1							
Polychaetes	Phyllodocidae		1														
Polychaetes	Pilargis sp B																1
Polychaetes	Pista brevibranchiata				2	1					2						
Polychaetes	Pista estevanica											1	1			2	
Polychaetes	Pista wui							3	1								1
Polychaetes	Platynereis bicanaliculata						1	6									
Polychaetes	Podarkeopsis glabrus					1											
Polychaetes	Poecilochaetus johnsoni					2				1	1				1		
Polychaetes	Poecilochaetus martini					1					5						
Polychaetes	Poecilochaetus sp										2						
Polychaetes	Polycirrus californicus					2										1	2
Polychaetes	Polycirrus sp A					1				3	2			2		1	1
Polychaetes	Polydora cirrosa	2	2	1													

Appendix D - Species List and Abundance Table

Group	Species Name	Trans-1	Trans-2	Trans-3	Trans-4	Trans-5	Trans-6	Trans-7	Trans-8	Trans-9	Trans-10	EA-1	EA-2	EA-3	Ref-1	Ref-2	Ref-3
Polychaetes	Polyodontes panamensis					1											
Polychaetes	Praxillella pacifica				2					2		2					
Polychaetes	Prionospio (Minuspio) lighti					1											
Polychaetes	Prionospio (Prionospio) dubia					2							6	5	5	2	3
Polychaetes	Prionospio (Prionospio) jubata			4		3				1	2		2		2	2	6
Polychaetes	Pseudopotamilla sp							1									
Polychaetes	Sabellariidae					2					2						
Polychaetes	Sabellides manriquei					1											
Polychaetes	Scalibregma californicum					10					4	1	12	12	15	12	4
Polychaetes	Scoletoma sp									2							
Polychaetes	Scoletoma sp A			1													
Polychaetes	Scoletoma tetraura Cmplx	2															
Polychaetes	Scoloplos armiger Cmplx													1			
Polychaetes	Sigalion spinosus		1						3								
Polychaetes	Sphaerosyllis californiensis		7														
Polychaetes	Spio filicornis															1	
Polychaetes	Spiochaetopterus costarum Cmplx				3	1				1							
Polychaetes	Spiophanes berkeleyorum				1												
Polychaetes	Spiophanes duplex			1	25	13				42	4	6	7	8	6	6	10
Polychaetes	Spiophanes norrisi	2								4							
Polychaetes	Sternaspis fossor				4	6				7	2		3	1	1	2	
Polychaetes	Sthenelais tertiaglabra				3	1				1	2		1	1	5		4
Polychaetes	Sthenelais verruculosa						1										
Polychaetes	Sthenelanella uniformis			3	25	9				16	21	7	14	8	5	6	5
Polychaetes	Streblosoma crassibranchia				2					4	1						
Polychaetes	Streblosoma sp B									1	1						
Polychaetes	Tenonia priops																1
Polychaetes	Terebellidae									1							
Polychaetes	Terebellides californica				2	3					2		4	2	2	1	1
Polychaetes	Terebellides reishi												1	3	2		2
Polychaetes	Terebellides sp					1											
Polychaetes	Terebellides sp Type C					2											
Polychaetes	Travisia brevis											3	1		1	1	3
Polychaetes	Typosyllis heterochaeta															1	1
Polychaetes	Typosyllis hyperioni					2											
Polychaetes Total Count		**12**	**40**	**63**	**130**	**144**	**9**	**27**	**8**	**165**	**145**	**63**	**100**	**112**	**97**	**83**	**97**
Crustaceans	Acidostoma hancocki					1											
Crustaceans	Alienacanthomysis macropsis						1	2									
Crustaceans	Americhelidium shoemakeri					1											
Crustaceans	Americhelidium sp SD4													1			
Crustaceans	Ampelisca agassizi	1				4			1	25	9		2			1	3
Crustaceans	Ampelisca brevisimulata			11	13	9			4	43	15	6	5	7	8	5	7
Crustaceans	Ampelisca careyi					3					10	1	2	3	1	4	2
Crustaceans	Ampelisca cristata cristata			7					7	2	1						1
Crustaceans	Ampelisca cristata microdentata			4	2	6				6	16	2	7	3	5	4	5
Crustaceans	Ampelisca hancocki					1					1	1	1		1	1	
Crustaceans	Ampelisca indentata					1					2	1			1		1
Crustaceans	Ampelisca lobata					9					1						
Crustaceans	Ampelisca milleri					2											
Crustaceans	Ampelisca nr. brevisimulata					1							2	1	1	1	1
Crustaceans	Ampelisca pacifica					3					4	2	6	2	4	1	3
Crustaceans	Ampelisca pugetica				2	2				12	6	2	4	3	3	2	1
Crustaceans	Ampelisca sp			1	1				1	4	1	1	1				
Crustaceans	Ampelisciphotis podophthalma				2	6				3	2						
Crustaceans	Amphideutopus oculatus				21	9				19	7						2
Crustaceans	Aoroides exilis		1														
Crustaceans	Aoroides inermis	4	1		1	2	1	3		3	7		1	1	3	6	
Crustaceans	Araphura breviaria																1
Crustaceans	Argissa hamatipes				1						1						
Crustaceans	Aruga holmesi													3			
Crustaceans	Aruga oculata				2	2				1	1						
Crustaceans	Bathymedon pumilus											1	2				
Crustaceans	Brachyura	1	2	4													
Crustaceans	Byblis millsi				4	2				1	4	2	2	1	1	4	
Crustaceans	Caecognathia crenulatifrons					4				2	3	2	1				3
Crustaceans	Calanoida										1			1			1
Crustaceans	Campylaspis canaliculata										2		1				1
Crustaceans	Cancridae	1	1	4	3		1			14	1						
Crustaceans	Caprella californica		1			2	1				4						
Crustaceans	Caprella mendax					1					1		1		8	1	1
Crustaceans	Crangon sp							1									
Crustaceans	Cyclaspis nubila	1															
Crustaceans	Deflexilodes norvegicus											3	2	1	1	3	6
Crustaceans	Diastylis crenellata											1	1	1			1
Crustaceans	Diastylopsis tenuis	1	1				3	2	8	1							
Crustaceans	Edotia sublittoralis						1										
Crustaceans	Ericthonius brasiliensis		1					1			3						
Crustaceans	Euphilomedes carcharodonta			4		9					32		3	2	2	8	3
Crustaceans	Foxiphalus golfensis				2												
Crustaceans	Foxiphalus obtusidens			4						4							
Crustaceans	Foxiphalus similis													1	1		
Crustaceans	Gammaropsis thompsoni	2	1	1						4	1						
Crustaceans	Gibberosus myersi						2										
Crustaceans	Gnathiidae				2												
Crustaceans	Gnathopleustes sp					5		1									
Crustaceans	Haliophasma geminatum									3		1		1	3		2
Crustaceans	Hamatoscalpellum californicum					1					54		5		2	1	
Crustaceans	Hartmanodes hartmanae					4				1							
Crustaceans	Hemilamprops californicus					1							1				
Crustaceans	Heptacarpus stimpsoni				1					1							
Crustaceans	Heterocrypta occidentalis									1		1					1
Crustaceans	Heterophoxus oculatus				2	3					1	1	1	8	4	3	1
Crustaceans	Heterophoxus sp										1			1			
Crustaceans	Hippolytidae				1						1						
Crustaceans	Hippomedon sp A											1					
Crustaceans	Leptochelia dubia				1	9				3	5	7	2	6	3	2	3
Crustaceans	Listriella goleta			1				1									
Crustaceans	Listriella melanica			1						1							
Crustaceans	Loxorhynchus sp							1									
Crustaceans	Maera similis					4											
Crustaceans	Majidae									1							
Crustaceans	Megalopa/Zoea			1	1			2	2		1	1					
Crustaceans	Mesolamprops bispinosus											3	2	7		3	3
Crustaceans	Metamysidopsis elongata		1														
Crustaceans	Microjassa bousfieldi	3					1										
Crustaceans	Monoculodes emarginatus												1	1	1		
Crustaceans	Neastacilla californica									1							
Crustaceans	Nebalia daytoni									1							
Crustaceans	Nebalia pugettensis Cmplx				1							1			1	1	
Crustaceans	Neomysis kadiakensis						1										
Crustaceans	Neotrypaea gigas					1											
Crustaceans	Neotrypaea sp	1			1	2					4				4		
Crustaceans	Nicippe tumida											1			1		
Crustaceans	Ogyrides sp A						1										
Crustaceans	Opisa tridentata															1	
Crustaceans	Pacifacanthomysis nephrophthalma	6	1				3										
Crustaceans	Paraxanthias taylori					1											
Crustaceans	Photis brevipes		5	5		3				13	3				3	5	
Crustaceans	Photis californica				6	1				29	18		1	2	6	1	
Crustaceans	Photis lacia										1						
Crustaceans	Photis sp		1			3				2	6		1				

Appendix D - Species List and Abundance Table

Group	Species Name	Trans-1	Trans-2	Trans-3	Trans-4	Trans-5	Trans-6	Trans-7	Trans-8	Trans-9	Trans-10	EA-1	EA-2	EA-3	Ref-1	Ref-2	Ref-3
Crustaceans	Photis sp C			1						5							
Crustaceans	Photis sp OC1				1				1								
Crustaceans	Pinnixa hiatus			1													
Crustaceans	Pinnixa occidentalis Cmplx					1					1			1	3	2	
Crustaceans	Pinnixa sp				1	2		1	10	2		4		1		2	4
Crustaceans	Pinnixa tubicola									1							
Crustaceans	Pinnotheridae			6	5						1						
Crustaceans	Pleusymtes subglaber				1	2											
Crustaceans	Podocerus cristatus					25										1	
Crustaceans	Procampylaspis caenosa												1	1		1	1
Crustaceans	Protomedeia articulata Cmplx					1						2	2	1		4	1
Crustaceans	Rhachotropis sp A												3		1		
Crustaceans	Rhepoxynius bicuspidatus				3	2					2	6	9	10	4	6	8
Crustaceans	Rhepoxynius menziesi	1			1	1	4	1	2	1	3	1		1	3	2	4
Crustaceans	Rhepoxynius stenodes		1	2					3	3							
Crustaceans	Rhepoxynius variatus	1															
Crustaceans	Romaleon jordani		1	1					5								
Crustaceans	Rudilemboides sp									1							
Crustaceans	Rudilemboides stenopropodus				1												
Crustaceans	Rutiderma rostratum					1											
Crustaceans	Tritella pilimana													3			
Crustaceans	Westwoodilla tone			1	3	1				4	5		3	1	2	6	6
Crustaceans	Xenoleberis californica				1	1				1					1	3	
Crustaceans Total Count		**23**	**19**	**60**	**87**	**155**	**20**	**16**	**44**	**219**	**243**	**55**	**76**	**76**	**82**	**85**	**77**
Echinoderms	Amphiodia sp			2		7			1		1	3	29	11	7	4	21
Echinoderms	Amphiodia urtica				5	2				1	5	37	28	33	30	31	28
Echinoderms	Amphioplus sp A										3						1
Echinoderms	Amphipholis squamata			1													
Echinoderms	Amphiura arcystata										1				1		
Echinoderms	Amphiuridae			1	1	6			1		2	8	12	7	8	6	14
Echinoderms	Asteroidea										1						1
Echinoderms	Astropecten californicus				1					1					1		
Echinoderms	Chiridota sp					4					1	1	1	4	1	1	4
Echinoderms	Leptosynapta sp					2						4	4	5	5	6	3
Echinoderms	Ophiura luetkenii					11					7	1				1	
Echinoderms	Ophiuroconis bispinosa				25	10				2	4	1	1	1		5	5
Echinoderms Total Count		**0**	**0**	**4**	**32**	**42**	**0**	**0**	**2**	**4**	**25**	**55**	**75**	**61**	**53**	**54**	**77**
Molluscs	Acanthodoris sp							1									
Molluscs	Acteocina cerealis		1					2	1			1					
Molluscs	Acteocina culcitella							1									
Molluscs	Acteocina harpa			1													
Molluscs	Aglaja ocelligera												1				
Molluscs	Amphissa undata					1					1						
Molluscs	Axinopsida serricata				1											1	
Molluscs	Bartschella sp HYP1			4													
Molluscs	Bivalvia						1										
Molluscs	Chaetoderma marinelli												2				
Molluscs	Chaetodermatida																1
Molluscs	Compsomyax subdiaphana										1	2	4	3	1	2	5
Molluscs	Cooperella subdiaphana									1			2	1		1	1
Molluscs	Crepidula sp	2	1														
Molluscs	Cuspidaria parapodema													1			
Molluscs	Cylichna diegensis			1	1					1							
Molluscs	Dendronotus sp		1														
Molluscs	Ennucula tenuis					1											1
Molluscs	Ensis myrae			1													
Molluscs	Epitonium indianorum												1				
Molluscs	Eulithidium substriatum						1										
Molluscs	Gadila aberrans			2	10	3				1	2	1	3	2		1	1
Molluscs	Gari fucata				1												
Molluscs	Gastropteron pacificum													2		2	1
Molluscs	Glossaulax reclusianus							1									
Molluscs	Hiatella arctica					1					2						
Molluscs	Kurtzia arteaga									1					1		
Molluscs	Kurtzina beta					1						2	2	8	8	1	3
Molluscs	Leptopecten latiauratus	1						1		2						1	
Molluscs	Lirobittium rugatum													1	2		
Molluscs	Lucinisca nuttalli	1		1													
Molluscs	Lucinoma annulatum																1
Molluscs	Lyonsia californica								1		3	1					1
Molluscs	Macoma yoldiformis			1		4				2	2				1	1	1
Molluscs	Megasurcula carpenteriana									1							
Molluscs	Melanella rosa					1					1	1	2			1	3
Molluscs	Melanella sp													1			
Molluscs	Melanochlamys diomedea									1							
Molluscs	Modiolus neglectus					1				1							
Molluscs	Modiolus rectus							1									
Molluscs	Modiolus sp	3					1	1		1							
Molluscs	Neaeromya rugifera										1						
Molluscs	Nemocardium centifilosum													1		1	
Molluscs	Nuculana sp A														1	2	2
Molluscs	Nuculana taphria			3	9	11			1	2	4	1	4	6	3	2	3
Molluscs	Nutricola ovalis	1															
Molluscs	Nutricola tantilla	3					4										
Molluscs	Odostomia sp		5	1					2			1		3			
Molluscs	Ophiodermella inermis									1							
Molluscs	Pandora bilirata								1			1	1		1		
Molluscs	Pandora filosa														1		
Molluscs	Parvilucina tenuisculpta			3	1	1			1	4							1
Molluscs	Periploma discus															1	
Molluscs	Philine auriformis										3	1	1		1		
Molluscs	Polygireulima rutila								2						1		
Molluscs	Polyschides quadrifissatus												3	1	1		
Molluscs	Rictaxis punctocaelatus									1							
Molluscs	Rochefortia compressa			1													
Molluscs	Rochefortia grippi				1												
Molluscs	Rochefortia tumida			2	2	5		1		7	10	4	3	6	8	7	7
Molluscs	Saxicavella nybakkeni														3		6
Molluscs	Siliqua lucida							1									
Molluscs	Solamen columbianum			1						1							1
Molluscs	Solemya pervernicosa												3				
Molluscs	Solen sicarius			1	3	7				3	6			2			1
Molluscs	Tellina modesta		2	6	2		3		7	4	1						
Molluscs	Tellina sp B					2					3	2	4	2	2	1	4
Molluscs	Thracia trapezoides			1	1												
Molluscs	Thyasira flexuosa					1					2	1					
Molluscs	Turbonilla sp	1		5								1					
Molluscs	Turbonilla sp A									1				1	1		
Molluscs	Turbonilla sp HYP8			1													
Molluscs	Turbonilla sp SMB2														1		
Molluscs	Veneridae							1									
Molluscs	Volvulella californica											2					
Molluscs	Volvulella cylindrica					1											
Molluscs	Volvulella panamica										1			1			1
Molluscs Total Count		**12**	**10**	**36**	**32**	**41**	**10**	**11**	**16**	**36**	**43**	**22**	**36**	**42**	**37**	**25**	**45**
Minor Phyla	Actiniaria										1		1				
Minor Phyla	Agnezia septentrionalis									10		3		3	1	3	2
Minor Phyla	Apionsoma misakianum																1
Minor Phyla	Arachnanthus sp A				1	7					4		3	3	3	1	11
Minor Phyla	Ascidiacea				1												
Minor Phyla	Bougainvilliidae		1	1	1	1	1	1			1	1		1	2	1	1

Appendix D - Species List and Abundance Table

Group	Species Name	Trans-1	Trans-2	Trans-3	Trans-4	Trans-5	Trans-6	Trans-7	Trans-8	Trans-9	Trans-10	EA-1	EA-2	EA-3	Ref-1	Ref-2	Ref-3
Minor Phyla	Carinoma mutabilis		2		1	2		3								2	
Minor Phyla	Celleporina sp							1			1				1		1
Minor Phyla	Ceriantharia				2	1				2	1	1	1	1			
Minor Phyla	Cheilostomata		1			1		1			1						
Minor Phyla	Corymorpha bigelowi				1				2								
Minor Phyla	Corymorpha palma								1								
Minor Phyla	Crisia occidentalis										1						1
Minor Phyla	Edwardsia juliae					2								2			
Minor Phyla	Edwardsia olguini										2				1	2	
Minor Phyla	Edwardsiidae									1	2						
Minor Phyla	Enopla		1			1		1		1				2	2		
Minor Phyla	Enteropneusta					1						1					1
Minor Phyla	Euphysa sp A				1												
Minor Phyla	Glottidia albida				6	2		1			1		1		1		2
Minor Phyla	Halcampa decemtentaculata											1					
Minor Phyla	Hoplonemertea	1															
Minor Phyla	Leuckartiara octona														1	1	
Minor Phyla	Lineidae	1				3						2	1		1		
Minor Phyla	Lineus bilineatus				2	2				1	2	1		1			
Minor Phyla	Listriolobus pelodes					1									1		1
Minor Phyla	Molgula sp				1	1											
Minor Phyla	Nematoda					1				1							
Minor Phyla	Nemertea					1					1						
Minor Phyla	Oerstedia dorsalis														1		
Minor Phyla	Paranemertes californica								1						1		
Minor Phyla	Phascolion sp A																1
Minor Phyla	Phoronida										3	1		1		1	1
Minor Phyla	Phoronis sp									2	1						
Minor Phyla	Rhizorhagium formosum													1			
Minor Phyla	Stereobalanus sp					4					2	1	3	3	2	4	
Minor Phyla	Stylatula elongata		1									1					
Minor Phyla	Stylatula sp A												1	1			
Minor Phyla	Tubulanidae sp B													1			
Minor Phyla	Tubulanus polymorphus		1			1				2						1	
Minor Phyla	Virgularia agassizii												2			2	
	Minor Phyla Total Count	**2**	**7**	**1**	**17**	**32**	**1**	**8**	**4**	**20**	**24**	**13**	**13**	**20**	**18**	**18**	**23**
	Total Count for all Groups	**49**	**76**	**164**	**298**	**414**	**40**	**62**	**74**	**444**	**480**	**208**	**300**	**311**	**287**	**265**	**319**

Bioassay Test Results: Sylmar Ground Return System Undersea Electrode

Prepared for:

LADWP
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Los Angeles, CA 90012-2607

Prepared by:

Weston Solutions, Inc.
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June 2012

1.0 BIOASSAY TEST METHODS AND RESULTS

Bioassay testing was performed in accordance with procedures outlined in *Methods for Assessing Toxicity of Sediment-Associated Contaminants with Estuarine and Marine Amphipods* (USEPA 1994) and American Society for Testing and Materials (ASTM) Standard E1367-03 (ASTM 2010). The project plan involved bioassay testing of 10 samples collected in Santa Monica Bay. In addition, a laboratory control sample was run with the selected test species. Bioassay testing for this project consisted of a solid phase (SP) toxicity test using the amphipod *Eohaustorius estuarius*.

1.1 **Solid Phase Testing**

1.1.1 Summary of Methods

The SP tests with the amphipod *E. estuarius* were conducted in accordance with procedures described in *Methods for Assessing Toxicity of Sediment-Associated Contaminants with Estuarine and Marine Amphipods* (USEPA 1994) and ASTM Standard E1367-03 (ASTM 2010). Sediment was press-sieved for all test and control materials prior to solid phase testing through a 2 mm stainless steel mesh screen. Each treatment (i.e., test material and control) was performed with five replicates containing 20 organisms per test chamber. Control sediment was provided by Northwestern Aquatic Sciences, Newport, Oregon. The test was conducted under constant light and at 15°C. All instruments used by Weston were calibrated daily and calibration curves were documented in equipment calibration logs.

1.1.2 *Eohaustorius estuarius* 10-Day Solid Phase Test Results

Water quality parameters were within the appropriate limits. Mean percent survival of *E. estuarius* was 96.0% in the control, which met the minimum acceptable control survival criterion ($\geq 90\%$). Over 20 amphipods were recovered at test termination from replicate 1 of sample TRANS-7. Unable to confirm the number of organisms added at test initiation, this replicate was dropped from statistical analysis. Mean percent survival was generally high across all concentrations (86.0 – 96.3%) with the exception of sample REF-3 (62.0%), which was significantly different from the control. A summary of test results is provided in Table 2.

In the ammonium chloride reference toxicant test, LC_{50} values of 54.4 mg total NH_3/L and 0.977 mg un-ionized NH_3/L were determined from survivorship at measured concentrations of 0, 12.5, 25.5, 49.3, 102, and 206 mg total NH_3/L, and calculated unionized concentrations of 0, 0.366, 0.592, 0.92, 1.19, and 1.53 mg un-ionized NH_3/L. Measured total ammonia and unionized ammonia in tests conducted with project materials were below concurrent reference toxicant effect levels (LC_{50} = 54.4 mg total NH_3/L; no observable effect concentration [NOEC] = 12.5 mg total NH_3/L). Therefore, ammonia is not expected to have contributed to any toxicity found in tests using project materials.

Table 1. Test Conditions for the 10 Day Solid Phase Test Using *Eohaustorius estuarius*

Test Conditions: *Eohaustorius estuarius* SP Test		
Sample Identification	**TRANS-2, TRANS-4, TRANS-7, TRANS-9, EA-1, EA-2, EA-3. REF-1, REF-2 and REF-3**	
Date sampled	March 30 - 31, 2012	
Date received at Carlsbad Laboratory	April 2, 2012	
Approximate volume received	10L per sample	
Sample storage conditions	4°C, dark, minimal head space	
Test Species	***E. estuarius***	
Supplier	Northwestern Aquatic Sciences, Newport, Oregon	
Date acquired	April 5, 2012	
Acclimation/holding time	1 days	
Age/Size class	3 – 5 mm	
Test Procedures	**ASTM E1367-03 (ASTM 2010) and USEPA (1994)**	
Test location	Weston Solutions Carlsbad lab, Room 2	
Test type/duration	Static – Acute SP / 10 days	
Test dates	April 6 – 16, 2012	
Control water	Scripps Institute of Oceanography seawater; 3 µm filtered, UV sterilized	
Test temperature	Target: 15 ± 2°C	Actual: 14 - 16°C
Test Salinity	Target: 30 ± 2 ppt	Actual: 29 – 32 ppt
Test dissolved oxygen	Target: > 6.0 mg/L	Actual: 7.2 – 8.8 mg/L
Test pH	Target: monitor drift	Actual: 7.9 - 8.2
Test overlying total ammonia	No recommended concentration	Actual: <0.500 – 2.67 mg/L
Test overlying un-ionized ammonia	No recommended concentration	Actual: <0.009 - 0.056 mg/L
Test interstitial total ammonia	Target: < 60 mg/L	Actual: <0.500 – 10.4 mg/L
Test interstitial un-ionized ammonia	Target: <0.8 mg/L	Actual: <0.002 – 0.111 mg/L
Test photoperiod	Constant light	
Test chamber	1 L glass jars	
Replicates/treatment	5	
Organisms/replicate	20	
Exposure volume	2 cm sediment; 800 mL water	
Feeding	None	
Water renewal	Day 0	
Deviations from Test Protocol	More than 20 amphipods were recovered at test termination from replicate 1 of sample TRANS-7. Since the number of organisms added at test initiation could not be confirmed, the replicate was dropped from statistical analysis. This should not affect the test results.	

Table 2. Results of Solid Phase Test Using *Eohaustorius estuarius*

Composite Area ID	**Amphipods (*Eohaustorius estuarius*)**				
	Overlying Total Ammonia Concentration (mg/L)		Interstitial Total Ammonia Concentration (mg/L)		% Survival
	Initial	Day 10	Initial	Day 10	
Control 1	<0.500	<0.500	<0.500	<0.500	96.0
TRANS-2	<0.500	2.52	8.77	3.45	88.0
TRANS-4	<0.500	1.86	4.82	3.75	88.0
TRANS-7	<0.500	1.11	4.42	2.57	96.3
TRANS-9	<0.500	2.02	10.4	3.99	94.0
EA-1	<0.500	<0.500	4.32	2.41	86.0
EA-2	<0.500	2.15	7.75	4.67	86.0
EA-3	<0.500	<0.500	2.64	2.10	89.0
REF-1	<0.500	1.53	3.96	2.98	93.0
REF-2	<0.500	1.22	4.13	3.12	89.0
REF-3	<0.500	2.67	5.90	6.55	*62.0

	Total NH_3	Un-ionized NH_3		Total NH_3		Un-ionized NH_3	
	Actual Concentration (mg/L)	Calculated Concentration (mg/L)	% Survival	LC_{50} (mg/L)	NOEC (mg/L)	LC_{50} (mg/L)	NOEC (mg/L)
Ammonium Chloride Reference Toxicant	Control	Control	95.0	54.4	12.5	0.977	0.366
	12.5	0.366	95.0				
	25.5	0.592	82.5				
	49.3	0.920	60.0				
	102	1.19	0.00				
	206	1.53	0.00				

*Significantly different from control.

2.0 REFERENCES

American Society for Testing and Materials (ASTM). 2010. E1367-03 Standard Guide for Conducting 10-Day Static Sediment Toxicity Tests With Marine and Estuarine Amphipods. *Annual Book of Standards, Water and Environmental Technology, Vol. 11.06*, West Conshohocken, PA.

United States Environmental Protection Agency, (USEPA) 1994. Methods for Assessing Toxicity of Sediment-Associated Contaminants with Estuarine and Marine Amphipods. EPA/600/R-94/025. EPA Office of Research and Development.

United States Environmental Protection Agency and United States Army Corps of Engineers (USEPA/USACE). 1998. Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual (Inland Testing Manual). EPA 823-B-98-004. EPA Office of Water, Washington, DC. February.

Acute Sediment Test-10 Day Survival

Start Date:	4/6/2012 13:10	Test ID:	Sylmar	Sample ID:	SEDIMENT
End Date:	4/16/2012 13:25	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	SE-Sediment
Sample Date:	3/31/2012	Protocol:	USEPA-USACE 1998 ITM	Test Species:	EE-Eohaustorius estuarius

Comments: Replicate 1 of TRANS-7 sample dropped due to > than 20 organisms recovered.

Conc-%	1	2	3	4	5
Control	1.0000	0.9500	1.0000	0.9000	0.9500
Trans-2	0.9000	0.9000	0.8500	0.8500	0.9000
Trans-4	0.9500	0.9000	0.9000	0.8000	0.8500
Trans-7	1.0000	0.9500	0.9000	1.0000	
Trans-9	0.9500	0.9500	0.9500	0.9500	0.9000
EA-1	0.8500	1.0000	0.7500	0.8000	0.9000
EA-2	0.7500	0.8500	0.9000	0.9500	0.8500
EA-3	0.9000	0.8000	0.9500	0.9000	0.9000
REF-1	0.9500	1.0000	0.9000	0.9500	0.8500
REF-2	0.7500	1.0000	0.9500	0.8000	0.9500
REF-3	0.8000	0.8500	0.3000	0.6000	0.5500

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	0.9600	1.0000	0.9600	0.9000	1.0000	4.358	5			
Trans-2	0.8800	0.9167	0.8800	0.8500	0.9000	3.112	5	1.390	2.695	0.1551
Trans-4	0.8800	0.9167	0.8800	0.8000	0.9500	6.478	5	1.390	2.695	0.1551
Trans-7	0.9625	1.0026	0.9625	0.9000	1.0000	4.974	4	-0.041	2.695	0.1645
Trans-9	0.9400	0.9792	0.9400	0.9000	0.9500	2.379	5	0.348	2.695	0.1551
EA-1	0.8600	0.8958	0.8600	0.7500	1.0000	11.183	5	1.738	2.695	0.1551
EA-2	0.8600	0.8958	0.8600	0.7500	0.9500	8.623	5	1.738	2.695	0.1551
EA-3	0.8900	0.9271	0.8900	0.8000	0.9500	6.154	5	1.217	2.695	0.1551
REF-1	0.9300	0.9688	0.9300	0.8500	1.0000	6.130	5	0.521	2.695	0.1551
REF-2	0.8900	0.9271	0.8900	0.7500	1.0000	12.179	5	1.217	2.695	0.1551
*REF-3	0.6200	0.6458	0.6200	0.3000	0.8500	35.429	5	5.909	2.695	0.1551

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.01)	0.95069	1.035	-0.6161	4.31813
Bartlett's Test indicates unequal variances (p = 3.77E-04)	32.1579	23.2093		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test indicates significant differences	0.15507	0.16153	0.04325	0.00828	5.4E-05	10, 43

Reviewed by:

Test: SED-Acute Sediment Test
Species: EE-Eohaustorius estuarius
Sample ID: SEDIMENT
Start Date: 4/6/2012 13:10 End Date: 4/16/2012 13:25

Test ID: Sylmar
Protocol: USEPA-USACE 1998 ITM
Sample Type: SE-Sediment
Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Group	Day 0	Day 10	Notes
	1	1	Control	20	20	
	2	2	Control	20	19	
	3	3	Control	20	20	
	4	4	Control	20	18	
	5	5	Control	20	19	
	6	1	Trans-2	20	18	
	7	2	Trans-2	20	18	
	8	3	Trans-2	20	17	
	9	4	Trans-2	20	17	
	10	5	Trans-2	20	18	
	11	1	Trans-4	20	19	
	12	2	Trans-4	20	18	
	13	3	Trans-4	20	18	
	14	4	Trans-4	20	16	
	15	5	Trans-4	20	17	
	16	1	Trans-7	20	20	
	17	2	Trans-7	20	19	
	18	3	Trans-7	20	18	
	19	4	Trans-7	20	20	
	20	1	Trans-9	20	19	
	21	2	Trans-9	20	19	
	22	3	Trans-9	20	19	
	23	4	Trans-9	20	19	
	24	5	Trans-9	20	18	
	25	1	EA-1	20	17	
	26	2	EA-1	20	20	
	27	3	EA-1	20	15	
	28	4	EA-1	20	16	
	29	5	EA-1	20	18	
	30	1	EA-2	20	15	
	31	2	EA-2	20	17	
	32	3	EA-2	20	18	
	33	4	EA-2	20	19	
	34	5	EA-2	20	17	
	35	1	EA-3	20	18	
	36	2	EA-3	20	16	
	37	3	EA-3	20	19	
	38	4	EA-3	20	18	
	39	5	EA-3	20	18	
	40	1	REF-1	20	19	
	41	2	REF-1	20	20	
	42	3	REF-1	20	18	
	43	4	REF-1	20	19	
	44	5	REF-1	20	17	
	45	1	REF-2	20	15	
	46	2	REF-2	20	20	
	47	3	REF-2	20	19	
	48	4	REF-2	20	16	
	49	5	REF-2	20	19	
	50	1	REF-3	20	16	
	51	2	REF-3	20	17	
	52	3	REF-3	20	6	
	53	4	REF-3	20	12	

Reviewed by:

Test: SED-Acute Sediment Test		Test ID: Sylmar
Species: EE-Eohaustorius estuarius		Protocol: USEPA-USACE 1998 ITM
Sample ID: SEDIMENT		Sample Type: SE-Sediment
Start Date: 4/6/2012 13:10	End Date: 4/16/2012 13:25	Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Group	Day 0	Day 10	Notes
	54	5	REF-3	20	11	

Comments:

Reviewed by:

10 DAY SOLID PHASE TEST DATA SHEET 2

WESTON SOLUTIONS

CLIENT LADWP	PROJECT Sylmar Ground Return System Undersea Electrode	SPECIES *Eohaustorius estuarius*		WESTON LABORATORY Carlsbad Room 2	PROTOCOL USACE/USEPA (1998) / WESTON BIO066
WESTON JOB NUMBER 13537.002.001.1006.01/13537.002.011.1006.01	PROJECT MANAGER D. McCoy	TEST START DATE 06Apr12	TIME 1310 SH/KC JH/BG	TEST END DATE 16Apr12	TIME 1325 JH/BG/ KC/SH

WATER QUALITY DATA

TEST CONDITIONS	DO (mg/L)	TEMP (C)	SALINITY (ppt)	pH	NH3 (mg/L)	DILUTION WATER BATCH	TEMP.RECDR./HOBO#
	> 6.0	15 ± 2	30 ± 2	7.8 ± 0.5	< 4.0	SIO040312	778889

CLIENT/WESTON ID	DAY	REP	JAR #	D.O. meter	D.O. mg/L	TEMP meter	TEMP °C	SALINITY meter	SALINITY ppt	pH meter	pH unit	OVERLY. NH3 Techn.	OVERLY. NH3 mg/L	INTER. NH3 Techn.	INTER. NH3 mg/L	INTER. SULFIDE Techn.	INTER. SULFIDE mg/L	TECHNICIAN			WATER RENEWAL
Control / C120405.01	0	1	29	3	7.7	3	15.2	6	29.3	4	8.0	BG	<0.5	BG				JH			BG/KC
		2	3	↓	7.9	↓	14.5	↓	29.3	↓	8.0	↓	↓					↓			↓
		3	47		7.8		15.2		29.5		8.0										
		4	35		7.9		15.2		29.6		8.0										
		5	14		8.1		14.0		29.1		8.0										
Control / C120405.01	1	1	29	3	8.7	3	14.7	6	29.1	4	8.0			▨	▨	▨	▨	KS			
Control / C120405.01	2	2	3	3	8.7	3	14.9	6	29.2	4	8.0			▨	▨	▨	▨	KS			
Control / C120405.01	3	3	47	3	7.6	3	15.3	6	29.3	2	7.9			▨	▨	▨	▨	JH			
Control / C120405.01	4	4	35	3	7.3	3	15.5	6	29.4	2	8.0			▨	▨	▨	▨	BG			
Control / C120405.01	5	5	14	3	7.5	3	14.1	6	29.3	4	7.9			▨	▨	▨	▨	BG			
Control / C120405.01	6	1	29	3	7.7	3	14.9	6	29.4	4	7.9			▨	▨	▨	▨	JH			
Control / C120405.01	7	2	3	3	7.5	3	14.3	6	29.2	2	8.0			▨	▨	▨	▨	BG			
Control / C120405.01	8	3	47	3	7.5	3	15.2	6	29.4	2	7.9			▨	▨	▨	▨	KC			
Control / C120405.01	9	4	35	3	7.2	3	15.4	6	29.4	2	8.0			▨	▨	▨	▨	KC			
Control / C120405.01	10	1	29	3	7.9	3	15.0	6	29.7	2	7.9	BG	<0.5					JH/BG			
		2	3	↓	7.9	↓	14.3	↓	29.0	↓	7.9	↓	↓					↓			
		3	47		7.8		14.9		29.9		7.9										
		4	35		7.8		14.9		29.6		7.9										
		5	14		8.0		14.0		29.4		7.9										

10 DAY SOLID PHASE TEST DATA SHEET 2

WESTON SOLUTIONS

CLIENT LADWP	PROJECT Sylmar Ground Return System Undersea Electrode	SPECIES *Eohaustorius estuarius*		WESTON LABORATORY Carlsbad Room 2	PROTOCOL USACE/USEPA (1998) / WESTON BIO066
WESTON JOB NUMBER 13537.002.001.1006.01/13537.002.011.1006.01	PROJECT MANAGER D. McCoy	TEST START DATE 06Apr12	TIME 1310 SH/KC/ JH/BG	TEST END DATE 16Apr12	TIME 1325 JH/BG/ KC/SH

WATER QUALITY DATA

TEST CONDITIONS	DO (mg/L)	TEMP (C)	SALINITY (ppt)	pH	NH3 (mg/L)	DILUTION WATER BATCH	TEMP.RECDR./HOBO#
	> 6.0	15 ± 2	30 ± 2	7.8 ± 0.5	< 4.0	SIO040312	778889

CLIENT/WESTON ID	DAY	REP	JAR #	D.O.		TEMP		SALINITY		pH		OVERLY. NH3		INTER. NH3		INTER. SULFIDE		TECHNICIAN		WATER RENEWAL
				meter	mg/L	meter	°C	meter	ppt	meter	unit	Techn.	mg/L	Techn.	mg/L	Techn.	mg/L			
TRANS-2 / C120402.01	0	1	48	3	7.9	3	15.5	6	30.0	4	8.0	BG	<0.5					JH/KC		BG/KC
		2	36	↓	8.0	↓	15.0	↓	29.9	↓	8.0	↓	↓					↓		↓
		3	28	↓	7.9	↓	14.4	↓	29.9	↓	8.0	↓	↓					↓		↓
		4	22	↓	8.0	↓	14.1	↓	29.9	↓	8.0	↓	↓					↓		↓
		5	4	↓	8.0	↓	14.2	↓	30.2	↓	8.1	↓	↓					↓		↓
TRANS-2 / C120402.01	1	1	48	3	8.6	3	15.0	6	30.2	4	8.0			▨	▨	▨	▨	KS		
TRANS-2 / C120402.01	2	2	36	3	8.7	3	14.8	6	30.1	4	8.0			▨	▨	▨	▨	KS		
TRANS-2 / C120402.01	3	3	28	3	8.0	3	14.6	6	30.1	2	7.9			▨	▨	▨	▨	JH		
TRANS-2 / C120402.01	4	4	22	3	7.4	3	14.3	6	30.0	2	8.0			▨	▨	▨	▨	BG		
TRANS-2 / C120402.01	5	5	4	3	7.7	3	14.2	6	30.2	4	8.1			▨	▨	▨	▨	BG		
TRANS-2 / C120402.01	6	1	48	3	7.8	3	15.1	6	30.4	4	8.0			▨	▨	▨	▨	JH		
TRANS-2 / C120402.01	7	2	36	3	7.5	3	14.5	6	30.4	2	8.0			▨	▨	▨	▨	BG		
TRANS-2 / C120402.01	8	3	28	3	7.9	3	14.8	6	30.3	2	8.0			▨	▨	▨	▨	KC		
TRANS-2 / C120402.01	9	4	22	3	7.3	3	14.5	6	30.1	2	8.0			▨	▨	▨	▨	KC		
TRANS-2 / C120402.01	10	1	48	3	8.0	3	14.9	6	30.6	2	8.0	BG	2.52					JH/BG		
		2	34	↓	8.0	↓	14.5	↓	30.4	↓	7.9	↓	↓					↓		
		3	28	↓	8.0	↓	14.2	↓	30.3	↓	8.0	↓	↓					↓		
		4	22	↓	8.1	↓	13.9	↓	30.4	↓	8.0	↓	↓					↓		
		5	4	↓	8.1	↓	14.0	↓	30.3	↓	8.0	↓	↓					↓		

10 DAY SOLID PHASE TEST DATA SHEET 2

CLIENT LADWP	PROJECT Sylmar Ground Return System Undersea Electrode	SPECIES *Eohaustorius estuarius*		WESTON LABORATORY Carlsbad Room 2	PROTOCOL USACE/USEPA (1998) / WESTON BIO066
WESTON JOB NUMBER 13537.002.001.1006.01/13537.002.011.1006.01	PROJECT MANAGER D. McCoy	TEST START DATE 06Apr12	TIME 1310 SH/KC/ JH/BG	TEST END DATE 16Apr12	TIME 1325 JH/BG/ KC/SH

WATER QUALITY DATA

TEST CONDITIONS	DO (mg/L)	TEMP (C)	SALINITY (ppt)	pH	NH3 (mg/L)	DILUTION WATER BATCH	TEMP.RECDR./HOBO#
	> 6.0	15 ± 2	30 ± 2	7.8 ± 0.5	< 4.0	SIO040312	778889

CLIENT/WESTON ID	DAY	REP	JAR #	D.O. meter	D.O. mg/L	TEMP meter	TEMP °C	SALINITY meter	SALINITY ppt	pH meter	pH unit	OVERLY. NH3 Techn.	OVERLY. NH3 mg/L	INTER. NH3 Techn.	INTER. NH3 mg/L	INTER. SULFIDE Techn.	INTER. SULFIDE mg/L	TECHNICIAN			WATER RENEWAL
TRANS-4 / C120402.02	0	1	27	3	8.1	3	14.3	6	29.9	4	8.0	BG	<0.5					JH/KC			BG/KC
		2	46		7.8		15.1		30.2		8.0										
		3	12		8.3		14.1		29.9		8.0										
	KC ①	4	~~42~~ 9		8.0		13.9		30.0		8.0										
		5	39	↓	8.2	↓	14.6	↓	30.3	↓	8.0	↓	↓					↓			↓
TRANS-4 / C120402.02	1	1	27	3	8.6	3	14.3	6	29.5	4	8.0			▨	▨	▨	▨	KS			
TRANS-4 / C120402.02	2	2	46	3	8.4	3	14.6	6	29.8	4	8.0			▨	▨	▨	▨	KS			
TRANS-4 / C120402.02	3	3	12	3	8.4	3	14.0	6	30.4	2	8.0			▨	▨	▨	▨	JH			
TRANS-4 / C120402.02	4	4	9	3	7.6	3	13.8	6	30.5	2	8.0			▨	▨	▨	▨	BG			
TRANS-4 / C120402.02	5	5	39	3	7.8	3	15.0	6	30.7	4	8.1			▨	▨	▨	▨	BG			
TRANS-4 / C120402.02	6	1	27	3	7.8	3	14.3	6	30.0	4	8.0			▨	▨	▨	▨	JH			
TRANS-4 / C120402.02	7	2	40	3	7.6	3	14.9	6	30.6	2	8.1			▨	▨	▨	▨	BG			
TRANS-4 / C120402.02	8	3	12	3	8.0	3	14.1	6	30.3	2	8.0			▨	▨	▨	▨	KC			
TRANS-4 / C120402.02	9	4	9	3	7.5	3	14.0	6	30.5	2	8.0			▨	▨	▨	▨	KC			
TRANS-4 / C120402.02	10	1	27	3	8.0	3	14.1	4	30.3	2	7.9	BG	1.86					JH/BG			
		2	46		8.0		14.7		30.7		8.0										
		3	12		8.2		13.8		30.7		8.0										
		4	9		7.9		13.7		30.8		7.9										
		5	39	↓	7.8	↓	14.5	↓	31.1	↓	8.0	↓	↓					↓			

① WC 4/6/12 KC

10 DAY SOLID PHASE TEST DATA SHEET 2

WESTON SOLUTIONS

CLIENT LADWP	PROJECT Sylmar Ground Return System Undersea Electrode	SPECIES *Eohaustorius estuarius*		WESTON LABORATORY Carlsbad Room 2	PROTOCOL USACE/USEPA (1998) / WESTON BIO066
WESTON JOB NUMBER 13537.002.001.1006.01/13537.002.011.1006.01	PROJECT MANAGER D. McCoy	TEST START DATE 06Apr12	TIME 1310 SH/KC/JH/BG	TEST END DATE 16Apr12	TIME 1325 JH/BG/KC/SH

WATER QUALITY DATA

TEST CONDITIONS	DO (mg/L)	TEMP (C)	SALINITY (ppt)	pH	NH3 (mg/L)	DILUTION WATER BATCH	TEMP.RECDR./HOBO#
	> 6.0	15 ± 2	30 ± 2	7.8 ± 0.5	< 4.0	SIO040312	778889

CLIENT/WESTON ID	DAY	REP	JAR #	D.O.		TEMP		SALINITY		pH		OVERLY. NH3		INTER. NH3		INTER. SULFIDE		TECHNICIAN			WATER RENEWAL
				meter	mg/L	meter	°C	meter	ppt	meter	unit	Techn.	mg/L	Techn.	mg/L	Techn.	mg/L				
TRANS-7 / C120402.03	0	1	34	3	8.5	3	15.1	6	30.0	4	8.0	BG	<0.5					JH/KC			BG/KC
		2	2	↓	8.1	↓	14.3	↓	29.8	↓	8.0	↓	↓					↓			↓
		3	23	↓	8.1	↓	14.0	↓	29.9	↓	8.0	↓	↓					↓			↓
		4	13	↓	8.2	↓	13.8	↓	29.9	↓	8.0	↓	↓					↓			↓
		5	49	↓	8.0	↓	14.9	↓	30.2	↓	8.0	↓	↓					↓			↓
TRANS-7 / C120402.03	1	1	34	3	8.5	3	14.8	6	29.9	4	8.0			▨	▨	▨	▨	KS			
TRANS-7 / C120402.03	2	2	2	3	8.4	3	14.9	6	30.0	4	8.0			▨	▨	▨	▨	KS			
TRANS-7 / C120402.03	3	3	23	3	7.9	3	14.2	6	30.0	2	8.0			▨	▨	▨	▨	JH			
TRANS-7 / C120402.03	4	4	13	3	7.8	3	13.8	6	30.4	2	8.1			▨	▨	▨	▨	BG			
TRANS-7 / C120402.03	5	5	49	3	7.7	3	15.5	6	30.7	4	8.0			▨	▨	▨	▨	BG			
TRANS-7 / C120402.03	6	1	34	3	7.7	3	15.1	6	30.2	4	8.1			▨	▨	▨	▨	JH			
TRANS-7 / C120402.03	7	2	2	3	7.8	3	14.0	6	30.0	2	8.1			▨	▨	▨	▨	BG			
TRANS-7 / C120402.03	8	3	23	3	7.8	3	14.1	6	30.0	2	8.0			▨	▨	▨	▨	KC			
TRANS-7 / C120402.03	9	4	13	3	7.7	3	13.8	6	30.3	2	8.1			▨	▨	▨	▨	KC			
TRANS-7 / C120402.03	10	1	34	3	8.0	3	15.0	6	30.2	2	8.0	BG	1.11					JH/BG			
		2	2	↓	8.5	↓	14.0	↓	30.1	↓	8.0	↓	↓					↓			
		3	23	↓	8.2	↓	13.9	↓	30.6	↓	8.0	↓	↓					↓			
		4	13	↓	8.2	↓	13.7	↓	31.1	↓	8.0	↓	↓					↓			
		5	49	↓	7.9	↓	14.8	↓	30.9	↓	8.0	↓	↓					↓			

10 DAY SOLID PHASE TEST DATA SHEET 2

CLIENT LADWP	PROJECT Sylmar Ground Return System Undersea Electrode	SPECIES *Eohaustorius estuarius*		WESTON LABORATORY Carlsbad Room 2	PROTOCOL USACE/USEPA (1998) / WESTON BIO066
WESTON JOB NUMBER 13537.002.001.1006.01/13537.002.011.1006.01	PROJECT MANAGER D. McCoy	TEST START DATE 06Apr12	TIME 1310 JH/KC/SH/BG	TEST END DATE 16Apr12	TIME 1325 JH/BG/KC/SH

WATER QUALITY DATA

TEST CONDITIONS	DO (mg/L)	TEMP (C)	SALINITY (ppt)	pH	NH3 (mg/L)	DILUTION WATER BATCH	TEMP.RECDR./HOBO#
	> 6.0	15 ± 2	30 ± 2	7.8 ± 0.5	< 4.0	SIO040312	778889

CLIENT/WESTON ID	DAY	REP	JAR #	D.O.		TEMP		SALINITY		pH		OVERLY. NH3		INTER. NH3		INTER. SULFIDE		TECHNICIAN			WATER RENEWAL
				meter	mg/L	meter	°C	meter	ppt	meter	unit	Techn.	mg/L	Techn.	mg/L	Techn.	mg/L				
TRANS-9 / C120402.04	0	1	8	3	7.9	3	13.7	6	29.9	4	8.0	BG	<0.5					JH/KC			BG/KC
		2	50	|	7.8	|	14.7	|	30.2	|	8.1	|	|					|			|
		3	31	|	8.2	|	15.0	|	30.2	|	8.1	|	|					|			|
		4	38	|	8.2	|	14.7	|	30.1	|	8.1	|	|					|			|
		5	20	↓	7.7	↓	14.6	↓	30.1	↓	8.0	↓	↓					↓			↓
TRANS-9 / C120402.04	1	1	8	3	8.8	3	13.7	6	29.8	4	8.0			▨	▨	▨	▨	KS			
TRANS-9 / C120402.04	2	2	50	3	8.7	3	14.2	6	29.9	4	8.0			▨	▨	▨	▨	KS			
TRANS-9 / C120402.04	3	3	31	3	8.0	3	15.1	6	30.2	2	8.0			▨	▨	▨	▨	JH			
TRANS-9 / C120402.04	4	4	38	3	7.6	3	14.9	6	30.7	2	8.1			▨	▨	▨	▨	BG			
TRANS-9 / C120402.04	5	5	20	3	7.9	3	14.9	6	30.3	4	8.1			▨	▨	▨	▨	BG			
TRANS-9 / C120402.04	6	1	8	3	7.8	3	14.0	6	30.3	4	8.0			▨	▨	▨	▨	JH			
TRANS-9 / C120402.04	7	2	50	3	7.6	3	14.8	6	30.7	2	8.1			▨	▨	▨	▨	BG			
TRANS-9 / C120402.04	8	3	31	3	7.8	3	15.1	6	30.4	2	8.0			▨	▨	▨	▨	KC			
TRANS-9 / C120402.04	9	4	38	3	7.6	3	15.0	6	30.7	2	8.0			▨	▨	▨	▨	KC			
TRANS-9 / C120402.04	10	1	8	3	8.1	3	13.7	6	30.4	2	8.0	BG	2.02					JH/BG			
		2	50	|	8.0	|	14.7	|	30.6	|	8.0	|	|					|			
		3	31	|	8.0	|	14.7	|	30.6	|	8.0	|	|					|			
		4	38	|	8.2	|	14.6	|	30.6	|	8.0	|	|					|			
		5	20	↓	8.0	↓	14.5	↓	30.4	↓	8.0	↓	↓					↓			

10 DAY SOLID PHASE TEST DATA SHEET 2

CLIENT LADWP	PROJECT Sylmar Ground Return System Undersea Electrode	SPECIES *Eohaustorius estuarius*		WESTON LABORATORY Carlsbad Room 2	PROTOCOL USACE/USEPA (1998) / WESTON BIO066
WESTON JOB NUMBER 13537.002.001.1006.01/13537.002.011.1006.01	PROJECT MANAGER D. McCoy	TEST START DATE 06Apr12	TIME 1310 SH/KC/ JH/BG	TEST END DATE 16Apr12	TIME 1325 JH/BG/ KC/SH

WATER QUALITY DATA

TEST CONDITIONS	DO (mg/L)	TEMP (C)	SALINITY (ppt)	pH	NH3 (mg/L)	DILUTION WATER BATCH	TEMP.RECDR./HOBO#
	> 6.0	15 ± 2	30 ± 2	7.8 ± 0.5	< 4.0	SIO040312	778889

CLIENT/WESTON ID	DAY	REP	JAR #	D.O. meter	D.O. mg/L	TEMP meter	TEMP °C	SALINITY meter	SALINITY ppt	pH meter	pH unit	OVERLY. NH3 Techn.	OVERLY. NH3 mg/L	INTER. NH3 Techn.	INTER. NH3 mg/L	INTER. SULFIDE Techn.	INTER. SULFIDE mg/L	TECHNICIAN			WATER RENEWAL
EA-1 / C120402.05	0	1	21	3	8.1	3	14.5	6	30.0	4	8.0	BG	<05					JH/KC			BG/KC
		2	37	↓	8.0	↓	14.6	↓	30.1	↓	8.0	↓	↓					↓			↓
		3	30	↓	8.0	↓	14.9	↓	30.2	↓	8.0	↓	↓					↓			↓
		4	5	↓	8.1	↓	14.4	↓	29.9	↓	8.0	↓	↓					↓			↓
		5	51	↓	8.0	↓	14.6	↓	30.2	↓	8.0	↓	↓					↓			↓
EA-1 / C120402.05	1	1	21	3	8.4	3	14.3	6	30.1	4	8.0			▨	▨	▨	▨	KS			
EA-1 / C120402.05	2	2	37	3	8.5	3	14.6	6	30.2	4	8.0			▨	▨	▨	▨	KS			
EA-1 / C120402.05	3	3	30	3	8.0	3	15.0	6	30.2	2	8.0			▨	▨	▨	▨	JH			
EA-1 / C120402.05	4	4	5	3	7.6	3	14.4	6	30.2	2	8.0			▨	▨	▨	▨	BG			
EA-1 / C120402.05	5	5	51	3	7.4	3	15.0	6	30.3	4	8.0			▨	▨	▨	▨	BG			
EA-1 / C120402.05	6	1	21	3	7.8	3	14.7	6	30.3	4	8.1			▨	▨	▨	▨	JH			
EA-1 / C120402.05	7	2	37	3	7.8	3	14.5	6	30.4	2	8.1			▨	▨	▨	▨	BG			
EA-1 / C120402.05	8	3	30	3	7.7	3	14.8	6	30.3	2	8.1			▨	▨	▨	▨	KC			
EA-1 / C120402.05	9	4	5	3	7.5	3	14.5	6	30.2	2	8.1			▨	▨	▨	▨	KC			
EA-1 / C120402.05	10	1	21	3	8.1	3	14.5	6	30.3	2	8.0	BG	<0.5					JH/BG			
		2	37	↓	8.1	↓	14.5	↓	30.5	↓	7.9	↓	↓					↓			
		3	30	↓	8.0	↓	14.7	↓	30.6	↓	8.0	↓	↓					↓			
		4	5	↓	8.1	↓	14.2	↓	30.2	↓	7.9	↓	↓					↓			
		5	51	↓	8.4	↓	14.6	↓	30.7	↓	8.0	↓	↓					↓			

10 DAY SOLID PHASE TEST DATA SHEET 2

CLIENT LADWP	PROJECT Sylmar Ground Return System Undersea Electrode	SPECIES *Eohaustorius estuarius*	WESTON LABORATORY Carlsbad Room 2	PROTOCOL USACE/USEPA (1998) / WESTON BIO066
WESTON JOB NUMBER 13537.002.001.1006.01/13537.002.011.1006.01	PROJECT MANAGER D. McCoy	TEST START DATE 06Apr12	TIME 1310 SH/KC/ JH/BG	TEST END DATE 16Apr12	TIME 1325 JH/BG/ KC/SH

WATER QUALITY DATA

TEST CONDITIONS	DO (mg/L)	TEMP (C)	SALINITY (ppt)	pH	NH3 (mg/L)	DILUTION WATER BATCH	TEMP.RECDR./HOBO#
	> 6.0	15 ± 2	30 ± 2	7.8 ± 0.5	< 4.0	SIO040312	778889

CLIENT/WESTON ID	DAY	REP	JAR #	D.O. meter	D.O. mg/L	TEMP meter	TEMP °C	SALINITY meter	SALINITY ppt	pH meter	pH unit	OVERLY. NH3 Techn.	OVERLY. NH3 mg/L	INTER. NH3 Techn.	INTER. NH3 mg/L	INTER. SULFIDE Techn.	INTER. SULFIDE mg/L	TECHNICIAN			WATER RENEWAL
EA-2 / C120402.06	0	1	25	3	8.3	3	14.1	6	29.9	4	8.0	BG	<0.5					JH/KC			BG/KC
		2	7	↓	8.0	↓	14.3	↓	30.1	↓	8.1	↓	↓					↓			↓
		3	44	↓	7.9	↓	14.9	↓	30.2	↓	8.0	↓	↓					↓			↓
		4	40	↓	8.0	↓	14.9	↓	30.1	↓	8.0	↓	↓					↓			↓
		5	17	↓	8.1	↓	14.7	↓	30.0	↓	8.0	↓	↓					↓			↓
EA-2 / C120402.06	1	1	25	3	8.6	3	14.0	6	29.9	4	8.1			▨	▨	▨	▨	KS			
EA-2 / C120402.06	2	2	7	3	8.5	3	14.7	6	30.0	4	8.0			▨	▨	▨	▨	KS			
EA-2 / C120402.06	3	3	44	3	7.9	3	15.1	6	30.2	2	7.9			▨	▨	▨	▨	JH			
EA-2 / C120402.06	4	4	40	3	7.7	3	14.5	6	30.6	2	8.1			▨	▨	▨	▨	BG			
EA-2 / C120402.06	5	5	17	3	7.7	3	15.0	6	30.2	4	8.0			▨	▨	▨	▨	BG			
EA-2 / C120402.06	6	1	25	3	8.0	3	14.3	6	30.1	4	8.1			▨	▨	▨	▨	JH			
EA-2 / C120402.06	7	2	7	3	7.9	3	14.0	6	30.4	2	8.1			▨	▨	▨	▨	BG			
EA-2 / C120402.06	8	3	44	3	7.8	3	14.9	6	30.2	2	8.0			▨	▨	▨	▨	KC			
EA-2 / C120402.06	9	4	40	3	7.6	3	14.8	6	30.5	2	8.1			▨	▨	▨	▨	KC			
EA-2 / C120402.06	10	1	25	3	8.1	3	14.1	6	30.2	2	8.0	BG	2.15					JH/BG			
		2	7	↓	8.0	↓	14.0	↓	30.5	↓	8.0	↓	↓					↓			
		3	44	↓	8.3	↓	14.7	↓	30.7	↓	8.0	↓	↓					↓			
		4	40	↓	8.3	↓	14.8	↓	30.7	↓	8.0	↓	↓					↓			
		5	17	↓	7.8	↓	14.4	↓	30.3	↓	7.9	↓	↓					↓			

10 DAY SOLID PHASE TEST DATA SHEET 2

CLIENT LADWP	PROJECT Sylmar Ground Return System Undersea Electrode	SPECIES *Eohaustorius estuarius*		WESTON LABORATORY Carlsbad Room 2	PROTOCOL USACE/USEPA (1998) / WESTON BIO066
WESTON JOB NUMBER 13537.002.001.1006.01/13537.002.011.1006.01	PROJECT MANAGER D. McCoy	TEST START DATE 06Apr12	TIME 1310 JH/KC/SH/BG	TEST END DATE 16Apr12	TIME 1325 JH/BG/KC/SH

WATER QUALITY DATA

TEST CONDITIONS	DO (mg/L)	TEMP (C)	SALINITY (ppt)	pH	NH3 (mg/L)		DILUTION WATER BATCH	TEMP.RECDR./HOBO#
	> 6.0	15 ± 2	30 ± 2	7.8 ± 0.5	< 4.0		SIO040312	778889

CLIENT/WESTON ID	DAY	REP	JAR #	D.O.		TEMP		SALINITY		pH		OVERLY. NH3		INTER. NH3		INTER. SULFIDE		TECHNICIAN			WATER RENEWAL
				meter	mg/L	meter	°C	meter	ppt	meter	unit	Techn.	mg/L	Techn.	mg/L	Techn.	mg/L				
EA-3 / C120402.07	0	1	55	3	8.3	3	15.0	6	30.1	4	8.0	BG	<0.5					JH/KC			BG/KC
		2	6	↓	7.9	↓	14.2	↓	30.1	↓	8.0	↓	↓					↓			↓
		3	16	↓	8.0	↓	14.4	↓	30.1	↓	8.0	↓	↓					↓			↓
		4	32	↓	7.9	↓	14.9	↓	30.2	↓	8.0	↓	↓					↓			↓
		5	45	↓	8.0	↓	14.9	↓	30.0	↓	8.0	↓	↓					↓			↓
EA-3 / C120402.07	1	1	55	3	8.5	3	14.9	6	30.2	4	8.0			▨	▨	▨	▨	KS			
EA-3 / C120402.07	2	2	6	3	8.6	3	15.0	6	30.2	4	8.0			▨	▨	▨	▨	KS			
EA-3 / C120402.07	3	3	16	3	8.0	3	14.6	6	30.1	2	7.9			▨	▨	▨	▨	JH			
EA-3 / C120402.07	4	4	32	3	7.6	3	15.1	6	30.4	2	8.1			▨	▨	▨	▨	BG			
EA-3 / C120402.07	5	5	45	3	7.7	3	15.6	6	32.1	4	8.0			▨	▨	▨	▨	BG			
EA-3 / C120402.07	6	1	55	3	7.4	3	14.9	6	30.2	4	8.1			▨	▨	▨	▨	JH			
EA-3 / C120402.07	7	2	6	3	7.8	3	14.0	6	30.7	2	8.1			▨	▨	▨	▨	BG			
EA-3 / C120402.07	8	3	16	3	7.6	3	14.7	6	30.3	2	8.0			▨	▨	▨	▨	KC			
EA-3 / C120402.07	9	4	32	3	7.7	3	15.0	6	30.5	2	8.1			▨	▨	▨	▨	KC			
EA-3 / C120402.07	10	1	55	3	8.1	3	14.8	6	30.5	2	8.0	BG	<0.5					JH/BG			
		2	6	↓	7.9	↓	14.1	↓	30.6	↓	7.9	↓	↓					↓			
		3	16	↓	8.0	↓	14.3	↓	30.4	↓	7.9	↓	↓					↓			
		4	32	↓	7.9	↓	14.8	↓	30.7	↓	8.0	↓	↓					↓			
		5	45	↓	8.0	↓	14.9	↓	32.1	↓	7.9	↓	↓					↓			

10 DAY SOLID PHASE TEST DATA SHEET 2

CLIENT LADWP	PROJECT Sylmar Ground Return System Undersea Electrode	SPECIES *Eohaustorius estuarius*		WESTON LABORATORY Carlsbad Room 2	PROTOCOL USACE/USEPA (1998) / WESTON BIO066
WESTON JOB NUMBER 13537.002.001.1006.01/13537.002.011.1006.01	PROJECT MANAGER D. McCoy	TEST START DATE 06Apr12	TIME 1310 SH/KC JH/BG	TEST END DATE 16Apr12	TIME 1325 JH/BG/ KC/SH

WATER QUALITY DATA

TEST CONDITIONS	DO (mg/L)	TEMP (C)	SALINITY (ppt)	pH	NH3 (mg/L)	DILUTION WATER BATCH	TEMP.RECDR./HOBO#
	> 6.0	15 ± 2	30 ± 2	7.8 ± 0.5	< 4.0	SIO040312	778889

CLIENT/WESTON ID	DAY	REP	JAR #	D.O.		TEMP		SALINITY		pH		OVERLY. NH3		INTER. NH3		INTER. SULFIDE		TECHNICIAN		WATER RENEWAL
				meter	mg/L	meter	°C	meter	ppt	meter	unit	Techn.	mg/L	Techn.	mg/L	Techn.	mg/L			
REF-1 / C120402.08	0	1	19	3	8.2	3	14.5	6	29.9	4	8.0	BG	<0.5					JH/KC		BG/KC
		2	43		8.1		15.0		30.2		8.1									
		3	1		8.2		14.0		29.9		8.0									
		4	26		8.2		13.9		30.1		8.0									
		5	52	↓	8.1	↓	14.7	↓	30.2	↓	8.0	↓	↓					↓		↓
REF-1 / C120402.08	1	1	19	3	8.7	3	14.5	6	30.1	4	8.1			▨	▨	▨	▨	KS		
REF-1 / C120402.08	2	2	43	3	8.6	3	14.8	6	30.2	4	8.1			▨	▨	▨	▨	KS		
REF-1 / C120402.08	3	3	1	3	8.0	3	14.1	6	30.2	2	8.0			▨	▨	▨	▨	JH		
REF-1 / C120402.08	4	4	26	3	7.5	3	14.4	6	30.3	2	8.0			▨	▨	▨	▨	BG		
REF-1 / C120402.08	5	5	52	3	7.8	3	15.5	6	30.7	4	8.1			▨	▨	▨	▨	BG		
REF-1 / C120402.08	6	1	19	3	7.9	3	14.6	6	30.1	4	8.1			▨	▨	▨	▨	JH		
REF-1 / C120402.08	7	2	43	3	7.8	3	14.9	6	30.9	2	8.1			▨	▨	▨	▨	BG		
REF-1 / C120402.08	8	3	1	3	7.8	3	14.3	6	30.4	2	8.1			▨	▨	▨	▨	KC		
REF-1 / C120402.08	9	4	26	3	7.5	3	14.6	6	30.4	2	8.0			▨	▨	▨	▨	KC		
REF-1 / C120402.08	10	1	19	3	8.0	3	14.6	6	30.4	2	8.0	BG	1.53					JH/BG		
		2	43		8.0		14.8		30.6		8.0									
		3	1		8.2		14.0		30.7		8.0									
		4	26		8.2		14.1		30.9		8.0									
		5	52	↓	8.0	↓	14.7	↓	30.9	↓	8.0	↓	↓					↓		

10 DAY SOLID PHASE TEST DATA SHEET 2

WESTON SOLUTIONS

CLIENT LADWP	PROJECT Sylmar Ground Return System Undersea Electrode	SPECIES *Eohaustorius estuarius*		WESTON LABORATORY Carlsbad Room 2	PROTOCOL USACE/USEPA (1998) / WESTON BIO066
WESTON JOB NUMBER 13537.002.001.1006.01/13537.002.011.1006.01	PROJECT MANAGER D. McCoy	TEST START DATE 06Apr12	TIME 1310 SH/KC/ JH/BG	TEST END DATE 16Apr12	TIME 1325 JH/BG/ KC/SH

WATER QUALITY DATA

TEST CONDITIONS	DO (mg/L)	TEMP (C)	SALINITY (ppt)	pH	NH3 (mg/L)	DILUTION WATER BATCH	TEMP.RECDR./HOBO#
	> 6.0	15 ± 2	30 ± 2	7.8 ± 0.5	< 4.0	SIO040312	778889

CLIENT/WESTON ID	DAY	REP	JAR #	D.O. meter	D.O. mg/L	TEMP meter	TEMP °C	SALINITY meter	SALINITY ppt	pH meter	pH unit	OVERLY. NH3 Techn.	OVERLY. NH3 mg/L	INTER. NH3 Techn.	INTER. NH3 mg/L	INTER. SULFIDE Techn.	INTER. SULFIDE mg/L	TECHNICIAN		WATER RENEWAL
REF-2 / C120402.09	0	1	33	3	8.0	3	14.9	6	30.0	4	8.0	BG	<0.5					JH/KC		BG/KC
		2	10	↓	8.3	↓	13.7	↓	29.9	↓	8.0	↓	↓					↓		↓
		3	53	↓	8.1	↓	14.7	↓	30.2	↓	8.0	↓	↓					↓		↓
		4	42	↓	8.1	↓	14.9	↓	30.2	↓	8.1	↓	↓					↓		↓
		5	15	↓	8.3	↓	14.3	↓	30.0	↓	8.0	↓	↓					↓		↓
REF-2 / C120402.09	1	1	33	3	8.7	3	14.8	6	30.3	4	8.1			▨	▨	▨	▨	KS		
REF-2 / C120402.09	2	2	10	3	8.7	3	14.9	6	30.2	4	8.1			▨	▨	▨	▨	KS		
REF-2 / C120402.09	3	3	53	3	8.1	3	15.2	6	30.5	2	8.0			▨	▨	▨	▨	JH		
REF-2 / C120402.09	4	4	42	3	7.6	3	15.2	6	30.4	2	8.1			▨	▨	▨	▨	BG		
REF-2 / C120402.09	5	5	15	3	7.9	3	14.7	6	30.3	4	8.1			▨	▨	▨	▨	BG		
REF-2 / C120402.09	6	1	33	3	7.9	3	15.0	6	30.7	4	8.1			▨	▨	▨	▨	JH		
REF-2 / C120402.09	7	2	10	3	7.8	3	13.8	6	30.0	2	8.1			▨	▨	▨	▨	BG		
REF-2 / C120402.09	8	3	53	3	7.6	3	15.2	6	30.4	2	8.1			▨	▨	▨	▨	KC		
REF-2 / C120402.09	9	4	42	3	7.5	3	15.0	6	30.3	2	8.1			▨	▨	▨	▨	KC		
REF-2 / C120402.09	10	1	33	3	8.1	3	15.1	6	31.0	2	8.0	BG	1.22					JH/BG		
		2	10	↓	8.2	↓	13.8	↓	30.6	↓	8.0	↓	↓					↓		
		3	53	↓	8.1	↓	14.6	↓	31.1	↓	8.0	↓	↓					↓		
		4	42	↓	8.0	↓	14.9	↓	30.5	↓	8.0	↓	↓					↓		
		5	15	↓	8.0	↓	14.3	↓	30.4	↓	8.0	↓	↓					↓		

10 DAY SOLID PHASE TEST DATA SHEET 2

CLIENT LADWP	**PROJECT** Sylmar Ground Return System Undersea Electrode	**SPECIES** *Eohaustorius estuarius*		**WESTON LABORATORY** Carlsbad Room 2	**PROTOCOL** USACE/USEPA (1998) / WESTON BIO066
WESTON JOB NUMBER 13537.002.001.1006.01/13537.002.011.1006.01	**PROJECT MANAGER** D. McCoy	**TEST START DATE** 06Apr12	**TIME** 1310 SH/KC/ JH/BG	**TEST END DATE** 16Apr12	**TIME** 1325 JH/BG/ KC/SH

WATER QUALITY DATA

TEST CONDITIONS	DO (mg/L)	TEMP (C)	SALINITY (ppt)	pH	NH3 (mg/L)	DILUTION WATER BATCH	TEMP.RECDR./HOBO#
	> 6.0	15 ± 2	30 ± 2	7.8 ± 0.5	< 4.0	SIO040312	778889

CLIENT/WESTON ID	DAY	REP	JAR #	D.O.		TEMP		SALINITY		pH		OVERLY. NH3		INTER. NH3		INTER. SULFIDE		TECHNICIAN			WATER RENEWAL
				meter	mg/L	meter	°C	meter	ppt	meter	unit	Techn.	mg/L	Techn.	mg/L	Techn.	mg/L				
REF-3 / C120402.10	0	1	41	3	7.8	3	15.0	6	30.0	4	8.1	BG	<0.5					JH/KC			BG/KC
		2	18	↓	8.1	↓	14.6	↓	30.0	↓	8.0	↓	↓					↓			↓
		3	24	↓	8.1	↓	14.0	↓	29.9	↓	8.0	↓	↓					↓			↓
		4	54	↓	8.0	↓	14.7	↓	30.2	↓	8.1	↓	↓					↓			↓
		5	11	↓	7.9	↓	13.8	↓	29.9	↓	8.0	↓	↓					↓			↓
REF-3 / C120402.10	1	1	41	3	8.7	3	14.9	6	30.2	4	8.1			▨	▨	▨	▨	VS			
REF-3 / C120402.10	2	2	18	3	8.6	3	14.8	6	30.1	4	8.1			▨	▨	▨	▨	VS			
REF-3 / C120402.10	3	3	24	3	8.2	3	14.2	6	30.3	2	8.0			▨	▨	▨	▨	JH			
REF-3 / C120402.10	4	4	54	3	7.5	3	15.3	6	30.7	2	8.1			▨	▨	▨	▨	BG			
REF-3 / C120402.10	5	5	11	3	7.9	3	14.2	6	30.7	4	8.1			▨	▨	▨	▨	BG			
REF-3 / C120402.10	6	1	41	3	7.6	3	15.0	6	31.3	4	8.2			▨	▨	▨	▨	JH			
REF-3 / C120402.10	7	2	18	3	7.8	3	14.5	6	30.5	2	8.1			▨	▨	▨	▨	BG			
REF-3 / C120402.10	8	3	24	3	7.9	3	14.4	6	30.3	2	8.1			▨	▨	▨	▨	KC			
REF-3 / C120402.10	9	4	54	3	7.6	3	15.3	6	30.8	2	8.1			▨	▨	▨	▨	KC			
REF-3 / C120402.10	10	1	41	3	7.9	3	14.9	6	31.9	2	8.0	BG	2.67					JH/BG			
		2	18	↓	8.0	↓	14.5	↓	30.6	↓	8.0	↓	↓					↓			
		3	24	↓	8.2	↓	14.0	↓	31.1	↓	8.1	↓	↓					↓			
		4	54	↓	8.0	↓	14.7	↓	31.1	↓	8.0	↓	↓					↓			
		5	11	↓	8.2	↓	13.8	↓	31.1	↓	8.0	↓	↓					↓			

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WESTON SOLUTIONS

Ammonia Analysis
Total Ammonia (mg/L)

Client/Project: LADPW Sylmar	**Organism:** Eoh	**Weston Test ID:**	**Test Duration (days):**

PRETEST / [✓ INITIAL] / FINAL / OTHER (circle one) DAY of TEST: 0
OVERLYING (OV) / [✓ POREWATER (PW)] (circle one)

Calibration Standards Temperature		Sample temperature should be within ±1°C of standards temperature at time and date of analysis.
Date:	**Temperature:**	
4/9/12	23.0	

Sample ID or Description	Conc. or Rep	Date of Sampling and Initials	Ammonia Value (mg/L)	Temp °C	Date of Reading and Initials	Sample Frozen (Y/N)	pH	Sal (ppt)
0		4/6/12 BG	<0.5	24.3	4/9/12 BG	Y	7.3	30
Trans-2		↓	8.77	22.0	↓	↓	7.5	33
Trans-4			4.82	24.4			7.5	33
Trans-7			4.42	21.5			7.8	33
Trans-9			10.4	22.0			7.7	33
EA-1			4.32	21.6			7.6	33
EA-2			7.75	22.0			7.7	34
EA-3			2.64	22.0			7.6	32
Ref-1			3.96	22.5			7.4	33
Ref-2			4.13	22.0			7.4	33
Ref-3			5.90	22.0			7.5	34

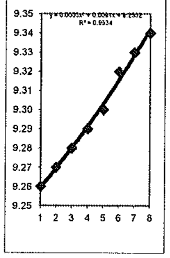
WESTON SOLUTIONS®

Un-ionized Ammonia Calculator

Project:	LADWP	Date of Test:	06-Apr-12
Project ID:	Sylmar Ground Return System Undersea Electrode	Test Type:	Eoh Initial OV

To convert Total Ammonia (mg/L) to Free (un-ionized) Ammonia (mg/L) enter the corresponding total ammonia, salinity, temperature, and pH.

Integer:	I-factor
1	9.26
2	9.27
3	9.28
4	9.29
5	9.30
6	9.32
7	9.33
8	9.34



	TEST	NH3T (mg/L)	salinity (ppt)	pH	temp (C)	temp (K)	i-factor	NH3U (mg/L)
	Example	0.610	22.9	8.0	24.1	297.26	9.3053	0.027
	Example2	2.000	10.0	7.5	5.0	278.16	9.2750	0.008
1	Control	< 0.500	29.4	8.0	14.8	287.96	9.3225	< 0.011
2	TRANS-2	< 0.500	30.0	8.0	14.6	287.76	9.3242	< 0.011
3	TRANS-4	< 0.500	30.1	8.0	14.4	287.56	9.3244	< 0.011
4	TRANS-7	< 0.500	30.0	8.0	14.4	287.56	9.3242	< 0.011
5	TRANS-9	< 0.500	30.1	8.1	14.5	287.66	9.3244	< 0.013
6	EA-1	< 0.500	30.1	8.0	14.6	287.76	9.3244	< 0.011
7	EA-2	< 0.500	30.1	8.0	14.6	287.76	9.3244	< 0.011
8	EA-3	< 0.500	30.1	8.0	14.7	287.86	9.3244	< 0.011
9	REF-1	< 0.500	30.1	8.0	14.4	287.56	9.3244	< 0.011
10	REF-2	< 0.500	30.1	8.0	14.5	287.66	9.3244	< 0.011
11	REF-3	< 0.500	30.0	8.0	14.4	287.56	9.3242	< 0.011
12								
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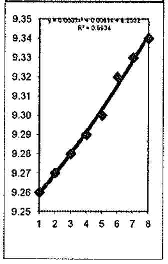
WESTON SOLUTIONS

Un-ionized Ammonia Calculator

Project:	LADWP	Date of Test:	06-Apr-12
Project ID:	Sylmar Ground Return System Undersea Electrode	Test Type:	Eoh Initial PW

To convert Total Ammonia (mg/L) to Free (un-ionized) Ammonia (mg/L) enter the corresponding total ammonia, salinity, temperature, and pH.

Integer:	I-factor
1	9.26
2	9.27
3	9.28
4	9.29
5	9.30
6	9.32
7	9.33
8	9.34



	TEST	NH3T (mg/L)	salinity (ppt)	pH	temp (C)	temp (K)	i-factor	NH3U (mg/L)
	Example	0.610	22.9	8.0	24.1	297.26	9.3053	0.027
	Example2	2.000	10.0	7.5	5.0	278.16	9.2750	0.008
1	Control	< 0.500	30.0	7.3	14.8	287.96	9.3242	< 0.002
2	TRANS-2	8.770	33.0	7.5	14.6	287.76	9.3326	0.060
3	TRANS-4	4.820	33.0	7.5	14.4	287.56	9.3326	0.032
4	TRANS-7	4.420	33.0	7.8	14.4	287.56	9.3326	0.059
5	TRANS-9	10.400	33.0	7.7	14.5	287.66	9.3326	0.111
6	EA-1	4.320	33.0	7.6	14.6	287.76	9.3326	0.037
7	EA-2	7.750	34.0	7.7	14.6	287.76	9.3355	0.083
8	EA-3	2.640	32.0	7.6	14.7	287.86	9.3298	0.023
9	REF-1	3.960	33.0	7.4	14.4	287.56	9.3326	0.021
10	REF-2	4.130	33.0	7.4	14.5	287.66	9.3326	0.022
11	REF-3	5.900	34.0	7.5	14.4	287.56	9.3355	0.039
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Page 1 of 1

WESTON SOLUTIONS

Ammonia Analysis
Total Ammonia (mg/L)

Client/Project: LAD PW Sylmar	**Organism:** Eoh	**Weston Test ID:**	**Test Duration (days):** 10 days

PRETEST / INITIAL / [✓ FINAL] / ~~OTHER (circle one)~~ **DAY of TEST:** 10
OVERLYING (OV) / [✓ POREWATER (PW)] (circle one)

Calibration Standards Temperature		Sample temperature should be within ±1°C of standards temperature at time and date of analysis.
Date:	**Temperature:**	
kc ① ~~4/16/12~~	22.0	
4/17/12		

Sample ID or Description	Conc. or Rep	Date of Sampling and Initials	Ammonia Value (mg/L)	Temp °C	Date of Reading and Initials	Sample Frozen (Y/N)	pH	Sal (ppt)
0		4/16/12 kc	<0.5	22.0	4/17/12 BG	Y	kc ②	31.0
Trans-2			3.46				7.4	32.0
Trans-4			3.75				7.2	28.0
Trans-7			2.57				7.3	31.0
Trans-9			3.99				7.2	30.0
EA-1			2.41				7.3	30.0
EA-2			4.07				7.2	27.0
EA-3			2.10				kc ②	29.0
Ref-1			2.98				7.2	25.0
Ref-2			3.12				7.2	22.0
Ref-3			0.55				kc ②	30.0

① FE 4/16/12 kc

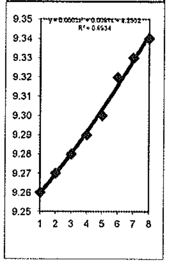
② PW preserved before pH could be taken. 4/16/12 kc

Un-ionized Ammonia Calculator

Project:	LADWP	Date of Test:	06-Apr-12
Project ID:	Sylmar Ground Return System Undersea Electrode	Test Type:	Eoh Final OV

To convert Total Ammonia (mg/L) to Free (un-ionized) Ammonia (mg/L) enter the corresponding total ammonia, salinity, temperature, and pH.

Integer:	I-factor
1	9.26
2	9.27
3	9.28
4	9.29
5	9.30
6	9.32
7	9.33
8	9.34



	TEST	NH3T (mg/L)	salinity (ppt)	pH	temp (C)	temp (K)	i-factor	NH3U (mg/L)
	Example	0.610	22.9	8.0	24.1	297.26	9.3053	0.027
	Example2	2.000	10.0	7.5	5.0	278.16	9.2750	0.008
1	Control	< 0.500	29.5	7.9	14.6	287.76	9.3228	< 0.009
2	TRANS-2	2.520	30.4	8.0	14.3	287.46	9.3253	0.053
3	TRANS-4	1.860	30.7	8.0	14.2	287.36	9.3261	0.039
4	TRANS-7	1.110	30.6	8.0	14.3	287.46	9.3258	0.023
5	TRANS-9	2.020	30.5	8.0	14.4	287.56	9.3256	0.043
6	EA-1	< 0.500	30.5	8.0	14.5	287.66	9.3256	< 0.011
7	EA-2	2.150	30.5	8.0	14.4	287.56	9.3256	0.046
8	EA-3	< 0.500	30.9	7.9	14.6	287.76	9.3267	< 0.009
9	REF-1	1.530	30.7	8.0	14.4	287.56	9.3261	0.032
10	REF-2	1.220	30.7	8.0	14.5	287.66	9.3261	0.026
11	REF-3	2.670	31.2	8.0	14.4	287.56	9.3275	0.056
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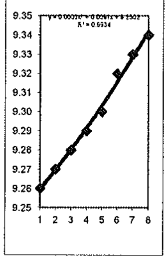
Un-ionized Ammonia Calculator

Project:	LADWP	Date of Test:	06-Apr-12
Project ID:	Sylmar Ground Return System Undersea Electrode	Test Type:	Eoh Final PW

To convert Total Ammonia (mg/L) to Free (un-ionized) Ammonia (mg/L) enter the corresponding total ammonia, salinity, temperature, and pH.

Integer:	I-factor
1	9.26
2	9.27
3	9.28
4	9.29
5	9.30
6	9.32
7	9.33
8	9.34



	TEST	NH3T (mg/L)	salinity (ppt)	pH	temp (C)	temp (K)	i-factor	NH3U (mg/L)
	Example	0.610	22.9	8.0	24.1	297.26	9.3053	0.027
	Example2	2.000	10.0	7.5	5.0	278.16	9.2750	0.008
1	Control	< 0.500	31.0	7.3	14.6	287.76	9.3270	< 0.002
2	TRANS-2	3.450	32.0	7.4	14.3	287.46	9.3298	0.018
3	TRANS-4	3.750	28.0	7.2	14.2	287.36	9.3187	0.013
4	TRANS-7	2.570	31.0	7.3	14.3	287.46	9.3270	0.011
5	TRANS-9	3.990	30.0	7.2	14.4	287.56	9.3242	0.014
6	EA-1	2.410	30.0	7.3	14.5	287.66	9.3242	0.010
7	EA-2	4.670	27.0	7.2	14.4	287.56	9.3160	0.016
8	EA-3	2.100	29.0	7.3	14.6	287.76	9.3214	0.009
9	REF-1	2.980	25.0	7.2	14.4	287.56	9.3107	0.011
10	REF-2	3.120	22.0	7.2	14.5	287.66	9.3030	0.011
11	REF-3	6.550	30.0	7.3	14.4	287.56	9.3242	0.028
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13	▨	pH not taken, 7.3 used as an assumption that actual pH values were not significantely different.						
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10 DAY SOLID PHASE TEST DATA SHEET 3

CLIENT	PROJECT	WESTON JOB N0.	PROJECT MAN.	WESTON LABORATORY	PROTOCOL	SPECIES	ACCLM.MORT.
LADWP	Sylmar Ground Return System Undersea Electrode	13597.002.001.1004.01/13597.002.011.1004.01	D. McCoy	Carlsbad Room 2	USACE/USEPA (1998) / WESTON BIO066	*Eohaustorius estuarius*	< 5%

ENDPOINT DATA & OBSERVATIONS

OBSERVATIONS KEY

N = normal
L = anoxic surface
B= no burrows
F= fungal patches
M= dead on surface
D= no air flow (DO2)
A= avoidance
U= excess food

CLIENT/ WESTON ID	REP	JAR #	INITIAL #	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	NUMBER REMAINING		
			DATE	4/7/12	4/8/12	4/9/12	4/10/12	4/11/12	4/12/12	4/13/12	4/14/12	4/15/12	4/16/12			
			TECHNICIAN	BS	BS	JH	BG	~~4/11/12~~ ① BG	JH	KC	KC	KC	JH/BG			
				OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.			
Control / C120405.01	1	29	20	N	N	N	N	N	N	N	N	N	N	20		
	2	3	↓	N	N	N	N	N	N	N	N	N	N	19		
	3	47		N	N	N	N	N	N	N	N	N	N	20		
	4	35		N	N	N	N	N	N	N	N	N	N	18		
	5	14		N	1M	N	N	N	N	N	N	N	N	19		
TRANS-2 / C120402.01	1	40	20	N	N	N	N	N	N	N	N	N	1M	18		
	2	36	↓	N	N	N	N	N	N	N	N	1M	N	18		
	3	28		N	N	N	N	N	N	N	N	N	N	17		
	4	22		1M	1M	N	N	N	1M	2M	2M	2M	2M	17		
	5	4		N	N	1M	1M	N	N	N	N	N	1M	18		
TRANS-4 / C120402.02	1	27	20	N	N	N	N	2A	N	N	N	N	N	19		
	2	46	↓	N	N	N	N	N	N	N	N	N	N	18		
	3	12		N	N	N	N	N	N	N	N	N	1M	18		
	4	9		N	1M	2M	N	N	1M	2M	2M	2M	2M	16		
	5	39		N	N	N	N	N	N	N	N	N	N	17		
TRANS-7 / C120402.03	1	34	②JH	N	N	N	N	N	1M	N	N	N	1M	32	②JH	
	2	2	20	N	N	N	N	N	N	N	N	1A	1A	20		
	3	23	↓	N	N	N	N	N	N	N	N	N	N	19		
	4	13		N	N	N	N	N	N	N	N	N	N	18		
	5	49		N	N	N	N	N	N	N	N	N	N	20		

① WC 4/11/12 BG

② Marked on jar that possibly more than 20 organisms were added. 4/16/12 JH

WESTON SOLUTIONS

10 DAY SOLID PHASE TEST DATA SHEET 3

CLIENT	PROJECT	WESTON JOB NO.	PROJECT MAN.	WESTON LABORATORY	PROTOCOL	SPECIES	ACCLM.MORT.
LADWP	Sylmar Ground Return System Underesa Electrode	13657.002.001.1004.01/13657.002.012.1004.01	D. McCoy	Carlsbad Room 2	USACE/USEPA (1998) / WESTON BIO066	*Eohaustorius estuarius*	< 5%

ENDPOINT DATA & OBSERVATIONS

OBSERVATIONS KEY
N = normal L = anoxic surface
B= no burrows F= fungal patches
M= dead on surface D= no air flow (DO2)
A= avoidance U= excess food

				DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	
			DATE	4/7/12	4/8/12	4/9/12	4/10/12	4/11/12	4/12/12	4/13/12	4/14/12	4/15/12	4/16/12	
			TECHNICIAN	KS	KS	JH	BG	BG	JH	KC	KC	KC	JH/BG	
CLIENT/ WESTON ID	REP	JAR #	INITIAL #	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	NUMBER REMAINING
TRANS-9 / C120402.04	1	8	20	1M	1M	N	N	1A	N	N	N	N	1M	19
	2	50		N	N	N	N	N	N	N	N	2A	N	19
	3	31		N	N	N	N	N	N	N	N	N	1M	19
	4	38		N	N	N	N	N	N	N	N	N	N	19
	5	20		N	N	N	N	N	N	N	N	N	1M	18
EA-1 / C120402.05	1	21	20	N	N	N	N	N	N	N	N	N	N	17
	2	37		N	N	N	N	N	N	N	N	N	N	20
	3	30		N	N	N	N	N	N	N	N	N	N	15
	4	5		N	N	N	N	N	1M	1M	1M	1M	1M	16
	5	51		N	N	N	N	N	1M	1M	1M	1M	1M	18
EA-2 / C120402.06	1	25	20	N	N	N	N	N	N	N	N	N	N	15
	2	7		N	N	N	N	N	N	N	N	N	N	17
	3	44		N	N	N	N	N	N	N	N	N	N	18
	4	40		N	N	N	N	N	N	N	N	N	N	19
	5	17		N	N	N	3A	N	N	N	N	N	N	17
EA-3 / C120402.07	1	55	20	N	N	N	N	N	N	N	N	N	N	18
	2	6		N	1M	N	1A	N	N	N	N	1A	1M	16
	3	16		N	N	N	2A	1A/1M	1M	1M	1M	1M	1M	19
	4	32		N	N	N	N	N	N	N	N	N	N	18
	5	45		N	N	N	N	N	1M	1M	1M	1M	N	18

WESTON SOLUTIONS

10 DAY SOLID PHASE TEST DATA SHEET 3

CLIENT	PROJECT	WESTON JOB N0.	PROJECT MAN.	WESTON LABORATORY	PROTOCOL	SPECIES	ACCLM.MORT.
LADWP	Sylmar Ground Return System Undersea Electrode	13437.003.001.1006 01/13437.003.011.1006 01	D. McCoy	Carlsbad Room 2	USACE/USEPA (1998) / WESTON BIO066	*Eohaustorius estuarius*	< 5%

ENDPOINT DATA & OBSERVATIONS

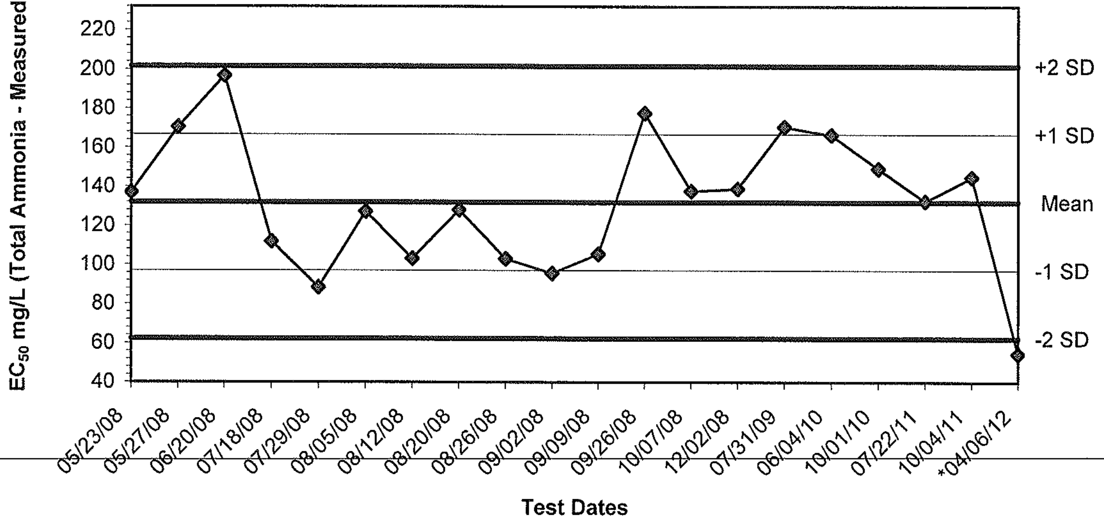
OBSERVATIONS KEY
N = normal L = anoxic surface
B= no burrows F= fungal patches
M= dead on surface D= no air flow (D-2)
A= avoidance U= excess food

				DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10			
				DATE 4/7/12	DATE 4/8/12	DATE 4/9/12	DATE 4/10/12	DATE 4/11/12	DATE 4/12/12	DATE 4/13/12	DATE 4/14/12	DATE 4/15/12	DATE 4/16/12			
				TECHNICIAN KS	TECHNICIAN KS	TECHNICIAN JH	TECHNICIAN BG	TECHNICIAN BG	TECHNICIAN JH	TECHNICIAN KC	TECHNICIAN KC	TECHNICIAN KC	TECHNICIAN JH/BG			
CLIENT/ WESTON ID	REP	JAR #	INITIAL #	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	OBSERVNS.	NUMBER REMAINING		
REF-1 / C120402.08	1	19	20	N	N	N	N	N	N	N	N	1A	N	19		
	2	43		N	N	N	N	N	N	N	N	N	N	20		
	3	1		N	N	N	N	N	N	N	N	N	N	18		
	4	26		N	N	N	N	N	N	N	N	N	N	19		
	5	52		N	N	N	N	N	N	N	N	N	N	17		
REF-2 / C120402.09	1	33	20	N	N	N	N	N	N	N	N	N	N	15		
	2	10		N	N	N	N	N	N	N	N	N	N KC ①	20		
	3	53		N	N	N	N	N	N	N	N	N	N	~~17~~ 19		
	4	42		N	N	N	N	N	N	1M	1M	1M	N	16		
	5	15		N	N	N	N	N	N	N	N	N	N	19		
REF-3 / C120402.10	1	41	20	N	N	N	N	N	N	N	N	N	N	16		
	2	18		N	N	N	N	N	N	N	N	N	N	17		
	3	24		N	N	N	N	N	N	N	N	N	N	6		
	4	54		N	N	N	N	N	N	N	N	N	N	12		
	5	11		N	N	N	N	N	N	N	N	N	N	11		

① IE 4/16/12 KC

Eohaustorius estuarius Reference Toxicant Control Chart: 96 Hour Survival

CV% = 26.4



Dates	Values	Mean	-1 SD	-2 SD	+1 SD	+2 SD
05/23/08	136.9920	131.9249	97.1072	62.2896	166.7425	201.5602
05/27/08	170.5800	131.9249	97.1072	62.2896	166.7425	201.5602
06/20/08	196.6930	131.9249	97.1072	62.2896	166.7425	201.5602
07/18/08	111.8160	131.9249	97.1072	62.2896	166.7425	201.5602
07/29/08	88.4329	131.9249	97.1072	62.2896	166.7425	201.5602
08/05/08	127.1670	131.9249	97.1072	62.2896	166.7425	201.5602
08/12/08	103.1700	131.9249	97.1072	62.2896	166.7425	201.5602
08/20/08	127.9600	131.9249	97.1072	62.2896	166.7425	201.5602
08/26/08	102.9850	131.9249	97.1072	62.2896	166.7425	201.5602
09/02/08	95.6667	131.9249	97.1072	62.2896	166.7425	201.5602
09/09/08	105.4620	131.9249	97.1072	62.2896	166.7425	201.5602
09/26/08	177.5580	131.9249	97.1072	62.2896	166.7425	201.5602
10/07/08	137.5810	131.9249	97.1072	62.2896	166.7425	201.5602
12/02/08	138.8030	131.9249	97.1072	62.2896	166.7425	201.5602
07/31/09	170.5000	131.9249	97.1072	62.2896	166.7425	201.5602
06/04/10	166.4000	131.9249	97.1072	62.2896	166.7425	201.5602
10/01/10	149.1240	131.9249	97.1072	62.2896	166.7425	201.5602
07/22/11	132.4600	131.9249	97.1072	62.2896	166.7425	201.5602
10/04/11	144.7240	131.9249	97.1072	62.2896	166.7425	201.5602
*04/06/12	54.4230	131.9249	97.1072	62.2896	166.7425	201.5602

*Value was out of 95% CI range at time of testing.

Updated 4/17/12 BG

Acute Sediment Test-96 Hr Survival

Start Date:	4/6/2012 12:50	Test ID:	C080206.131	Sample ID:	REF-Ref Toxicant
End Date:	4/10/2012 10:50	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	TNH3-Ammonia-total (measured)
Sample Date:		Protocol:	EPA USACE-1998	Test Species:	EE-Eohaustorius estuarius
Comments:					

Conc-mg/L	1	2	3	4
Control	0.9000	0.9000	1.0000	1.0000
12.5	1.0000	1.0000	0.9000	0.9000
25.5	0.8000	0.9000	0.8000	0.8000
49.3	0.5000	0.6000	0.7000	0.6000
102	0.0000	0.0000	0.0000	0.0000
206	0.0000	0.0000	0.0000	0.0000

			Transform: Untransformed						1-Tailed			
Conc-mg/L	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Control	0.9500	1.0000	0.9500	0.9000	1.0000	6.077	4				0.9500	0.0000
12.5	0.9500	1.0000	0.9500	0.9000	1.0000	6.077	4	0.000	2.290	0.1019	0.9500	0.0000
*25.5	0.8250	0.8684	0.8250	0.8000	0.9000	6.061	4	2.810	2.290	0.1019	0.8250	0.1316
*49.3	0.6000	0.6316	0.6000	0.5000	0.7000	13.608	4	7.867	2.290	0.1019	0.6000	0.3684
102	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	4				0.0000	1.0000
206	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	4				0.0000	1.0000

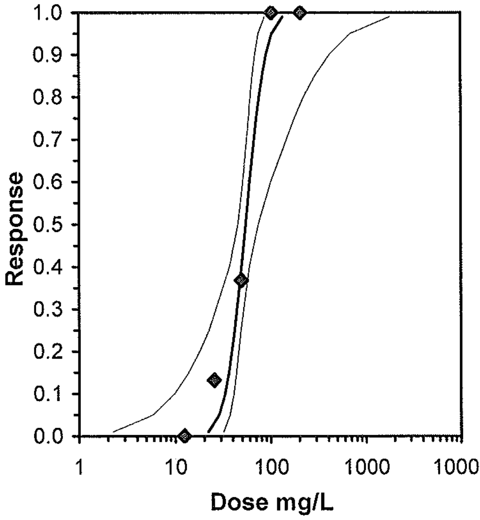
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93573	0.844	0.16034	-0.8988
Bartlett's Test indicates equal variances (p = 0.86)	0.74266	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	12.5	25.5	17.8536		0.10188	0.10724	0.10896	0.00396	1.2E-05	3, 12

Maximum Likelihood-Probit

Parameter	Value	SE	95% Fiducial Limits		Control	Chi-Sq	Critical	P-value	Mu	Sigma	Iter
Slope	5.9258	2.20328	1.60737	10.2442	0	2.19336	7.81473	0.53	1.73578	0.16875	13
Intercept	-5.2859	3.77114	-12.677	2.10554							
TSCR											

Point	Probits	mg/L	95% Fiducial Limits	
EC01	2.674	22.0396	2.24749	32.0574
EC05	3.355	28.7215	5.91411	37.6914
EC10	3.718	33.0762	9.86563	41.2565
EC15	3.964	36.3815	13.8824	44.0124
EC20	4.158	39.2425	18.1365	46.5269
EC25	4.326	41.8755	22.6865	49.0662
EC40	4.747	49.3207	37.4219	59.7779
EC50	5.000	54.423	45.6083	74.6395
EC60	5.253	60.0532	51.4051	100.775
EC75	5.674	70.7303	58.7689	177.145
EC80	5.842	75.4761	61.4843	223.36
EC85	6.036	81.4113	64.6484	293.378
EC90	6.282	89.5467	68.7025	414.416
EC95	6.645	103.124	74.9769	693.374
EC99	7.326	134.389	87.9437	1828.92



Reviewed by:

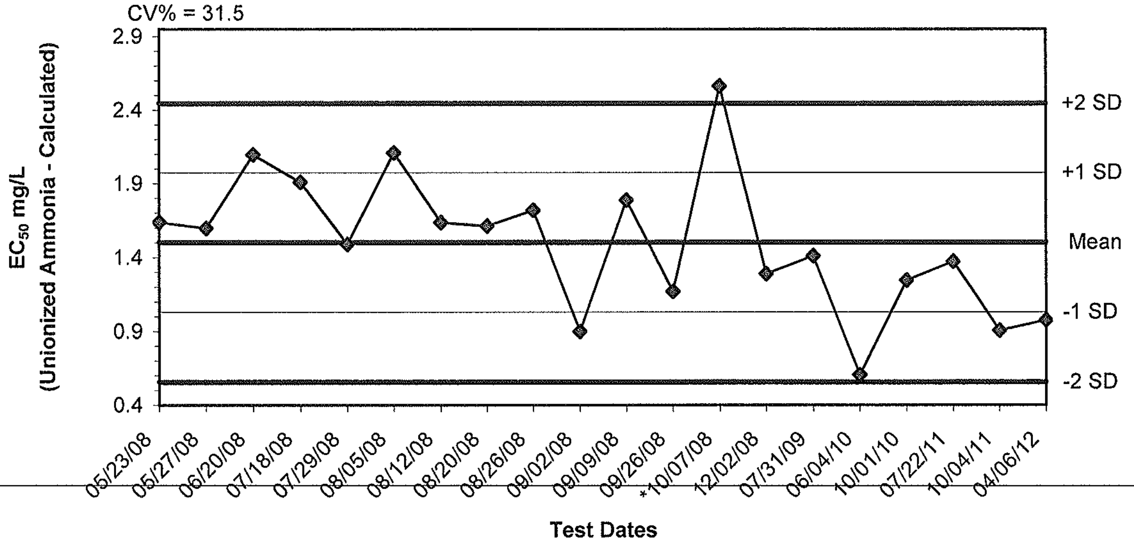
Test: SED-Acute Sediment Test	Test ID: C080206.131
Species: EE-Eohaustorius estuarius	Protocol: EPA USACE-1998
Sample ID: REF-Ref Toxicant	Sample Type: TNH3-Ammonia-total (measured)
Start Date: 4/6/2012 12:50 End Date: 4/10/2012 10:50	Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	Control	10				9	
	2	2	Control	10				9	
	3	3	Control	10				10	
	4	4	Control	10				10	
	5	1	12.500	10				10	
	6	2	12.500	10				10	
	7	3	12.500	10				9	
	8	4	12.500	10				9	
	9	1	25.500	10				8	
	10	2	25.500	10				9	
	11	3	25.500	10				8	
	12	4	25.500	10				8	
	13	1	49.300	10				5	
	14	2	49.300	10				6	
	15	3	49.300	10				7	
	16	4	49.300	10				6	
	17	1	102.000	10				0	
	18	2	102.000	10				0	
	19	3	102.000	10				0	
	20	4	102.000	10				0	
	21	1	206.000	10				0	
	22	2	206.000	10				0	
	23	3	206.000	10				0	
	24	4	206.000	10				0	

Comments:

Reviewed by:

Eohaustorius estuarius Reference Toxicant Control Chart: 96 Hour Survival



Dates	Values	Mean	-1 SD	-2 SD	+1 SD	+2 SD
05/23/08	1.6389	1.5016	1.0289	0.5562	1.9744	2.4471
05/27/08	1.5972	1.5016	1.0289	0.5562	1.9744	2.4471
06/20/08	2.0974	1.5016	1.0289	0.5562	1.9744	2.4471
07/18/08	1.9096	1.5016	1.0289	0.5562	1.9744	2.4471
07/29/08	1.4874	1.5016	1.0289	0.5562	1.9744	2.4471
08/05/08	2.1102	1.5016	1.0289	0.5562	1.9744	2.4471
08/12/08	1.6353	1.5016	1.0289	0.5562	1.9744	2.4471
08/20/08	1.6120	1.5016	1.0289	0.5562	1.9744	2.4471
08/26/08	1.7181	1.5016	1.0289	0.5562	1.9744	2.4471
09/02/08	0.9003	1.5016	1.0289	0.5562	1.9744	2.4471
09/09/08	1.7870	1.5016	1.0289	0.5562	1.9744	2.4471
09/26/08	1.1683	1.5016	1.0289	0.5562	1.9744	2.4471
*10/07/08	2.5639	1.5016	1.0289	0.5562	1.9744	2.4471
12/02/08	1.2891	1.5016	1.0289	0.5562	1.9744	2.4471
07/31/09	1.4099	1.5016	1.0289	0.5562	1.9744	2.4471
06/04/10	0.6070	1.5016	1.0289	0.5562	1.9744	2.4471
10/01/10	1.2452	1.5016	1.0289	0.5562	1.9744	2.4471
07/22/11	1.3732	1.5016	1.0289	0.5562	1.9744	2.4471
10/04/11	0.9064	1.5016	1.0289	0.5562	1.9744	2.4471
04/06/12	0.9765	1.5016	1.0289	0.5562	1.9744	2.4471

*Value within 95% CI range at time of testing.
Updated 4/17/12 BG

Acute Sediment Test-96 Hr Survival

Start Date:	4/6/2012 12:50	Test ID:	C080206.131	Sample ID:	REF-Ref Toxicant
End Date:	4/10/2012 10:50	Lab ID:	CCA-Weston, Carlsbad	Sample Type:	UNH3-Ammonia-unionized (calculated)
Sample Date:		Protocol:	EPA USACE-1998	Test Species:	EE-Eohaustorius estuarius
Comments:					

Conc-mg/L	1	2	3	4
Control	0.9000	0.9000	1.0000	1.0000
0.366	1.0000	1.0000	0.9000	0.9000
0.592	0.8000	0.9000	0.8000	0.8000
0.92	0.5000	0.6000	0.7000	0.6000
1.191	0.0000	0.0000	0.0000	0.0000
1.531	0.0000	0.0000	0.0000	0.0000

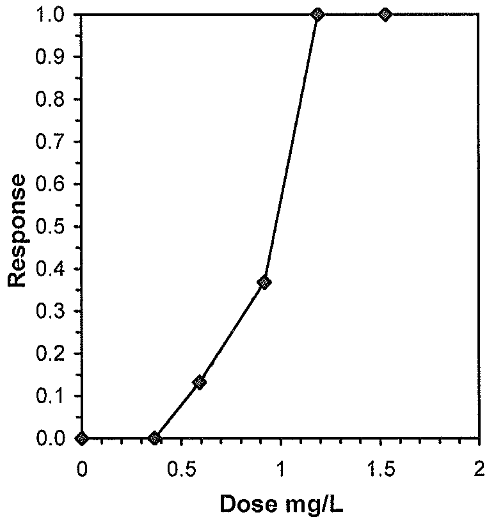
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-mg/L	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Control	0.9500	1.0000	0.9500	0.9000	1.0000	6.077	4				0.9500	1.0000
0.366	0.9500	1.0000	0.9500	0.9000	1.0000	6.077	4	0.000	2.290	0.1019	0.9500	1.0000
*0.592	0.8250	0.8684	0.8250	0.8000	0.9000	6.061	4	2.810	2.290	0.1019	0.8250	0.8684
*0.92	0.6000	0.6316	0.6000	0.5000	0.7000	13.608	4	7.867	2.290	0.1019	0.6000	0.6316
1.191	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	4				0.0000	0.0000
1.531	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	4				0.0000	0.0000

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93573	0.844	0.16034	-0.8988
Bartlett's Test indicates equal variances (p = 0.86)	0.74266	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	0.366	0.592	0.46548		0.10188	0.10724	0.10896	0.00396	1.2E-05	3, 12

Linear Interpolation (200 Resamples)

Point	mg/L	SD	95% CL(Exp)		Skew
IC05	0.4519	0.0499	0.2810	0.5435	-1.6888
IC10	0.5378	0.0450	0.3835	0.6654	0.0882
IC15	0.6175	0.0391	0.4562	0.7201	-0.0586
IC20	0.6868	0.0370	0.5351	0.7917	0.0290
IC25	0.7560	0.0396	0.6435	0.8581	0.7347
IC40	0.9336	0.0240	0.8240	0.9746	-1.2587
IC50	0.9765	0.0141	0.9254	1.0107	-0.3189



Reviewed by:

Test: SED-Acute Sediment Test	Test ID: C080206.131
Species: EE-Eohaustorius estuarius	Protocol: EPA USACE-1998
Sample ID: REF-Ref Toxicant	Sample Type: UNH3-Ammonia-unionized (calculated)
Start Date: 4/6/2012 12:50 End Date: 4/10/2012 10:50	Lab ID: CCA-Weston, Carlsbad

Pos	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	Control	10				9	
	2	2	Control	10				9	
	3	3	Control	10				10	
	4	4	Control	10				10	
	5	1	0.366	10				10	
	6	2	0.366	10				10	
	7	3	0.366	10				9	
	8	4	0.366	10				9	
	9	1	0.592	10				8	
	10	2	0.592	10				9	
	11	3	0.592	10				8	
	12	4	0.592	10				8	
	13	1	0.920	10				5	
	14	2	0.920	10				6	
	15	3	0.920	10				7	
	16	4	0.920	10				6	
	17	1	1.191	10				0	
	18	2	1.191	10				0	
	19	3	1.191	10				0	
	20	4	1.191	10				0	
	21	1	1.531	10				0	
	22	2	1.531	10				0	
	23	3	1.531	10				0	
	24	4	1.531	10				0	

Comments:

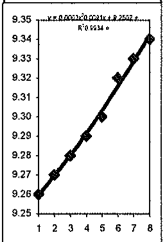
Reviewed by:

WESTON SOLUTIONS Un-ionized Ammonia Calculator

Client:	LADWP	Start Date:	06-Apr-12
Project ID:	Sylmar Ground Return System Undersea Electrode	Test Type:	*Eohaustorius estuarius* NH RT

To convert Total Ammonia (mg/L) to Free (un-ionized) Ammonia (mg/L) enter the corresponding total ammonia, salinity, temperature, and pH.

Integer:	I-factor
1	9.26
2	9.27
3	9.28
4	9.29
5	9.30
6	9.32
7	9.33
8	9.34



	TEST	*NH3T (mg/L)*	*salinity (ppt)*	*pH*	*temp (C)*	temp (K)	i-factor	**NH3U (mg/L)**
	Example	0.610	22.9	8.0	24.1	297.26	9.3053	**0.027**
	Example2	2.000	10.0	7.5	5.0	278.16	9.2750	**0.008**
1	Control	0.000	29.8	8.2	15.9	289.06	9.3236	**0.000**
2	15.625	12.500	30.0	8.1	15.7	288.86	9.3242	**0.366**
3	31.25	25.500	30.1	8.0	15.6	288.76	9.3244	**0.592**
4	62.5	49.300	30.2	7.9	15.7	288.86	9.3247	**0.920**
5	125	102.000	30.3	7.7	15.5	288.66	9.3250	**1.191**
6	250	206.000	30.7	7.5	15.6	288.76	9.3261	**1.531**
7								
8								
9								
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10 DAY SOLID PHASE TEST DATA SHEET 2 - REF TOX WQ

CLIENT LADWP	PROJECT Sylmar Ground Return System Undersea Electrode	SPECIES *Eohaustorius estuarius*		WESTON LABORATORY Carlsbad Room 2	PROTOCOL USACE/USEPA (1998) / WESTON
WESTON JOB NUMBER 13537.002.001.1006.01/13537.002.011.1006.01	PROJECT MANAGER D. McCoy	TEST START DATE 06Apr12	TIME 1250 SH/KC	TEST END DATE 10Apr12	TIME 1050 JH

WATER QUALITY DATA

TEST CONDITIONS	TEMP (C)	SAL (ppt)	DO (mg/L)	pH	DILTN.WAT.BATCH	REFERENCE TOXICANT MATERIAL	TOXICANT AMOUNT	DILUENT AMOUNT	REF. TOX. TEST I.D.
	15 ± 2	30 ± 2	> 6.0	7.8 ± 0.5	SIO040312	ammonium chloride	84.842 g	2000 mL	C080206.131

CLIENT/ WESTON ID	CONCENTRATION		DAY	REP	Dissolved Oxygen		Temperature		Salinity		pH		TECHNICIAN
	value	units			METER	mg/L	METER	°C	METER	ppt	METER	units	
Ref.Tox.-ammonia	0	mg/L	0	All	3	7.6	3	15.9	6	29.8	4	8.2	JH
			4	1	3	7.4	3	15.2	6	29.8	2	7.9	JH
Ref.Tox.-ammonia	15.625	mg/L	0	All	3	7.5	3	15.7	6	30.0	4	8.1	JH
			4	1	3	7.3	3	14.8	6	29.8	2	7.9	JH
Ref.Tox.-ammonia	31.25	mg/L	0	All	3	7.8	3	15.6	6	30.1	4	8.0	JH
			4	1	3	7.4	3	14.8	6	30.0	2	7.9	JH
Ref.Tox.-ammonia	62.5	mg/L	0	All	3	7.8	3	15.7	6	30.2	4	7.9	JH
			4	1	3	7.3	3	14.8	6	30.2	2	7.9	JH
Ref.Tox.-ammonia	125	mg/L	0	All	3	7.8	3	15.5	6	30.3	4	7.7	JH
			4										
Ref.Tox.-ammonia	250	mg/L	0	All	3	7.7	3	15.6	6	30.7	4	7.5	JH
			4										

10 DAY SOLID PHASE TEST DATA SHEET 3 - REF TOX

			SPECIES *Eohaustorius estuarius*		ACCLM.MORT. < 5%
CLIENT LADWP	PROJECT Sylmar Ground Return System Undersea Electrode	WESTON JOB N0. 15557.002.001.1006.01/15557.002.001.1006.01	PROJECT MANAGER D. McCoy	WESTON LABORATORY Carlsbad Room 2	PROTOCOL USACE/USEPA (1998) / WESTON BIO066

SURVIVAL & BEHAVIOR DATA

OBSERVATIONS KEY

N = normal
LOE= loss of equilibrium
Q = quiescent
SUR= surfacing
FOS = Floating on Surface
DC = discoloration
OB = on bottom
J = jumper
NB = no body

CLIENT/ WESTON ID	CONC.		REP	INITIAL NUMBER	DAY 1			DAY 2			DAY 3			DAY 4		
					DATE 4-7-12			DATE 4-8-12			DATE 4/9/12			DATE 4/10/12		
					TECHNICIAN KS			TECHNICIAN KS			TECHNICIAN JH			TECHNICIAN JH		
	value	units			#ALIVE	#DEAD	OBS	#ALIVE	#DEAD	OBS	#ALIVE	#DEAD	OBS	#ALIVE	#DEAD	OBS
Ref.Tox.-ammonia	0	mg/L	1	10	10	0	2 FOS	10	0	1 FOS	9	1	4FOS	9	0	1FOS
			2	10	10	0	1 FOS	10	0	N	10	0	1FOS	9	1	2FOS
			3	10	10	0	4 FOS	10	0	3 FOS	10	0	3FOS	10	0	2FOS
			4	10	10	0	N	10	0	3FOS	10	0	1FOS	10	0	3FOS
Ref.Tox.-ammonia	15.625	mg/L	1	10	10	0	1FOS	10	0	2 FOS	10	0	N	10	0	N
			2	10	10	0	4FOS	10	0	N	10	0	3FOS	10	0	1FOS
			3	10	10	0	N	10	0	6 FOS	9	1	5FOS	9	0	2FOS
			4	10	10	0	3FOS	10	0	2FOS	10	0	2FOS	9	1	3FOS
Ref.Tox.-ammonia	31.25	mg/L	1	10	10	0	2FOS	10	0	N	10	0	N	8	2	N
			2	10	10	0	6 FOS	10	0	3 FOS	10	0	2FOS	9	1	1FOS
			3	10	10	0	3 FOS	9	1	2 FOS	9	0	2FOS	8	1	1FOS
			4	10	9	1	1FOS	9	0	2 FOS	9	0	1FOS	8	1	1FOS
Ref.Tox.-ammonia	62.5	mg/L	1	10	10	0	1 FOS	8	2	3 FOS	7	1	W	5	2	N
			2	10	10	0	3FOS	10	0	3FOS	8	2	1FOS	6	2	N
			3	10	10	0	2FOS	10	0	2FOS	8	2	1FOS	7	1	1FOS
			4	10	10	0	2FOS	9	1	N	8	1	N	6	2	2FOS
Ref.Tox.-ammonia	125	mg/L	1	10	5	5	Q	2	3	Q	0	2	—			
			2	10	6	4	Q	1	5	Q	0	1	—			
			3	10	4	6	Q	4	0	Q	0	4	—			
			4	10	5	5	Q	4	1	Q	0	4	—			
Ref.Tox.-ammonia	250	mg/L	1	10	0	10	—									
			2	10	0	10	—									
			3	10	0	10	—									
			4	10	0	10	—									

Page 1 of 1

WESTON SOLUTIONS

Ammonia Analysis
Total Ammonia (mg/L)

Client/Project: LADPW Sylmar	**Organism:** EOh RT	**Weston Test ID:** C080206.131	**Test Duration (days):** 4

PRETEST / [✓ INITIAL] / FINAL / OTHER (circle one) **DAY of TEST:** 0
[✓ OVERLYING (OV)] / POREWATER (PW) (circle one)

Calibration Standards Temperature		
Date:	**Temperature:**	Sample temperature should be within ±1°C of standards temperature at time and date of analysis.
4/9/12	23.0	

Sample ID or Description	Conc. or Rep	Date of Sampling and Initials	Ammonia Value (mg/L)	Temp °C	Date of Reading and Initials	Sample Frozen (Y/N)	pH	Sal (ppt)
0		4/6/12	<0.5	22.0	4/9/12 BG	Y		
15.625		↓	12.5	21.6	↓	↓		
31.25		↓	25.5	22.3	↓	↓		
62.5		↓	49.3	22.0	↓	↓		
125		↓	102	23.0	↓	↓		
250		↓	206	23.0	↓	↓		

WESTON SOLUTIONS

BIOASSAY SEDIMENT SAMPLE RECEIPT

Client: LADPW	**WESTON ID:**	C120402.01	C120402.02	C120402.03	C120402.04
Project:	**CLIENT ID:**	TRANS-2	TRANS-4	TRANS-7	TRANS-9
Date/Time Received:		4/2/12 1415	4/2/12 145	4/2/12 1415	4/2/12 1415
Airbill #:		N/A	N/A	N/A	N/A
Sample Tracking Information Kept for Records: (Y/N)		N/A	N/A	N/A	N/A
Collection Date/Time:		3/30/12 1015	3/30/12 1130	3/30/12 1345	3/30/12 1500
Condition of Shipping Container:		N/A	N/A	N/A	N/A
Type of Sample Container:		sed. bag	sed. bag	sed. bag	sed. bag
Condition of Sampling Container:		good	good	good	good
Sample Container Appropriate: (Y/N)		y	y	y	y
Custody Seals Intact: (Y/N)		N/A	N/A	N/A	N/A
Ice or Frozen Blue Ice Present During Shipment/Transport: (Y/N)		y	y	y	y
Sampler's Name Present on COC Form: (Y/N)					
Internal Cooler Temp. (Water Temp. Blank) (°C) (0-6°C):		① JH →			→
Technician Initials:		JH	JH	JH	JH

*Notify project manager or study director of temperatures above 6°C. Client must be notified ASAP.

If there are sample receipt problems, complete the following:	
Reason for unacceptability:	
Name of Client Contact:	Contacted by:
Client Response and/or Action to be Taken:	Date Action Taken:

① Unable to take temps since no water present. 4/2/12 JH

WESTON SOLUTIONS

BIOASSAY SEDIMENT SAMPLE RECEIPT

Client: LADPW	**WESTON ID:**	C120402.05	C120402.06	C120402.07	C120402.08
Project:	**CLIENT ID:**	EA-1	EA-2	EA-3	REF-1
Date/Time Received:		4/2/12 1415	4/2/12 1415	4/2/12 1415	4/2/12 1415
Airbill #:		N/A	N/A	N/A	N/A
Sample Tracking Information Kept for Records: (Y/N)		N/A	N/A	N/A	N/A
Collection Date/Time:		3/31/12 1025	3/31/12 1130	3/31/12 1225	3/31/12 1410
Condition of Shipping Container:		N/A	N/A	N/A	N/A
Type of Sample Container:		sed. bag	sed. bag	sed. bag	sed. bag
Condition of Sampling Container:		good	good	good	good
Sample Container Appropriate: (Y/N)		y	y	y	y
Custody Seals Intact: (Y/N)		N/A	N/A	N/A	N/A
Ice or Frozen Blue Ice Present During Shipment/Transport: (Y/N)		y	y	y	y
Sampler's Name Present on COC Form: (Y/N)					
Internal Cooler Temp. (Water Temp. Blank) (°C) (0-6°C):		①JH →	→	→	→
Technician Initials:		JH	JH	JH	JH

*Notify project manager or study director of temperatures above 6°C. Client must be notified ASAP.

If there are sample receipt problems, complete the following:	
Reason for unacceptability:	
Name of Client Contact:	Contacted by:
Client Response and/or Action to be Taken:	Date Action Taken:

① Unable to take temps since no water present. 4/2/12 JH

BIOASSAY SEDIMENT SAMPLE RECEIPT

Client: LADPW	**WESTON ID:**	C120402.09	C120402.10		
Project:	**CLIENT ID:**	REF-2	REF-3		
Date/Time Received:		4/2/12 1415	4/2/12 1415		
Airbill #:		N/A	N/A		
Sample Tracking Information Kept for Records: (Y/N)		N/A	N/A		
Collection Date/Time:		3/31/12 1450	3/31/12 1530		
Condition of Shipping Container:		N/A	N/A		
Type of Sample Container:		sed. bag	sed. bag		
Condition of Sampling Container:		good	good		
Sample Container Appropriate: (Y/N)		y	y		
Custody Seals Intact: (Y/N)		N/A	N/A		
Ice or Frozen Blue Ice Present During Shipment/Transport: (Y/N)		y	y		
Sampler's Name Present on COC Form: (Y/N)					
Internal Cooler Temp. (Water Temp. Blank) (°C) (0-6°C):		① N/A →	→		
Technician Initials:		JH	JH		

*Notify project manager or study director of temperatures above 6°C. Client must be notified ASAP.

If there are sample receipt problems, complete the following:	
Reason for unacceptability:	
Name of Client Contact:	Contacted by:
Client Response and/or Action to be Taken:	Date Action Taken:

① unable to take temps since no water present. 4/2/12 JH

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BIOASSAY SEDIMENT SAMPLE RECEIPT

Client: LADWP	**WESTON ID:**	C120405.01			
Project: Sylmar	**CLIENT ID:**	Eoh Site 0 Sed.			
Date/Time Received:		4/5/12 1025			
Airbill #:		8756 0039 5119			
Sample Tracking Information Kept for Records: (Y/N)		N			
Collection Date/Time:		4/2/12			
Condition of Shipping Container:		good			
Type of Sample Container:		2L ziploc bag			
Condition of Sampling Container:		good			
Sample Container Appropriate: (Y/N)		y			
Custody Seals Intact: (Y/N)		N/A			
Ice or Frozen Blue Ice Present During Shipment/Transport: (Y/N)		y			
Sampler's Name Present on COC Form: (Y/N)		y			
Internal Cooler Temp. (Water Temp. Blank) (°C) (0-6°C):		① JH			
Technician Initials:		JH			

① Unable to take temp due lack of water 4/5/12 JH

*Notify project manager or study director of temperatures above 6°C. Client must be notified ASAP.

If there are sample receipt problems, complete the following:	
Reason for unacceptability:	
Name of Client Contact:	Contacted by:
Client Response and/or Action to be Taken:	Date Action Taken:

WESTON SOLUTIONS

☒ 2433 Impala Drive • Carlsbad, CA 92010 • (760) 795-6900, FAX 931-1580
☐ 1440 Broadway, Ste. 910 • Oakland, CA 94612 • (510) 808-0302, FAX 891-9710

0709

CHAIN OF CUSTODY

DATE 4/1/12 PAGE 1 OF 1

PROJECT NAME / SURVEY / PROJECT NUMBER: SYLMAR - LADWP
PROJECT MANAGER / CONTACT: DAN McCOY
COMPANY / CLIENT: WESTON SOLUTIONS
ADDRESS: SEE ABOVE
PHONE / FAX / EMAIL: " "

SITE ID (Location)	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE / VOLUME	TOTAL NUMBER OF CONTAINER	ANALYSIS/TEST REQUESTED TOXICITY - EOHS								PRESERVED HOW	SAMPLE TEMP. (°C) UPON RECEIPT	WESTON LAB ID
SANTA MONICA BAY	TRANS - 2	3/30/12	1015	SED	1 BAG	1	X								ICE		C120402.01
	TRANS - 4		1130			1	X										C120402.02
	TRANS - 7		1345			1	X										C120402.03
	TRANS - 9		1500			1	X										C120402.04
	EA - 1	3/31/12	1025			1	X										C120402.05
	EA - 2		1130			1	X										C120402.06
	EA - 3		1225			1	X										C120402.07
	REF - 1		1410			1	X										C120402.08
	REF - 2		1450			1	X										C120402.09
	REF - 3		1530			1	X										C120402.10

Sample Matrix Codes: FW= fresh water GW=ground water SLT=salt water SW=storm water WW=waste water [✓ SED=sediment] A=air BIO=biologic SS=soil T=tissue O=other (specify) ________

Container Code: G=glass P=plastic [✓ B=bags] ☐ O=other ________

Shipped By: ☐ Courier ☐ UPS ☐ FedEx ☐ USPS ☒ Client drop off ☐ Other ________

Turnaround Time: ☐ 2-day ☐ 5-day ☐ 7-day ☐ 10-day ☐ 14-day ☒ Standard ☐ Other ________

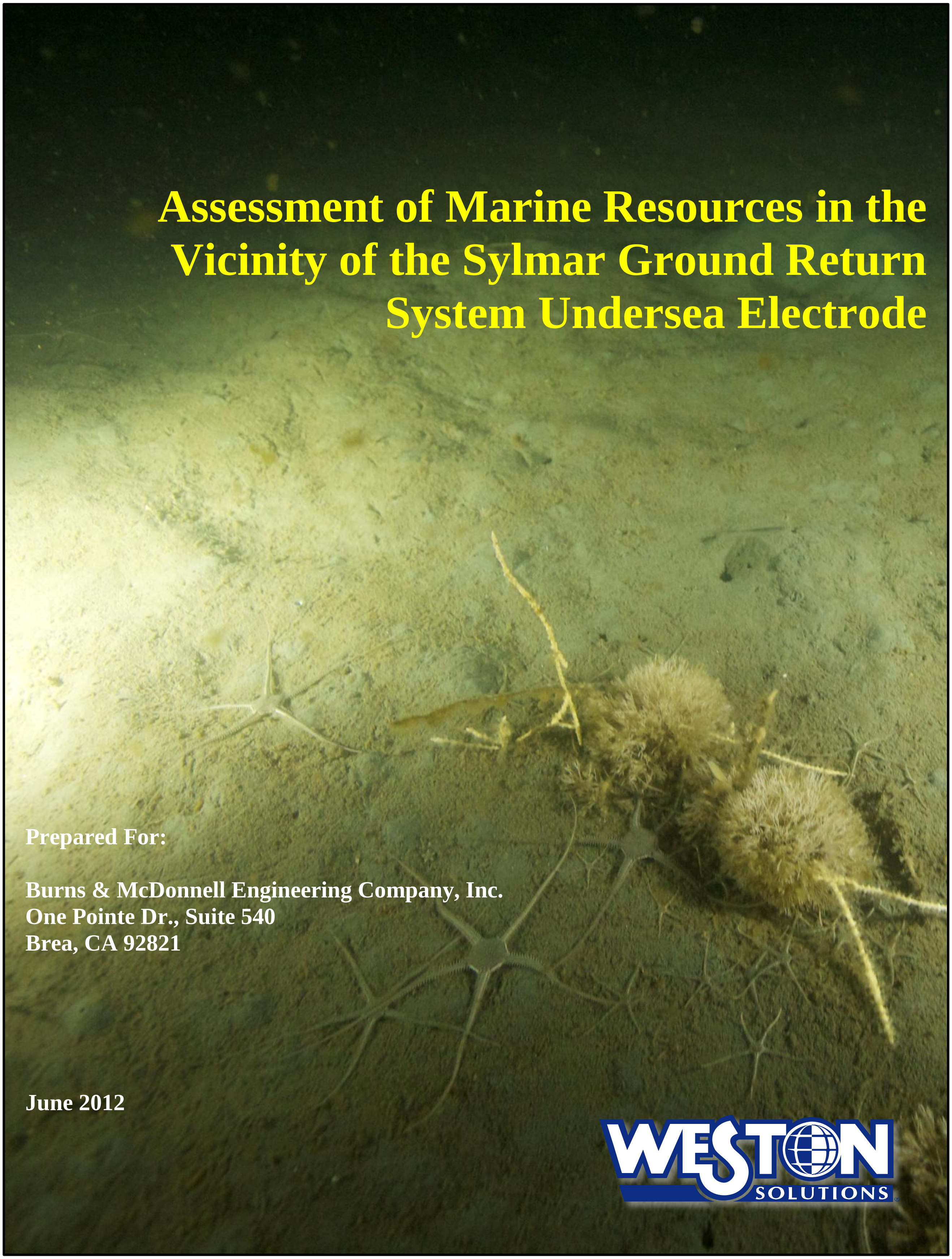
Reporting Requirements: ☒ PDF ☐ EDD ☒ Hard Copy ☐ Email ☐ Other ________

SAMPLED BY: PRINT SIGNATURE

COMMENTS / SPECIAL INSTRUCTIONS

RELINQUISHED BY				RECEIVED BY			
Print Name	Signature	Firm	Date/Time	Print Name	Signature	Firm	Date/Time
1. Chris Clark		Weston	4/1/12 1255	Sean M. Hasan		Weston	4/1/12 1235
2.				Jessie Hansen		Weston	4/2/12 1415
3.							
4.							
5.							
6.							

WHITE – return to originator • YELLOW – lab • PINK – retained by originator



Assessment of Marine Resources in the Vicinity of the Sylmar Ground Return System Undersea Electrode

Prepared For:

Burns & McDonnell Engineering Company, Inc.
One Pointe Dr., Suite 540
Brea, CA 92821

June 2012

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Prepared For:

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Brea, CA 92821

Prepared By:

Weston Solutions, Inc.
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Carlsbad, California 92010

June 2012

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ACRONYMS AND ABBREVIATIONS

APE	area of potential effect
ASTM	American Society for Testing and Materials
Bight ‘08	Southern California Bight 2008 Regional Monitoring Project
BIO	Biological Community
BMP	Best Management Practices
BRI	Benthic Response Index
Calscience	Calscience Environmental Laboratories, Incorporated
CEQA	California Environmental Quality Act
COC	chain of custody
COP	California Ocean Plan
CTD	conductivity, temperature, depth probe
DDT	dichlorodiphenyltrichloroethane
DGPS	Differential Global Positioning System
DO	dissolved oxygen
EA	electrode array
EIR	Environmental Impact Report
EMF	electro-magnetic field
ER-L	effects range- low
ER-M	effects range- medium
HU	Human Uses
ID	identification
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IS	Initial Study
LADWP	Los Angeles Department of Water and Power
LC50	Lethal Concentration 50
MM	mitigation measures
MRL	method reporting limit
NELAP	National Environmental Laboratory Accreditation Program
NOEC	no observable effect concentration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pH	hydrogen ion concentration
PDCI	Pacific DC Intertie
QA	quality assurance
QC	quality control
ROV	remotely operated vehicle
SAP	sampling and analysis plan
SCAMIT	Southern California Marine Invertebrate Taxonomists
SCCWRP	Southern California Coastal Water Research Project
SCUBA	self-contained underwater breathing apparatus
SOP	standard operating procedure
SP	solid phase
SWAMP	Surface Water Ambient Monitoring Program
SWQ	sediment and water quality
THM	trihalomethane

ACRONYMS AND ABBREVIATIONS

TOC	total organic carbon
USEPA	United States Environmental Protection Agency
WESTON	Weston Solutions, Inc.

UNITS OF MEASURE

A	ampere
cm	centimeter
°C	degrees Celsius
ft	feet or foot
g	gram
gal	gallon
in	inch
kg	kilogram
km	kilometer
kW	kilowatt
L	liter
m	meter
m^2	square meters
m^3	cubic meters
mi	mile
µg	microgram
µT	microTesla
mg	milligram
mL	milliliter
mm	millimeter
MW	megawatt
nV	nanovolt
oz	ounce
ppt	parts per thousand
sec	second
V	volt
%	percent

1.0 INTRODUCTION

1.1 Background and History

Los Angeles Department of Water and Power (LADWP) is engaged in studies to support upgrading its Pacific Direct Current Intertie (PDCI) by approximately 600 megawatts (MW) to accommodate the transfer of wind and hydroelectric power to its Sylmar Power Station. This upgrade will require both land-based and ocean-based enhancements to the existing PDCI electrode system that currently terminates approximately 1.8 kilometers (km) (1.1 miles (mi)) offshore from the coast of Santa Monica, California. The ocean-based enhancement includes replacement and relocation of two subsea electrical cables, which currently extend seaward from the Gladstone Vault in Santa Monica. Option 1 for the new cable route would begin at the Gladstone Vault and extend in a straight line approximately 5 km (3.1 mi) offshore in a southwesterly direction, and would terminate at an electrical array located on the floor of Santa Monica Bay (Figure 1-1). Option 2 for the new cable route would begin at the intersection of Chautauqua Blvd., Channel Blvd., and Pacific Coast Highway, and would extend in a west-southwesterly direction for approximately 2.8 km (1.7 mi), circumventing two artificial reef areas before straightening out and arriving at the proposed location of the electrode array, approximately 7 km (4.3 mi) from shore. The design of the new electrical array will differ from the previous electrical array, and will consist of 88 electrode elements placed within cylindrical vaults that are spaced at regular intervals on the seafloor in a large circular pattern that will have a radius of 210 meters (689 feet (ft)) (see Appendix A for electrode array design specifications).

An Initial Study (IS) prepared by LADWP determined that the Project will require an Environmental Impact Report (EIR) based on identification of site-specific impacts and evaluations of potential significance under the California Environmental Quality Act (CEQA). The IS determined that replacement or rehabilitation of the cables and electrode array has the potential to significantly impact marine resources due to construction-related impacts. The proposed Sylmar Electrode System will extend approximately 5 km (3.1 mi) offshore along a new cable route and is projected to be operated at a maximum of 3,650 amps (A) for approximately 50 hours per year. When in use, the subsea system has the potential to produce electromagnetic fields (EMFs) and electrochemical reactions that may impact marine organisms and the surrounding environment.

Weston Solutions (WESTON) was contracted by LADWP (under prime contractor, Burns and McDonnell) to determine the potential impacts on marine life, humans, and surroundings within Santa Monica Bay resulting from the installation of a new offshore segment for the Sylmar Electrode System. A scientifically-defensible study design that consisted of both field surveys and existing literature and data reviews was developed by WESTON to assess project impacts within the marine environment of Santa Monica Bay. Results of the field surveys are presented and discussed in the main body of this report, while the findings of the literature review are presented in Appendix A.

1.2 Objectives

The primary objective of this study was to determine the potential impacts of installing a new offshore segment of the Sylmar Electrode System on marine life, humans, and surroundings within Santa Monica Bay. To accomplish this, existing biological resources and activities within the Area of Potential Effect (APE) were assessed through video surveillance, direct observation, sample collection and analysis, and a literature review. Potential impacts to these resources and activities from short-term construction of the cable route and placement of the electrode array and potential long-term effects of electrode operation were also assessed. A secondary objective for this project included recommending strategies to mitigate any potential project impacts to these resources.

Figure 1-1. Project Location in Santa Monica Bay, Santa Monica, California

2.0 METHODS

Sampling and observational methods were used to assess the existing conditions within the proposed cable path and electrode array footprints. Field methods included:

- Collecting water chemistry samples at the proposed Electrode Array Area and adjacent Reference Area to determine chemical constituents in the water column prior to electrode operation (i.e., assessment of baseline conditions);
- Collecting water quality measurements at all stations to assess baseline water column conditions and physical factors (i.e., resistivity) that can affect the size and strength of the electric field. This will also help to document if short-term construction activities (i.e., trenching and laying of cables and placement of concrete vaults housing the electrode array) are impacting the water quality within the APE;
- Collecting sediment chemistry and benthic infauna samples at all stations, and toxicity at ten stations, to assess the potential release of chemicals of concern into the water column during construction activities. Benthic infauna was assessed to determine the anticipated level of impact to the soft bottom community associated with trenching and construction of the electrode array; and
- Capturing video footage and still footage from remote operated vehicle (ROV) surveys and diver surveys to assess local fish and invertebrate species, algae, and habitat within the APE.

A detailed description of the sampling and survey design used to assess the marine resources within the project footprint is provided as follows.

2.1 Overview of Field Sampling and Survey Design

Field surveys were conducted in the APE, extending from the shoreline to approximately 5 km miles (3.1 miles) offshore, to determine the existing baseline biological conditions in the vicinity of the proposed cable route and electrode array placement. Surveys consisted of visual assessments of the two cable route options as well as the footprint of the electrode array by divers and an ROV to document habitat quality and record observed species; sediment sampling to determine benthic community structure, chemistry, toxicity, and physical properties; and physical water quality assessments with a conductivity temperature depth (CTD) sensor. Data collected from field surveys were compared to the findings of previous studies at the site and regional studies that have characterized the biota within Santa Monica Bay.

Sampling and dive surveys were performed within five transect areas placed at regular intervals along each of the respective cable route options, three transects within the Electrode Array Area, and one transect within the Reference Area to assess and document the biological resources and habitat within the project footprint (Figure 2-1 and Figure 2-2). Video surveillance of the entire length of the cable routes and of the Electrode Array Area was performed using an ROV. Since the vast majority of both of the cable route options occurred over soft-bottom habitat, one or more transects were subject to relocation to include rocky reef habitat discovered during ROV surveys. All sampling locations were randomly placed within each of the transect areas prior to the start of field collection activities.

Water quality measurements were collected from a total of 16 sites─ 13 sites located within the project footprint (5 sites along the Option 1 proposed cable route, 5 sites along the Option 2 cable route, and 3 sites at the proposed location of the electrode array) and 3 sites within a nearby Reference Area located at an equivalent depth to the proposed Electrode Array Area. Water quality measurements were taken throughout the entire water column at each site using a CTD probe. Water chemistry samples were collected at depth (within two meters of the bottom) from the Electrode Array Area (3 samples) and the Reference Area (1 sample).

Sediment sampling was conducted using a Van Veen grab sampler at five sites along each of the cable routes and at three sites within the Electrode Array Area and three sites at the Reference Area. Sediment chemistry, grain size, and benthic infauna analyses were performed on samples collected at each of the 16 sites, while benthic toxicity was assessed at two sites along each of the cable routes (4 samples total), at the electrode array station (3 samples) and at the reference location (3 samples).

Dive Surveys of both of the proposed alternative cable routes and electrode array were performed to visually assess the biological community. Five replicate survey areas of 91.4 m (300 ft) in length and 30.5 m (100 ft) in width were sampled along each of the proposed cable route options. Survey locations were positioned along the proposed cable routes so that both hard-bottom rocky habitat and soft-bottom sandy habitat would be surveyed. Three 198-m (650-ft) long by 45.7-m (150-ft) wide areas within the proposed 1-km (0.62 mi) radius Electrode Array Area were also surveyed by divers. The dive survey team consisted of four different divers, and included two divers conducting the survey and one support diver. Divers recorded all observed flora and fauna to the lowest possible taxonomic unit. Video from the dive surveys was used to document the existing habitat and to supplement the list of observed species and their relative abundance as identified on data sheets by the dive team.

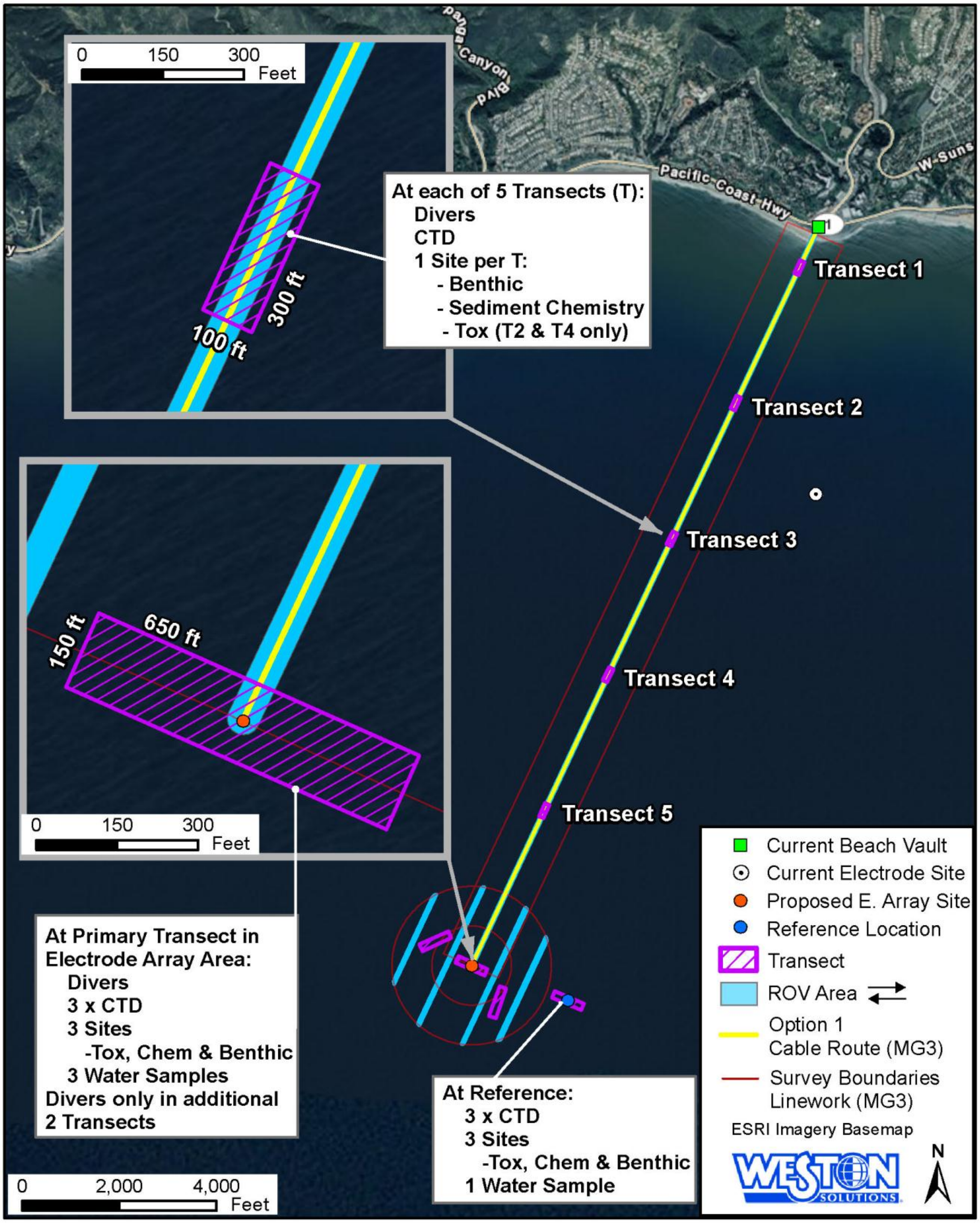


Figure 2-1. Pre-plotted Monitoring Locations along the Option 1 Cable Route

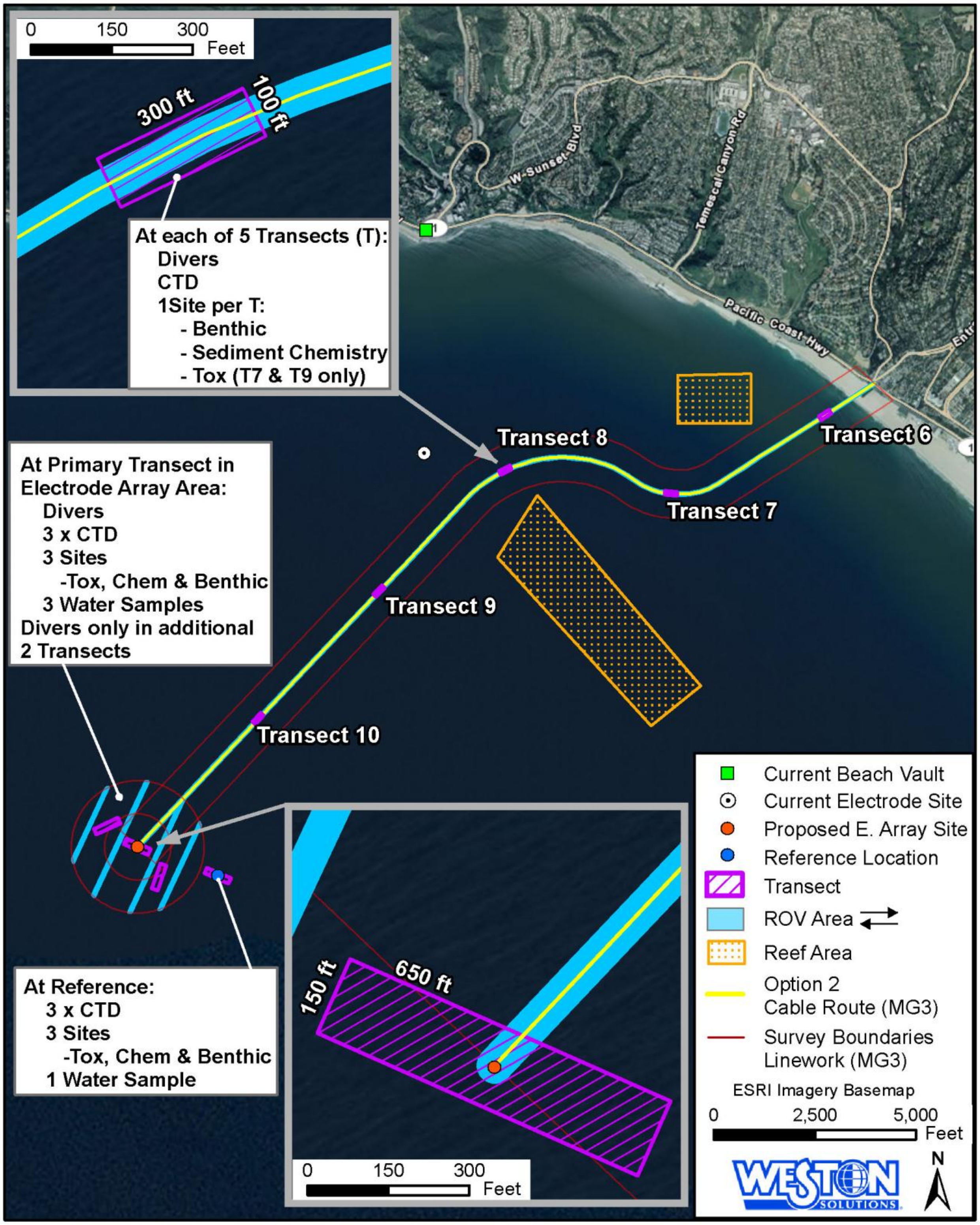


Figure 2-2. Pre-plotted Monitoring Locations along the Option 2 Cable Route

Field coordinates for sampling points within transect areas and analyses that were performed are provided in Table 2-1.

Table 2-1. Sampling Point Locations and Analyses

Area	Sampling point	Latitude	Longitude	Sediment Analyses	Water Analyses
(Option 1) Transect 1	TRANS-1	34.035735	-118.557110	Grain Size, Chemistry, Infauna	Water Quality Parameters (CTD)
(Option 1) Transect 2	TRANS-2	34.028722	-118.561385	Grain Size, Chemistry, Infauna, Toxicity	Water Quality Parameters (CTD)
(Option 1) Transect 3	TRANS-3	34.020903	-118.566032	Grain Size, Chemistry, Infauna	Water Quality Parameters (CTD)
(Option 1) Transect 4	TRANS-4	34.013042	-118.569672	Grain Size, Chemistry, Infauna, Toxicity	Water Quality Parameters (CTD)
(Option 1) Transect 5	TRANS-5	34.005652	-118.574692	Grain Size, Chemistry, Infauna	Water Quality Parameters (CTD)
(Option 2) Transect 6	TRANS-6	34.026108	-118.523128	Grain Size, Chemistry, Infauna	Water Quality Parameters (CTD)
(Option 2) Transect 7	TRANS-7	34.020630	-118.535232	Grain Size, Chemistry, Infauna, Toxicity	Water Quality Parameters (CTD)
(Option 2) Transect 8	TRANS-8	34.022282	-118.549652	Grain Size, Chemistry, Infauna	Water Quality Parameters (CTD)
(Option 2) Transect 9	TRANS-9	34.013905	-118.559173	Grain Size, Chemistry, Infauna, Toxicity	Water Quality Parameters (CTD)
(Option 2) Transect 10	TRANS-10	34.004880	-118.569503	Grain Size, Chemistry, Infauna	Water Quality Parameters (CTD)
Central Electrode Array	EA-1	33.996177	-118.579417	Grain Size, Chemistry, Infauna, Toxicity	Water Quality Parameters (CTD), Chemistry
	EA-2	33.996545	-118.580027	Grain Size, Chemistry, Infauna, Toxicity	Water Quality Parameters (CTD), Chemistry
	EA-3	33.995830	-118.578388	Grain Size, Chemistry, Infauna, Toxicity	Water Quality Parameters (CTD), Chemistry
West Electrode Array	No Samples				
East Electrode Array	No Samples				

Table 2-1. Sampling Point Locations and Analyses

Area	Sampling point	Latitude	Longitude	Sediment Analyses	Water Analyses
Reference	REF-1	33.995153	-118.573397	Grain Size, Chemistry, Infauna, Toxicity	Water Quality Parameters (CTD), Chemistry
	REF-2	33.995342	-118.572468	Grain Size, Chemistry, Infauna, Toxicity	Water Quality Parameters (CTD)
	REF-3	33.994735	-118.572682	Grain Size, Chemistry, Infauna, Toxicity	Water Quality Parameters (CTD)

2.1.1 Sampling Equipment

All water and sediment samples were collected from the *R/V Early Bird II*, a 12.8-m (42-ft) research vessel modified for environmental sampling (Figure 2-3). Sediment samples were collected using a stainless steel double Van Veen grab sampler (Figure 2-4), while water samples were collected using a 10-L Niskin Bottle. Water quality parameters were measured using a Seabird SBE 25 Sealogger (Figure 2-5). All sampling equipment was deployed from the stern of the vessel using the vessel's hydraulic A-frame and deck winch. Adequate water and sediment volumes were collected to allow for all testing described in the Sampling and Analysis Plan (WESTON, 2012), as well as re-testing of the samples, if necessary. All sampling equipment was cleaned prior to sampling. Between stations, sampling equipment and the deck of the vessel were rinsed with site water. Similarly, all stainless steel bowls and spoons used in transferring sediment from the grab sampler to the sample containers were cleaned with soapy water, and rinsed three times with tap water.

Figure 2-3. Sampling Vessel *R/V Early Bird II*

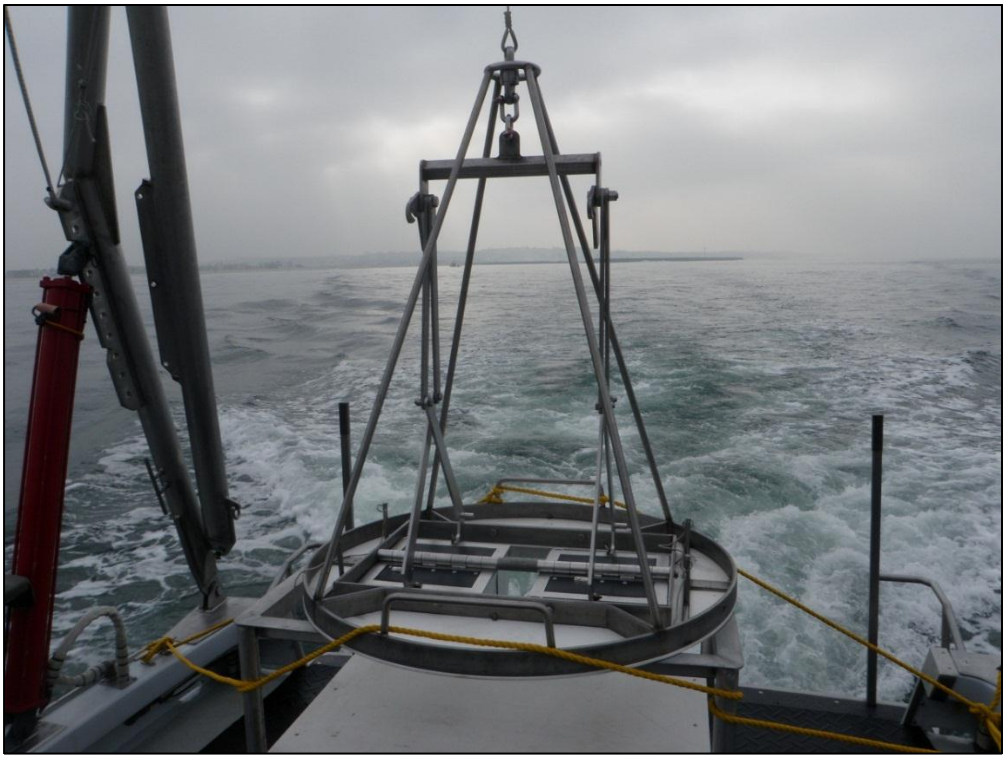


Figure 2-4. Double Van Veen Grab Sampler

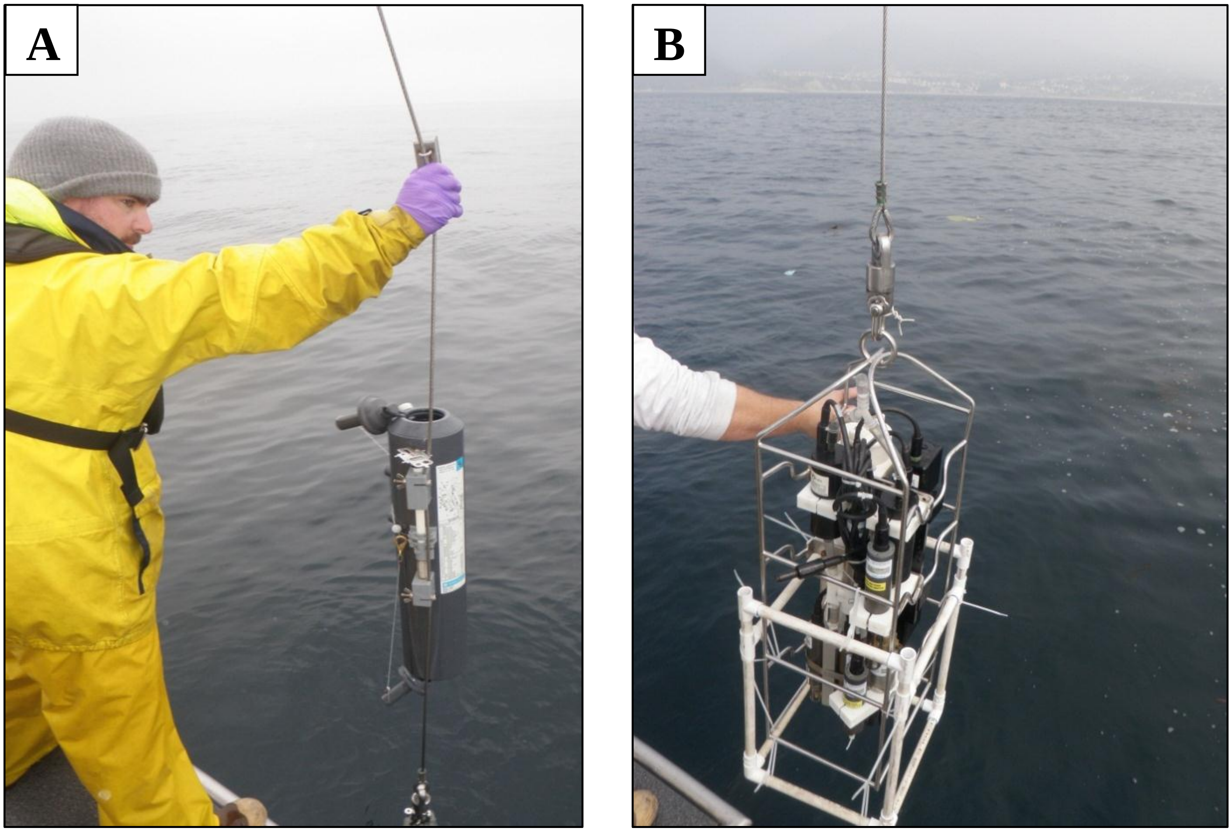


Figure 2-5. Niskin Water Sampler (A) and SeaBird SBE Sealogger (B)

2.1.2 Surveying Equipment

Surveys of the two proposed cable routes and Electrode Array Area were performed using a tethered ROV operated from the deck of the *R/V Early Bird II*. The SeaBotix 300-6 ROV used in the survey is capable of operating at depths down to 304 m (1,000 ft) below the surface and was equipped with six thrusters, external lighting, video and audio recording capabilities, and a subsea navigation component called MicroNav (Figure 2-6). The MicroNav system contains a surface USBL transducer unit with integral magnetic compass and pitch/roll sensors and operating software under control of the onboard laptop computer. The navigation system allowed for computer tracking and omni-directional coverage of the ROV at all times.

A team of SCUBA divers conducted biological surveys of transect areas along the cable routes and in the Electrode Array Area. The *R/V Westerly,* a 14.6-m (48-ft) research vessel equipped for conducting bathymetric and diver surveys (Figure 2-7), was used as the support vessel for all diving operations. Aside from standard dive equipment, the dive team used mixtures of compressed gases, dive computers, dive scooters, meter tapes, video cameras and still cameras to conduct the surveys.

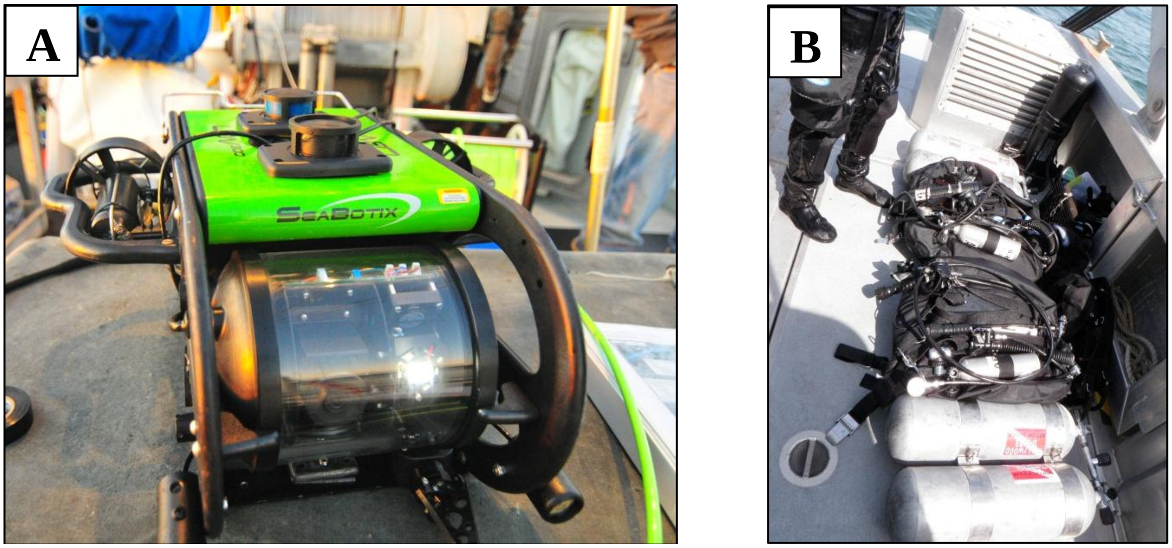


Figure 2-6. SeaBotix ROV (A) and Mixed Gas Dive Tanks, Buoyancy Compensators and Dive Scooters (B)

Figure 2-7. Dive Vessel *R/V Westerly*

2.1.3 Navigation

All sampling locations were pre-plotted (Table 2-1) and were determined using a differential Global Positioning System (dGPS) that is accurate to ± 0.5 m (1.6 ft). For dive surveys, the boat was anchored on one of the corners of the pre-plotted transect areas. For ROV surveys, the boat tracked toward points that had been pre-plotted along the cable routes and within the Electrode Array Area. All final station locations and survey points were recorded in the field using dGPS.

2.2 Sample Collection and Survey Methods

Project-specific methods performed for water and sediment collection, water quality monitoring, and dive and ROV surveys are detailed below. Water and sediment sample collection methods followed the Standard Operating Procedures (SOP) manual (WESTON, 2011) for each constituent. All samples were logged on a Chain of Custody (COC) form as they were collected and were subsequently handled and relinquished under said custody (see section 2.6 below for additional information).

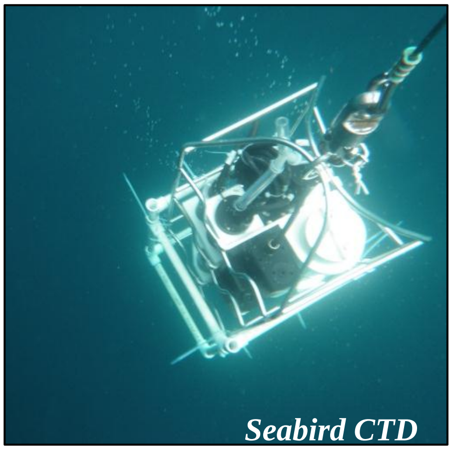
2.2.1 Water Sample Collection and Water Quality Monitoring

Water sampling

Water samples were collected from one Reference Area location and from three sites within the proposed Electrode Array Area using a 10-L acrylic Niskin bottle. The water sampler was slowly lowered to within approximately 2 m (6.6 ft) of the seafloor before being triggered to capture a water sample at depth using a weighted messenger. Care was taken to avoid disturbance of the sediment prior to triggering the sampler. Upon retrieval of the Niskin bottle, the bottle was checked to ensure that the rubber stop-valve had been engaged. Water samples were poured from the Niskin bottle into laboratory-certified, contaminant-free sample bottles and stored on ice in a cooler until delivery to Calscience Environmental Laboratories, Inc. (Calscience). The sample bottles were labeled with the following data: Project Name, Time, Date, Station identification (ID), Water Depth, Preservative, and Analysis to be performed. Water samples were analyzed for trace metals using U.S. Environmental Protection Agency (USEPA) Methods 1640 and 7470 (mercury), total residual chlorine using Standard Method 4500-Cl F, and both volatile and semi-volatile halogenated organic compounds using USEPA Methods 624 and 625. Halogenated organic compounds and chlorine produced oxidants (measured as total residual chlorine) were targeted for analysis based upon literature reviews that revealed the potential for halogenated and chlorinated compounds to form in the vicinity of subsea electrodes during electrode operation. Background levels of metals were targeted for analysis because they are a common sediment contaminant that can be re-suspended by construction activities and have the potential to cause toxicity to marine species.

Water Quality Monitoring

Water quality data were collected using a Seabird SBE 25 Sealogger to measure depth, temperature, hydrogen ion concentration (pH), transmissivity, salinity, density, chlorophyll *a*, and dissolved oxygen (DO) at each of the 16 stations (5 along each of the proposed cable routes, 3 at the proposed Electrode Array Area, and 3 at the Reference Area). These sampling station locations are shown in Figure 2-8 and Figure 2-9 for the Option 1 Cable Route, Electrode Array Area, and Reference Area. Figure 2-10 and Figure 2-11 show the sampling station locations for the Option 2 Cable Route. The Seabird CTD unit scans all sensors at 8 scans per second as the instrument is lowered through the water column. Data collected during each cast were stored in the unit's memory and were also recorded in real time on the deck support computer. The scans were averaged by 0.91-m (3-ft) depth intervals using software provided by Seabird. The unit was lowered at a speed of 0.2–0.4 m/s (0.65-1.3 ft/s) so that each depth interval was sampled several times.


Seabird CTD

At each site the pre-calibrated CTD unit was activated, suspended on a cable, and slowly lowered into the water from the A-frame of the *R/V Early Bird II*. Once in the water, the CTD was lowered approximately 2 m below the surface of the water and allowed to acclimate for 3 minutes. After the 3-minute acclimation period, the unit was brought to the surface and then slowly lowered through the water column at a steady rate of approximately 0.3 m/s (1 ft/s) until it was within approximately one meter of the ocean floor. Upon reaching a depth that was within one meter of the ocean floor, the CTD unit was slowly brought to the surface at the same steady rate of approximately 0.3 m/s. The unit was then brought aboard the sampling vessel and the data were downloaded to determine if the cast was successful. A technician then analyzed and converted the data into 0.91 m (3 ft) depth bins for reporting.

Field observations for CTD casts were recorded on site and entered into a field log for ambient water quality monitoring. This field log included station location information (i.e., site name, station, latitude, and longitude), time and date of sampling, CTD cast number, station depth, tide stage, visual observations (i.e., trash, floatable material, oil and grease, discoloration, or turbidity), odor, current speed, and direction.

Quality Assurance

A pre-cruise equipment checkout and calibration of the CTD was conducted within 24 hours prior to the survey. This checkout included a visual inspection of the equipment, battery status, and computer output tests for CTD sensors. During the survey, routine visual inspections of cast profiles were performed so immediate action could be taken to resample sites with poor data quality. Before beginning a cast, a 3-minute equilibration was performed to bring the CTD sensors to thermal equilibration with the ambient sea water. A post-cruise calibration was performed within 24 hours of the last sampling for the survey.

Prior to deployment of the Niskin bottle water sampler, and between sampling sites, decontamination of the water sampling equipment was performed. The Niskin bottle was scrubbed on the inside with a residue-free biodegradable detergent (e.g., Alconox), rinsed with site water, and rinsed three times with tap water.

To assess the effectiveness of the de-contamination procedure, one field blank sample was collected. For the field blank, approximately 1-L of de-ionized water was poured into the decontaminated 10-L Niskin bottle, circulated throughout, then poured into the appropriate sample jars for constituent analysis in the laboratory. The field blank samples were stored on ice and in a cooler with the other samples until delivery to Calscience.

2.2.2 Sediment Sample Collection

Sediment samples were collected from each of the 16 stations (5 along each of the proposed cable routes, 3 at the proposed Electrode Array Area, and 3 at the Reference Area) using two standard 0.1-m^2 stainless steel Van Veen grab samplers that were coupled together for simultaneous collection of sediment. Sampling station locations are shown in Figure 2-8 and Figure 2-9 for the Option 1 Cable Route, Electrode Array Area, and Reference Area. Figure 2-10 and Figure 2-11 show the sampling station locations for the Option 2 Cable Route. Four sediment grabs per site were collected at sites requiring the following analyses: benthic infauna, chemistry, grain size, and toxicity. Two sediment grabs were collected at sites Trans 1, 3, 5, 6, 8, and 10 since they did not require toxicity testing. A sample grab was determined to be acceptable if the surface of the grab was even, minimal surface disturbance occurred, and the penetration depth was at least 5 centimeters (cm). Rejected grabs were discarded and re-sampled. For a given site, the contents of one sediment grab was used for benthic infaunal analysis, while one and a half grabs were used for chemistry and grain size analysis, and one and a half grabs were used for evaluation of toxicity.

Samples collected for benthic infaunal analysis were rinsed through a 1.0-millimeter (mm) (0.04 in) mesh screen and transferred to a labeled quart jar. A seven percent (%) magnesium sulfate ($MgSO_4$) seawater solution was added for approximately 30 minutes to relax the collected specimens before they were fixed in a 10% buffered formalin solution. Infauna samples were sorted by WESTON and submitted to qualified taxonomists for identification to either species level or to the lowest taxonomic group that could be identified.

Sediment toxicity, chemistry, and grain size samples were collected from the top 5 cm (2 in) of the grab, avoiding sediment within 1 cm (0.4 in) of the sides of the grab. A minimum of 10 L (2.6 gal) of sediment was collected for toxicity and placed into 4 mm (0.16 in) food grade-quality poly open bags. Toxicity samples were kept at 4 °C on ice in coolers until delivery to WESTON. Sediment chemistry samples were placed into laboratory certified clean 8-oz glass jars with Teflon lids, labeled, and placed on ice inside a cooler until delivery to Calscience within 72 hours of collection. Grain size samples, comprised of approximately 150–200 g of sediment, were placed into 1-quart Ziploc™ bags and kept on ice until delivery to WESTON.

Sediment chemistry samples were analyzed for total organic carbon (TOC) using USEPA 9060A protocol, total solids using Standard Method 2540B, trace metals using USEPA 6020, chlorinated pesticides using USEPA 8081A, polychlorinated biphenyl (PCB) congeners using USEPA 8270C with selected ion monitoring (SIM) for PCB congeners, and polycyclic aromatic hydrocarbons (PAHs) using USEPA 8270C SIM for PAHs. The 2008 Southern California Bight Regional Monitoring Program (Bight ’08) used an identical analyte list for identifying sediment contaminant issues throughout Southern California embayments, harbors, and nearshore and offshore ocean environments (Southern California Coastal Water Research Project [SCCWRP], 2008).

2.2.3 Documentation of Chain of Custody

Samples were considered to be in custody if they were: (1) in the custodian’s possession or view, (2) retained in a secured place (under lock) with restricted access, or (3) placed in a secured container. The principal documents used to identify samples and to document possession were COC records, field log books, and field tracking forms. COC procedures were used for all samples throughout the collection, transport, and analytical process, and for all data and data documentation, whether in hard copy or electronic format.

COC procedures were initiated during sample collection. A COC record was provided with each sample or sample group. Each person who had custody of the samples signed the form and ensured that the samples were not left unattended unless properly secured. Minimum documentation of sample handling and custody included the following:

- Sample identification
- Sample collection date and time
- Any special notations on sample characteristics

- Initials of the person collecting the sample
- Date the sample was relinquished to the laboratory
- Shipping company and waybill information

The completed COC form was placed in a sealable plastic envelope that travelled with the listed samples and was signed by the person transferring custody of the samples. The condition of the samples was recorded by the receiver. COC records were included in the final analytical report prepared by the laboratory, and are considered an integral part of that report.

2.2.4 Analysis of Sediment Contaminants and Comparison to ER-L and ER-M Values

Results of chemical analyses of project dredged materials were compared to Effects Range-Low (ER-L) and Effects Range-Median (ER-M) values developed by Long et al. (1995). The effects range values are helpful in assessing the potential significance of elevated sediment-associated contaminants of concern, in conjunction with biological analyses. Briefly, these values were developed from a large data set where results of both benthic organism effects (e.g., toxicity tests and benthic assessments) and chemical concentrations were available for individual samples. To derive these guidelines, the chemical values for paired data demonstrating benthic impairment were sorted in ascending chemical concentration. The 10th percentile of this rank order distribution was identified as the ER-L and the 50th percentile as the ER-M. While these values are useful for identifying elevated sediment-associated contaminants, they should not be used to infer causality because of the inherent variability and uncertainty of the approach. The ER-L and ER-M sediment quality values were used in conjunction with bioassay testing and were included for comparative purposes only.

For certain pesticide compounds (e.g., dieldrin) the ER-L may be below detection levels of standard USEPA-approved analytical procedures; therefore, a non-detect concentration is not considered an ER-L or ER-M exceedance.

Quality Assurance

In addition to the sediment samples collected above, one randomly-selected sediment field duplicate sample was collected throughout the monitoring period in accordance with Surface Water Ambient Monitoring Program (SWAMP) protocols and analyzed for the constituents listed in Sub-section 2.5.2. The results were used to assess the accuracy and precision of the analytical data using the appropriate data quality objectives.

A pre-cruise equipment checkout was performed on the sampling gear to ensure that all surfaces and hinges were free of defects, rust, and missing hardware, and that all connectors, cables, and/or chains were in good condition. The “jaws” of the sampler were inspected to ensure minimal gaps existed when closed. Prior to sampler deployment and between sampling sites, decontamination of the equipment was performed. The sampler was scrubbed on the inside with Alconox and rinsed with site water.

Chemical analyses were performed in a nationally-certified laboratory (Calscience; National Environmental Laboratory Accreditation Program (NELAP) Certificate #03220CA and DoD ELAP Certificate #L10-41). Grain size analyses performed by WESTON were consistent with internal quality control (QC) criteria. Performance was evaluated via the use of standard reference materials or laboratory control samples, method blanks, surrogates, spiked samples, duplicate samples, and internal QC samples. Precision and accuracy objectives were established for method reporting limits (MRLs), spike recoveries, and duplicate analyses.

2.2.5 Benthic Infauna Analysis

Benthic infaunal samples were transported from the field to the laboratory and stored in a formalin solution for a minimum of three days before being transferred from formalin to 70% ethanol for laboratory processing. The organisms were initially sorted into five groups: polychaetes, crustaceans, molluscs, echinoderms, and miscellaneous minor phyla, using a dissecting microscope. While sorting, technicians kept a rough count for quality assurance/quality control (QA/QC) purposes, as described under the *Quality Assurrance* paragraph that follows. After initial sorting, qualified taxonomists identified each organism to the lowest possible taxon, and species counts were tabulated. Taxonomists used the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) Edition 5 for nomenclature and orthography (SCAMIT, 2008).

Standard community measures (i.e., total abundance, number of taxa, and diversity indices [Shannon-Wiener, Evenness, and Dominance]) were calculated for each sample. Additionally, the Benthic Response Index (BRI), developed by SCCWRP (Smith et al., 2001) was calculated. This index establishes numerical criteria (i.e., community response levels) correlated with the pollution tolerance of species on an abundance-weighted average that relates to habitat quality. The BRI measure is scaled such that values less than 25 represent reference conditions and characterize a ”healthy” community and good habitat quality (Table 2-2). Four levels of community response representing increasing degrees of community change are defined: marginal community deviation (BRI 25-34), loss of biodiversity (BRI 34-<44), loss of community function (BRI 44-72), and defaunation or exclusion of most species (BRI >72). Thus, BRI values greater than 25 represent increasing degrees of poorer habitat quality characterized by increasingly less “healthy” infaunal communities. The BRI as developed is applicable for open coastal waters for the Inner, Middle, and Outer Shelf depth zones (i.e., 10-30 m, 30-120 m and 120-200 m, respectively).

Table 2-2. Benthic Response Index Levels, Characterization, Definition, and Thresholds

Level	Characterization	Definition	BRI Threshold
Reference	Reference		< 25
Response Level 1	Marginal deviation	> 90% tolerance interval for reference index values	25-34
Response Level 2	Biodiversity loss	> 25% of reference species lost	34-< 44
Response Level 3	Community function loss	> 90% of echinoderm and 75% arthropod species lost	44-72

Table 2-2. Benthic Response Index Levels, Characterization, Definition, and Thresholds

Level	Characterization	Definition	BRI Threshold
Response Level 4	Defaunation	> 90% of reference species lost	> 72

Quality Assurance

A QA/QC procedure was performed on each of the sorted samples to ensure a 95% sorting efficiency. A 10% aliquot of a sample was then re-sorted by a senior technician trained in the QA/QC procedure, and the number of organisms found in the aliquot were divided by 10% and added to the total number found in the sample. The original total was then divided by the new total to calculate the percent sorting efficiency. If the sorting efficiency of the sample was below 95%, the remainder of the sample (90%) was re-sorted.

2.2.6 Toxicity Testing

A ten-day solid phase bioassay test using the marine amphipod *Eohaustorius estuarius* was conducted in accordance with procedures outlined in the amphipod testing manual (USEPA, 1994) and American Society for Testing and Materials (ASTM) Method E1367-03 (ASTM, 2010) to establish baseline toxicity levels for sediment collected along the proposed cable routes, Electrode Array Area, and Reference Area. Appropriate laboratory control samples were run concurrently with the amphipod test to ensure the test was run within acceptable control measures.

E. estuarius and laboratory control sediment were supplied by Northwestern Aquatic Sciences of Newport, Oregon. Composited sediment from all test areas and laboratory control sediment were placed in five replicate 1-L glass jars to a thickness of 2 cm (150 mL), to which was added approximately 800 mL of 30 ± 2 parts per thousand (ppt) seawater. Additional surrogate replicates (no animals) for each treatment were used to obtain measurements of pore water ammonia at test initiation and termination. The test was run under continuous light at a temperature of 15 ± 2 degrees Celsius (°C) and under gentle aeration. On Day 0, an initial set of water quality parameter measurements were made including temperature, DO, pH, and salinity for each replicate. Ammonia was measured in the overlying water of a composite of replicates from each test area and the control. In addition, a surrogate replicate from each test treatment was broken down, and sediment pore water was extracted via centrifugation for subsequent analysis of ammonia. At test initiation, 20 organisms were randomly distributed to each test chamber. Animals remaining in the water column and exhibiting abnormal behavior were replaced after 1 hour. The chambers were covered with petri dishes to minimize evaporation. Daily water quality measurements including DO, temperature, salinity, and pH were taken for one replicate for each treatment and daily observations of obvious mortality, sublethal effects, and abnormal behavior were recorded. At test termination on Day 10, the sediments from the chambers were sieved through a 0.5-mm (0.02 in) screen and the number of survivors was recorded. Test results were compared to test acceptability criterion (i.e., 90 % mean survival in controls at test termination).

The experimental design, bioassay procedures, and water quality measurements for the solid phase test on project sediments using *E. estuarius* are shown in Table 2-3.

Table 2-3. Experimental Design, Bioassay Procedure and Water Quality Measurements for the 10-day Solid Phase Bioassay using *Eohaustorius estuarius*

Toxicity Test Experimental Design 10-Day Solid Phase Bioassay		
Sample Identification		Trans-2, Trans-4, Trans-7, Trans-9, EA-1, EA-2, EA-3, Ref-1, Ref-2, Ref-3
Test Species		***Eohaustorius estuarius***
Acclimation/holding time		2–10 days including holding time required to adjust to test temperature and salinity (adjust by changing <3°C per day, and <5 ppt per day); water quality of DO, pH, salinity, temperature daily while holding; if problem, change water or perform corrective action.
Age/Size class		Mature, 3–5 mm
Test Procedures		**USEPA 1994; ASTM E1367-03 (2010)**
Test Type/Duration		Static - Acute SP/10 days
Sample Storage Conditions		4°C, dark, minimal head space
Control Water Source		Scripps Pier seawater, 3 µm filtered, UV sterilized
Recommended Water Quality Parameters	Temperature	15 ± 2°C
	Salinity	30 ± 2 ppt
	Dissolved Oxygen	≥ 60% saturation; ≥ 6.0 mg/L
	pH	Monitor drift
	Overlying Total Ammonia	No recommended concentration
	Overlying Un-ionized Ammonia	No recommended concentration
	Interstitial Total Ammonia	< 60 mg/L
	Interstitial Un-ionized Ammonia	< 0.8 mg/L
Photoperiod		Continuous light
Test Chamber		1 L glass jars
Replicates/Sample		5
No. of Organisms/Replicate		20
Exposure Volume		2 cm sediment, 800 mL water
Feeding		None
Water Renewal		None
Test Acceptability Criteria		Control survival $\geq$ 90%

Quality Assurance

A 96-hour reference toxicity test was conducted concurrently with the sediment test to establish sensitivity of the test organisms used in the evaluation of the sediments and to evaluate the potential influence of ammonia toxicity on the test organisms. The reference toxicant test was performed using the reference substance ammonium chloride with measured total ammonia concentrations of 0, 12.5, 25.5, 49.3, 102.0, and 206.0 mg NH_3/L. Un-ionized concentrations of 0, 0.366, 0.592, 0.920, 1.191, and 1.531 mg NH_3/L were calculated. Ten test organisms were added to each of four replicates for each concentration. Subsamples were collected at test initiation and were used to measure actual ammonia concentrations and to calculate un-ionized ammonia concentrations. The concentrations of total ammonia and un-ionized ammonia that caused 50% mortality of the organisms (the median lethal concentration, or LC_{50}) were calculated from the data. The LC_{50} values were then compared to historical laboratory data for the test species with ammonium chloride and the results of this test were used in combination with the control mortality to assess the health of the test organisms.

WESTON's QC staff performs periodic audits to ensure that test conditions, data collection, and test procedures are conducted in accordance with WESTON's SOPs. WESTON's SOPs have been audited and approved by an independent USEPA-approved laboratory and placed in the QA file as well as laboratory files.

2.3 Quality Assurance/Quality Control

The QA objectives for chemical analysis conducted by the participating analytical laboratories are detailed in their Laboratory QA Manual(s). These objectives for accuracy and precision involve all aspects of the testing process, including the following:

- Methods and SOPs
- Calibration methods and frequency
- Data analysis, validation, and reporting
- Internal quality control
- Laboratory controls, matrix replicates, matrix spikes, and method blanks
- Analysis of field duplicates and equipment blanks
- Preventive maintenance
- Procedures to ensure data accuracy and completeness

Results of all laboratory QC analyses were reported with the final data. Any QC samples that failed to meet the specified QC criteria in the methodology were identified, and the corresponding data were appropriately qualified in the final report.

All QA/QC records for the various testing programs were kept on file for review by regulatory agency personnel, if required.

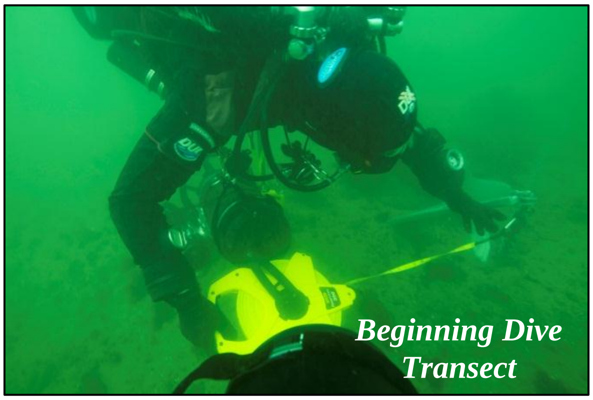
2.4 ROV Survey


Piloting ROV

A SeaBotix 300-6 ROV was used along each of the proposed cable routes and at the proposed location of the electrode array to document the seafloor habitat and biota in these areas and to supplement diver surveys. The ROV was tethered to the *R/V Early Bird II* by a 91-m (300-ft) fiber optic cable that attached to on-board computers and monitors for live imagery. To prevent the ROV tether from wrapping around the boat's propellers, the majority of the tether was secured to a cable that was anchored in place with a clump weight and lowered off the stern from the boat's A-frame. Approximately 9.1-m (30 ft) of free tether allowed the ROV to move in any direction out from the clump weight. During the survey, the clump weight was adjusted manually to remain approximately 2 m (6.5 ft) above the ocean floor. A steady course was maintained throughout the ROV survey by towing the ROV behind the boat at a speed ranging between 0.5 and 1.5 knots. This was done to minimize the effects of surface winds and currents pushing the boat in one direction while the ROV was pushed in a different direction by bottom currents. A transducer mounted on the side of the vessel communicated with the MicroNav subsea navigation system on the ROV, allowing for navigational tracking of both the ROV and the boat at all times during the survey.

The ROV survey consisted of two passes along the 5-km (3.1 mi) Option 1 and 7-km (4.3 mi) Option 2 cable routes and four passes through the 1-km (0.62 mi) diameter Electrode Array Area to ensure sufficient coverage of the seafloor habitat and to maximize the chance of observing resident organisms. The ROV survey paths are shown in Figure 2-8 and Figure 2-9 for the Option 1 Cable Route (2 passes) and Electrode Array Area (4 passes). Figure 2-10 and Figure 2-11 show the ROV paths (2 passes) for the Option 2 Cable Route. During the survey, a video recording was made of the illuminated seafloor as the ROV moved along the proposed cable routes and over the proposed location of the electrode array. Both the video recording of the seafloor and a computerized map of the navigational route taken by the ROV are provided on a hard drive for future reference by LADWP.

2.5 Dive Surveys


Beginning Dive Transect

An underwater biological resource and habitat survey was conducted by two marine biologists using SCUBA. The divers were knowledgeable of local marine flora and fauna and were proficient at conducting technical dives at depths greater than 39.6 m (130 ft). Diving was performed from the *R/V Westerly*, a 14.6-m (48-ft) support vessel, that anchored near the divers as they swam a systematic pattern of transects throughout the designated survey areas. In total, 10 transect areas (each measuring 91.4 m x 30.5 m (300 ft x 100 ft)) were surveyed by divers along the two optional cable routes. Additionally, three areas measuring 198 m x 45.7 m (650 ft x 150 ft) were surveyed within the proposed Electrode Array Area. The dive survey transects are shown in Figure 2-8 and Figure 2-9 for the Option 1 Cable Route and the Electrode Array Area. Figure 2-10 and Figure 2-11 show the dive survey transects for the Option 2 Cable Route. Motorized aqua scooters were used by the divers to facilitate greater coverage of the survey areas over a given time period. The dive vessel was equipped with a dGPS unit that was used to accurately mark the location of the survey boundaries. In areas where it was safe to do so, the boat anchored on one corner of the pre-plotted transect area and divers descended along the anchor line and took a compass heading to lay down a meter tape along one side of the rectangular area boundary. The divers then swam four parallel transects that were spaced approximately 7.6 m (25 ft) apart, perpendicular to the baseline meter tape, to visually survey the majority of the transect area. While conducting the survey, divers remained within sight of one another and within site of the bottom substrate at all times while swimming parallel transects across the transect area.

Divers were equipped with low-light cameras capable of taking both still photos and video footage of the survey area. Limited visibility necessitated the use of artificial lighting in some areas, particularly at depths below 30.5 m (100 ft). Visibility along the bottom dictated the maximum spacing of the divers and ultimately determined the percent coverage of a given transect area. While conducting the surveys, divers took notes of the physical and biological conditions within the survey area including substrate type (soft bottom or rocky reef), dominant flora and fauna, and observed species, and recorded information onto data sheets. Where reefs were encountered during the ROV surveys, the nearest diver transect areas were relocated from their pre-plotted position to areas with rocky reef so that biological communities associated with hard substrate along the cable route could be assessed. The observed reef areas are shown in Figure 2-8 and Figure 2-10.

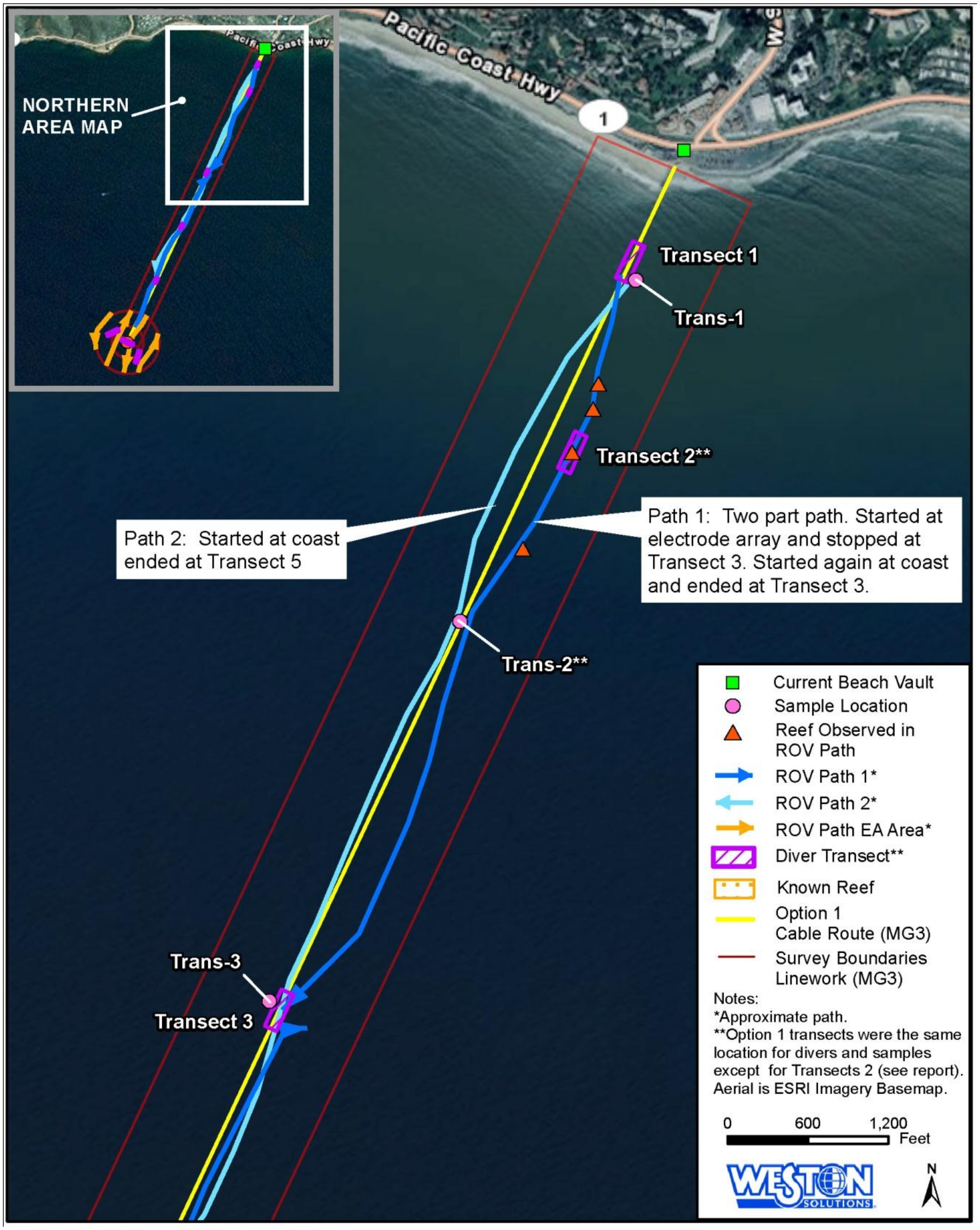


Figure 2-8. Northern Portion of Option 1 Cable Route Showing Water and Sediment Sample Locations, Diver Survey Transects, and ROV Paths (Two Passes), and Reef Areas Observed During ROV Survey

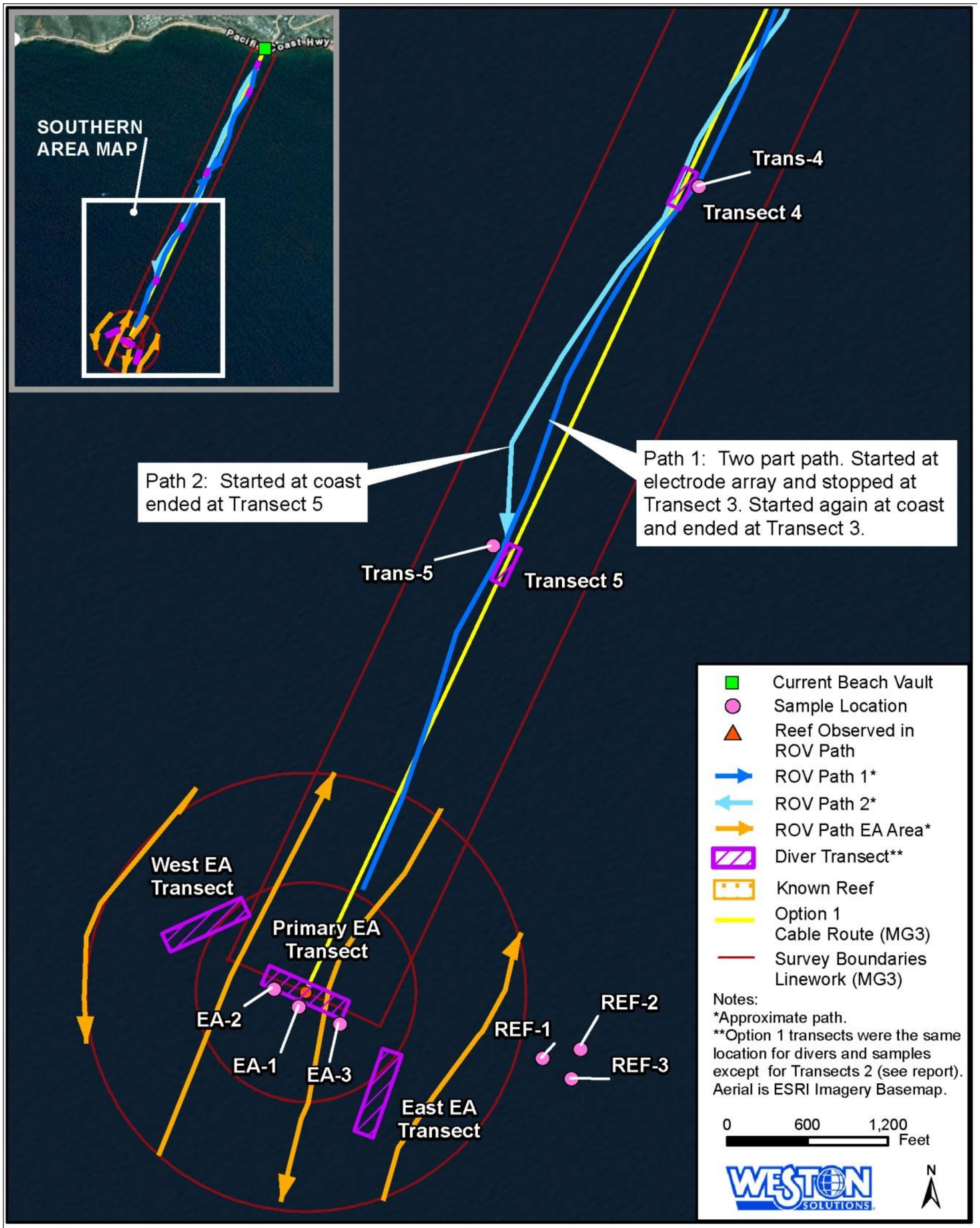
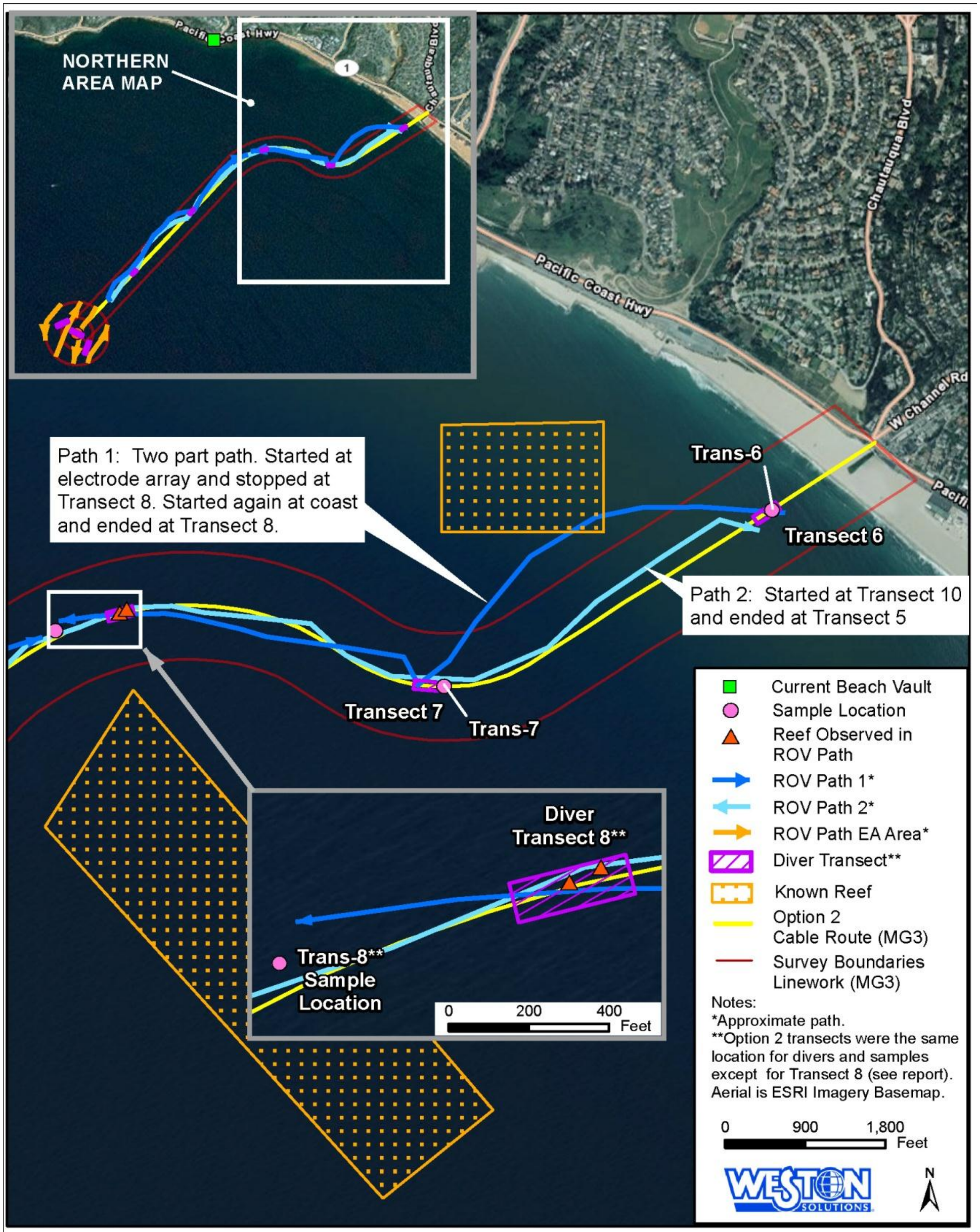


Figure 2-9. Southern Portion of Option 1 Cable Route and Electrode Array (EA) Area Showing Water and Sediment Sample Locations, Diver Survey Transects, ROV Paths (2 Passes in Cable Route and 4 Passes in EA Area), and Reefs Observed in ROV Survey



Path 1: Two part path. Started at electrode array and stopped at Transect 8. Started again at coast and ended at Transect 8.

Path 2: Started at Transect 10 and ended at Transect 5

Notes:
*Approximate path.
**Option 2 transects were the same location for divers and samples except for Transect 8 (see report).
Aerial is ESRI Imagery Basemap.

Figure 2-10. Northern Portion of Option 2 Cable Route Showing Water and Sediment Sample Locations, Diver Survey Transects, and ROV Paths (Two Passes), and Reefs Observed During ROV Survey

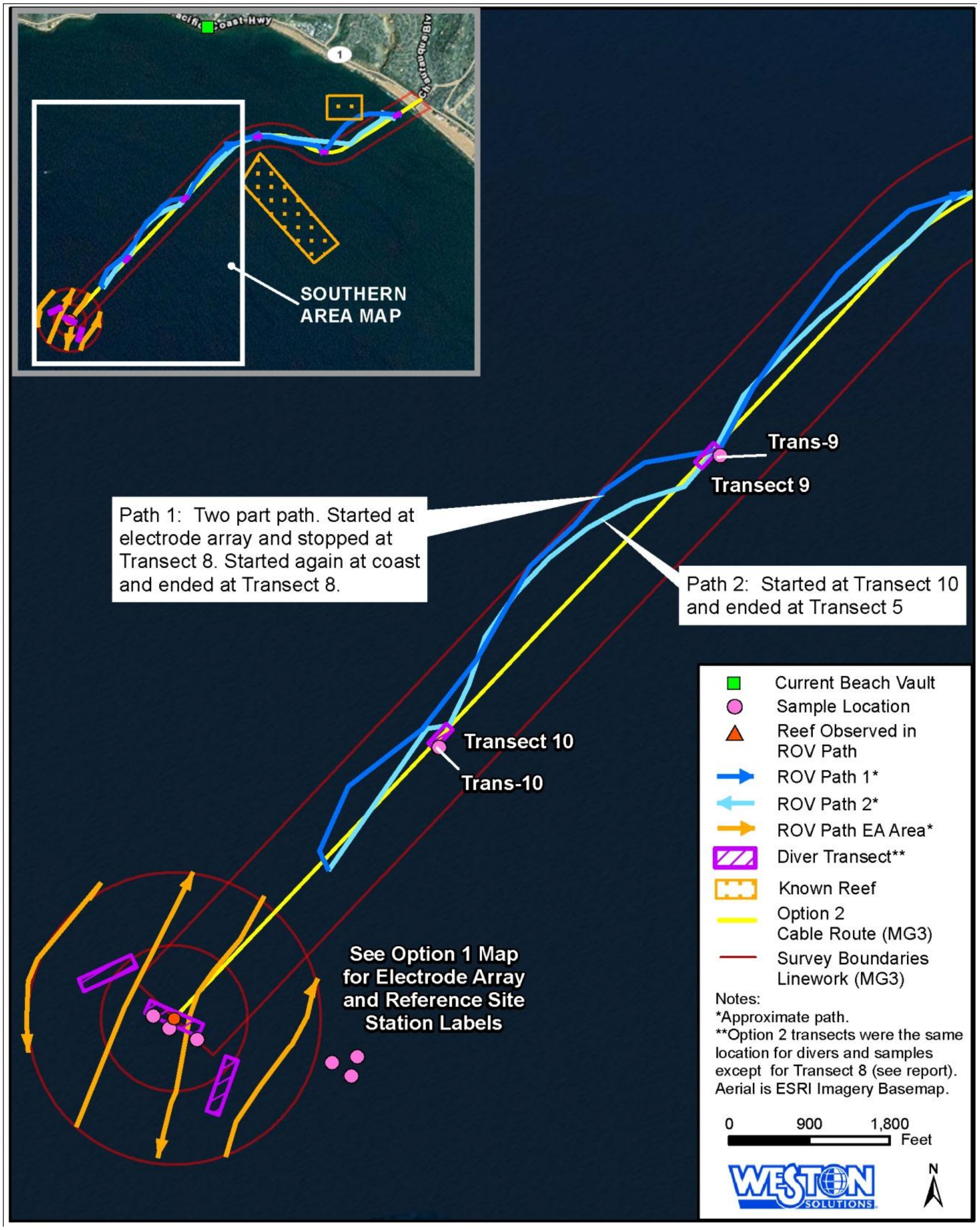


Figure 2-11. Southern Portion of Option 2 Cable Route and Electrode Array (EA) Area Showing Water and Sediment Sample Locations, Diver Survey Transects, and ROV Paths (2 Passes in Cable Route and 4 Passes in Electrode Array Area)

2.6 Data Review, Management and Analysis

2.6.1 Data Review

All data were reviewed and verified by participating team laboratories to determine if data quality objectives had been met and if appropriate corrective actions had been taken, when necessary. Data quality objectives followed the USEPA guidance documents for data review (USEPA, 2002, 2004, 2008). WESTON's QA Officer was responsible for the final review of all data generated.

2.6.2 Data Management

All laboratories supplied analytical results in both hard copy and electronic formats. Laboratories had the responsibility of ensuring that both forms were accurate. After completion of the data review by participating team laboratories, hard copy results were placed in the project file at WESTON and the results in electronic format were imported into WESTON's database system.

2.6.3 Quality Assurance/Quality Control and Laboratory Data Report

Analytical laboratories provided a QA/QC narrative describing the results of the standard QA/QC protocols that accompanied the analysis of field samples. All hard copies of results will be maintained in the project file at WESTON in Carlsbad and are included in the final report. In addition, back-up copies of results generated by each laboratory will be maintained at their respective facilities. At a minimum, the laboratory reports contain results of the laboratory analysis, QA/QC results, all protocols and any deviations from the project SAP, and a case narrative of COC details.

3.0 RESULTS

3.1 Sample Collection and Water Quality Monitoring

Water sampling, sediment sampling, and water quality monitoring was conducted March 29-30, 2012. During sampling, seas were relatively calm with 0.9-1.2 m (3-4 ft) swells out of the southwest and winds were generally light (0-10 mph) coming out of the west southwest. Water depth varied among the stations and was correlated with increased distance from shore. Station ID, field coordinates, date and time of sample collection and water depth are summarized in Table 3-1 for both sampling and water quality monitoring.

Table 3-1. Water Sample and Water Quality Monitoring Station Information

Location	Station ID	Type of Analysis	Date	Time	Latitude	Longitude	Water Depth (m)
Primary Cable Route (Option 1)	Trans-1	Sediment Chemistry, Water Quality	3/30/12	09:30	34°02.1441	118°33.4266	7.1
	Trans-2	Sediment Chemistry, Water Quality	3/30/12	10:00	34°01.7233	118°33.6831	12.2
	Trans-3	Sediment Chemistry, Water Quality	3/30/12	10:45	34°01.2542	118°33.9619	19.0
	Trans-4	Sediment Chemistry, Water Quality	3/30/12	11:15	34°00.7825	118°34.1803	28.0
	Trans-5	Sediment Chemistry, Water Quality	3/31/12	08:55	34°00.3391	118°34.4815	38.1
Secondary Cable Route (Option 2)	Trans-6	Sediment Chemistry, Water Quality	3/30/12	12:55	34°01.5665	118°31.3877	5.8
	Trans-7	Sediment Chemistry, Water Quality	3/30/12	13:25	34°01.2378	118°32.1139	11.8
	Trans-8	Sediment Chemistry, Water Quality	3/30/12	14:00	34°01.3369	118°32.9791	13.5
	Trans-9	Sediment Chemistry, Water Quality	3/30/12	14:45	34°00.8343	118°33.5504	23.5
	Trans-10	Sediment Chemistry, Water Quality	3/30/12	15:30	34°00.2928	118°34.1702	37.4
Electrode Array Area	EA-1	Water and Sediment Chemistry, Water Quality	3/31/12	10:00	33°59.7706	118°34.7650	48.2

Table 3-1. Water Sample and Water Quality Monitoring Station Information

Location	Station ID	Type of Analysis	Date	Time	Latitude	Longitude	Water Depth (m)
	EA-2	Water and Sediment Chemistry, Water Quality	3/31/12	11:25	33°59.7927	118°34.8016	48.5
	EA-3	Water and Sediment Chemistry, Water Quality	3/31/12	12:30	33°59.7498	118°34.7033	48.3
Reference Area	Ref-1	Water and Sediment Chemistry, Water Quality	3/31/12	13:55	33°59.7092	118°34.4038	47.6
	Ref-2	Sediment Chemistry, Water Quality	3/31/12	14:45	33°59.7205	118°34.3481	47.2
	Ref-3	Sediment Chemistry, Water Quality	3/31/12	15:20	33°59.6841	118°34.3609	48.0

3.2 Results of Chemical Analyses of Water Samples

Summary results of chemical analyses of water samples collected from the Electrode Array Area and the Reference Area are presented in Table 3-2. Target detection limits are provided in the SAP (WESTON, 2012). California Ocean Plan (COP) Daily Maximum and Instantaneous Maximum water quality objectives for the protection of marine aquatic life are provided in Table 3-2 for comparison to sample results. Only those compounds which have COP Daily Maximum and Instantaneous Maximum values are shown in Table 3-2. Detection limits and raw data for water sample analyses are provided in Appendix C.

Results of water chemistry analyses at stations EA-1, EA-2, EA-3 and REF-1 determined that there were no detectable concentrations of residual chlorine or halogenated organic compounds (volatile and semi-volatile) in any of the samples. Concentrations of trace metals were detected across all samples; however, all trace metal concentrations were substantially below the most conservative water quality objectives for the protection of marine life listed in the COP.

Table 3-2. Summary of Chemistry Analytical Results for Water Samples Collected from Electrode Array and Reference Areas

Analyte	Units	Methods	*COP Daily Max.	**COP Instant. Max.	EA-1	EA-2	EA-3	REF-1
Trace Metals								
Arsenic	µg/L	USEPA 1640	32	80	1.78	1.7	1.61	1.59
Cadmium	µg/L	USEPA 1640	4	10	0.102	0.111	0.111	0.109
Chromium	µg/L	USEPA 1640	8	20	0.194J	0.159J	0.157J	0.183J
Copper	µg/L	USEPA 1640	12	30	0.327	0.245	0.249	0.22
Lead	µg/L	USEPA 1640	8	20	0.115	0.0896	0.0817	0.104
Mercury	µg/L	USEPA 7470A	16	4	<0.0321	<0.0321	<0.0321	<0.0321
Nickel	µg/L	USEPA 1640	20	50	1.41	1.51	1.73	1.74
Selenium	µg/L	USEPA 1640	60	150	0.0489J	0.0621	0.0479J	0.0453J
Silver	µg/L	USEPA 1640	28	7	0.139	0.143	0.137	0.141
Zinc	µg/L	USEPA 1640	80	200	1.73	1.49	1.87	1.03
Chlorine								
Chlorine, Total Residual	mg/L	SM 4500-Cl F	8	60	<0.042	<0.042	<0.042	<0.042
Halogenated Organic Compounds (volatile and semi-volatile)								
2,4,6-Trichlorophenol	µg/L	USEPA 625	4	10	<2.5	<2.5	<2.5	<2.5
2,4-Dichlorophenol	µg/L	USEPA 625	4	10	<2.5	<2.5	<2.5	<2.5
2-Chlorophenol	µg/L	USEPA 625	4	10	<2.3	<2.3	<2.3	<2.3
4-Chloro-3-Methylphenol	µg/L	USEPA 625	4	10	<2.4	<2.4	<2.4	<2.4
All other halogenated organic compounds were below detection limits								

*California Ocean Plan Daily Maximum concentration

**California Ocean Plan Instantaneous Maximum concentration

J - Results above the method detection limit but below the reporting limit. Result is estimated.

< - Result below method detection limit.

3.3 Results of Water Quality Measurements

A summary of the results of water quality parameters measured by the SeaBird SBE datalogger at the surface, along the bottom, and the range throughout the entire water column for each station are provided in Table 3-3. Measurements included temperature, salinity, pH, DO, chlorophyll *a*, conductivity, density, and transmissivity. A complete record of these data, summarized in 0.91-m (3-ft) data bins, is provided in Appendix B. Profiles of temperature, DO, and pH at a deep water station (EA-1) and a shallow water station (Trans-2) are shown in Figure 3-1 and Figure 3-2 for comparison. Profiles of temperature, DO, and pH for all stations are provided in Appendix B.

Temperature

Water temperatures were consistent across all stations, varying gradually with depth. Surface temperatures ranged from approximately 13°C to 15°C and decreased steadily throughout the water column as depth increased. There were no notable thermoclines observed at shallow or deep water stations. Temperatures were approximately 12°C at 12.2 m (40 ft) in depth and were approximately 10°C at 48.8 m (160 ft) in depth.

Salinity

Salinity varied little with depth and was nearly uniform across all stations. In general, salinity was slightly higher in deeper waters, but varied by less than 1 ppt throughout the water column at any of the monitored stations. Salinity values ranged from 33.3 to 34.0 ppt across all stations and depths; no significant differences in salinity were observed between the two cable routes.

pH

Values of pH varied slightly throughout the water column. pH ranged from 8.0 to 8.1 pH units at the surface and decreased slightly below depths of 15.2 m (50 ft) or more. Throughout the entire water column pH ranged from 7.6 pH units at 46.9 m (154 ft) in depth to 8.1 pH units at the surface. Along the two cable routes, there were no substantial differences in pH between stations that were similar in depth.

Dissolved Oxygen

DO levels varied significantly with depth across all stations. DO values were generally between 6.5 mg/L and 8.0 mg/L in the upper surface waters, and peaked at approximately 8.5 to 9.0 mg/L between 3 and 9.1 m (10 and 30 ft) of depth. Below approximately 9.1 m (30 ft) in depth, DO values began to gradually decline at most stations as depth increased (Figure 3-1 and Figure 3-2). Across all stations, DO ranged from 3.4 mg/L at 46.9 m (154 ft) of depth to 9.4 mg/L at 4.6 m (15 ft) of depth. In general, the two cable routes had similar DO levels for stations similar in depth.

Transmissivity

Transmissivity of light tended to remain relatively constant throughout the water column for most stations. Stations further offshore had greater transmissivity values than stations located closer to shore. For example, Transect-1, located just offshore, had an average transmissivity value of 78.9% while Transect-2 and Transect-3, located further offshore, had average transmissivity values of 87.7% and 92%. Low light penetration can be attributed to increased turbidity in nearshore waters as a result of wave action. Transmissivity differences between the two cable routes were minimal. Most notably, Transect-6 had substantially lower transmissivity at the surface and along the bottom than Transect-1; however, the range in transmissivity values throughout the water column at Transect-6 encompassed the range in values at Transect-1.

Chlorophyll *a*

Chlorophyll *a* concentrations ranged from 0.9 mg/m^3 to 4.8 mg/m^3 across all stations. With the exception of Station Trans-6, chlorophyll *a* concentrations varied by less than 1.5 mg/m^3 throughout the water column of any station. The close proximity of a freshwater input (small stream) to Station Trans-6 may explain the higher chlorophyll *a* concentrations (range of 3.1 to 4.8 mg/m^3) observed there. Trans-6 also had the lowest transmissivity of any station (average of 61.8%), likely partially due to the increased phytoplankton in the water column. Differences in chlorophyll a concentrations among the two cable routes were relegated to the stations closest to shore (Transects 1 and 6).

Resistivity

Resistivity was measured by converting conductivity measurements in Seimens/cm units to resistivity in ohms/cm. Resistivity was correlated with increasing depth across all stations, and ranged from 24.35 to 25.24 ohms/cm in surface waters to 26.81 to 26.85 ohms/cm at 46.9 m (154 ft) in depth.

Table 3-3. Summary of Water Quality Parameters Measured at the Surface, Bottom, and throughout the Water Column at Each Station

Station	Range of Values	Depth (ft)	Temp (C)	Conductivity (mS/cm)	Resistivity (ohms/cm)	Salinity (ppt)	DO (mg/l)	pH	Trans-missivity	Chlorophyll *a* (mg/m^3)	Density (kg/m^3)
(Option 1) Trans-1	Surface	0	13.4	39.8	25.14	33.5	8.7	8.0	75.9	1.9	1025.2
	Bottom	18	12.9	39.4	25.40	33.6	8.9	8.0	77.0	2.1	1025.3
	Range	0-18	12.9-13.4	39.4-39.8	25.14-25.40	33.5-33.6	8.7-9.4	8.0-8.1	75.9-82.4	1.9-2.1	1025.2-1025.3
(Option 1) Trans-2	Surface	0	13.6	40.0	25.00	33.5	6.7	8.1	81.7	2.0	1025.1
	Bottom	36	12.4	38.9	25.71	33.6	7.1	8.0	87.6	1.9	1025.5
	Range	0-36	12.4-13.6	38.9-40.0	25.00-25.71	33.5-33.6	6.7-9.0	8.0-8.1	81.0-92.7	1.5-2.0	1025.1-1025.5
(Option 1) Trans-3	Surface	0	13.7	40.1	24.96	33.5	7.2	8.1	86.6	1.6	1025.1
	Bottom	57	12.2	38.8	25.79	33.6	7.7	7.9	86.7	1.8	1025.5
	Range	0-57	12.2-13.7	38.8-40.1	24.95-25.79	33.5-33.7	7.2-8.9	7.9-8.1	86.6-96.0	1.2-1.8	1025.1-1025.6
(Option 1) Trans-4	Surface	0	13.8	40.1	24.93	33.5	7.0	8.0	95.2	1.2	1025.1
	Bottom	84	12.1	38.7	25.87	33.6	6.8	7.9	84.7	2.0	1025.6
	Range	0-84	12.1-13.8	38.7-40.1	24.93-25.87	33.5-33.6	6.8-8.4	7.9-8.0	84.7-96.1	1.1-2.0	1025.1-1025.6
(Option 1) Trans-5	Surface	0	13.4	39.8	25.15	33.5	6.5	8.0	95.2	1.6	1025.1
	Bottom	120	10.7	37.5	26.68	33.7	3.7	7.6	85.7	2.5	1026.0
	Range	0-120	10.7-13.4	37.5-39.8	25.11-26.68	33.5-33.8	3.7-8.4	7.6-8.0	85.7-95.6	1.3-2.5	1025.1-1026.0

Table 3-3. Summary of Water Quality Parameters Measured at the Surface, Bottom, and throughout the Water Column at Each Station

Station	Range of Values	Depth (ft)	Temp (C)	Conductivity (mS/cm)	Resistivity (ohms/cm)	Salinity (ppt)	DO (mg/l)	pH	Trans-missivity	Chlorophyll *a* (mg/m^3)	Density (kg/m^3)
(Option 2) Trans-6	Surface	0	14.8	41.1	24.35	33.5	6.8	8.0	57.0	4.8	1024.8
	Bottom	15	14.1	41.0	24.42	34.0	7.8	8.0	61.3	3.1	1025.5
	Range	0-15	12.1-14.8	38.7-41.1	24.35-24.42	33.5-34.0	6.8-8.4	7.9-8.0	57.0-96.1	3.1-4.8	1024.8-1025.6
(Option 2) Trans-7	Surface	0	14.2	40.5	24.66	33.5	7.4	8.0	85.6	1.6	1025.0
	Bottom	36	12.6	39.1	25.56	33.6	7.8	8.0	83.3	2.4	1025.4
	Range	0-36	12.6-14.2	39.1-40.5	24.66-25.56	33.5-33.7	7.2-9.4	8.0	83.3-88.1	1.4-2.4	1025.0-1025.5
(Option 2) Trans-8	Surface	0	14.2	40.5	24.72	33.4	7.4	8.0	86.0	1.4	1024.9
	Bottom	39	12.8	39.3	25.44	33.6	8.9	8.0	89.2	1.7	1025.4
	Range	0-39	12.8-14.2	39.3-40.5	24.69-25.44	33.4-33.7	7.4-9.1	8.0	85.9-91.9	1.4-1.7	1024.9-1025.4
(Option 2) Trans-9	Surface	0	13.7	40.0	24.98	33.5	5.9	8.0	95.3	1.3	1025.0
	Bottom	72	12.5	39.0	25.61	33.6	8.4	8.0	84.3	1.9	1025.5
	Range	0-72	12.5-13.8	39.0-40.1	24.95-25.61	33.5-33.7	5.9-8.8	8.0	84.3-95.4	1.2-1.9	1025.0-1025.5
(Option 2) Trans-10	Surface	0	13.4	39.5	25.34	33.3	6.4	8.0	95.7	2.7	1025.0
	Bottom	117	10.9	37.7	26.52	33.7	4.5	7.6	85.7	2.4	1025.9
	Range	0-117	10.9-13.4	37.7-39.6	25.23-26.54	33.3-33.7	4.5-8.2	7.6-8.0	85.7-95.9	1.6-2.9	1025.0-1026.0

Table 3-3. Summary of Water Quality Parameters Measured at the Surface, Bottom, and throughout the Water Column at Each Station

Station	Range of Values	Depth (ft)	Temp (C)	Conductivity (mS/cm)	Resistivity (ohms/cm)	Salinity (ppt)	DO (mg/l)	pH	Trans-missivity	Chlorophyll *a* (mg/m^3)	Density (kg/m^3)
EA-1	Surface	0	13.2	39.6	25.24	33.5	6.4	8.0	93.3	1.5	1025.2
	Bottom	154	10.4	37.3	26.81	33.8	3.5	7.6	89.6	2.4	1026.2
	Range	0-154	10.4-13.2	37.3-39.6	25.24-26.81	33.5-33.8	3.5-8.4	7.6-8.0	89.0-96.5	1.2-2.4	1025.2-1026.2
EA-2	Surface	0	13.4	39.8	25.14	33.5	8.1	8.0	93.7	1.1	1025.2
	Bottom	154	10.4	37.3	26.82	33.8	3.4	7.6	89.7	2.2	1026.2
	Range	0-154	10.4-13.4	37.3-39.8	25.14-26.83	33.5-33.8	3.4-8.6	7.6-8.0	89.7-96.5	1.1-2.4	1025.2-1026.2
EA-3	Surface	0	13.4	39.8	25.13	33.5	6.9	8.0	93.5	1.2	1025.2
	Bottom	154	10.3	37.3	26.84	33.8	3.4	7.6	89.0	2.4	1026.2
	Range	0-154	10.3-13.4	37.3-39.8	25.13-26.84	33.5-33.8	3.4-8.5	7.6-8.0	89.0-96.5	1.1-2.4	1025.2-1026.2
REF-1	Surface	0	13.7	40.0	24.99	33.5	8.2	8.0	93.9	1.0	1025.1
	Bottom	151	10.3	37.2	26.85	33.8	3.4	7.6	90.3	2.4	1026.2
	Range	0-151	10.3-13.7	37.2-40.0	24.99-26.85	33.5-33.8	3.4-8.7	7.6-8.0	90.3-96.1	1.0-2.4	1025.1-1026.2
REF-2	Surface	0	14.0	40.4	24.77	33.5	8.3	7.9	94.6	1.0	1025.0
	Bottom	151	10.3	37.3	26.84	33.8	3.4	7.6	90.0	2.3	1026.2
	Range	0-151	10.3-14.0	37.3-40.4	24.77-26.84	33.5-33.8	3.4-8.7	7.6-8.0	87.4-96.1	1.0-2.3	1025.0-1026.2
REF-3	Surface	0	14.8	41.0	24.38	33.5	8.1	8.0	94.5	1.0	1024.9
	Bottom	154	10.3	37.3	26.84	33.8	3.4	7.6	89.9	2.2	1026.2
	Range	0-154	10.3-14.8	37.3-41.0	24.38-26.85	33.5-33.8	3.4-8.7	7.6-8.0	89.9-96.0	0.9-2.5	1024.9-1026.2

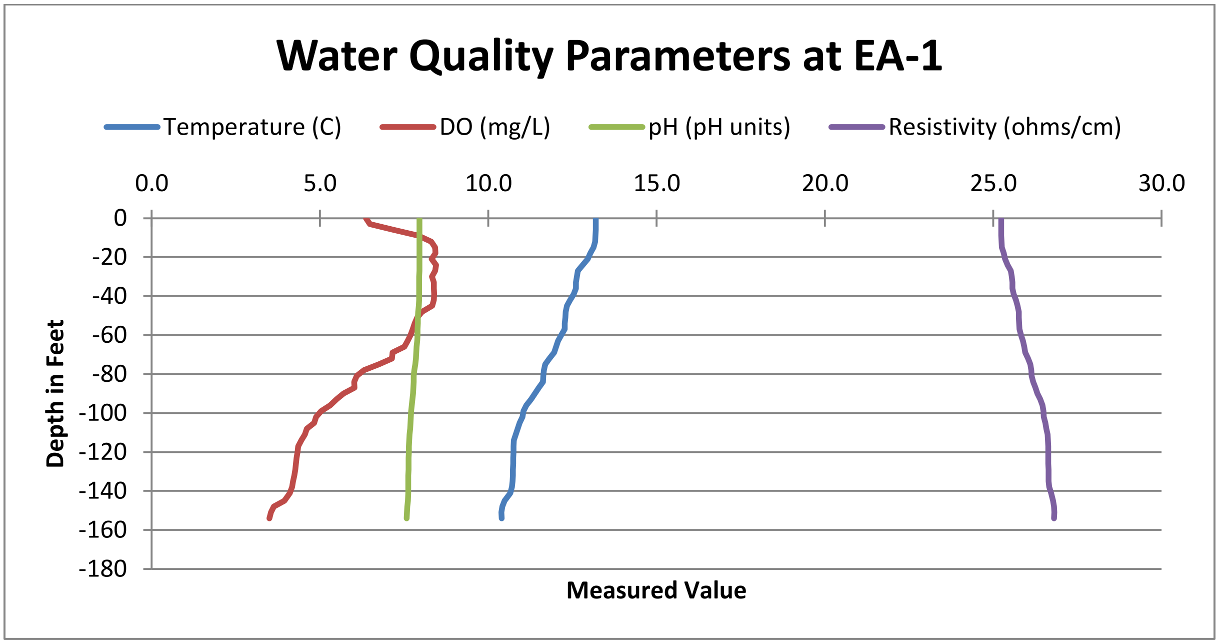


Figure 3-1. Water Column Measurements at a Deep Water Station, EA-1

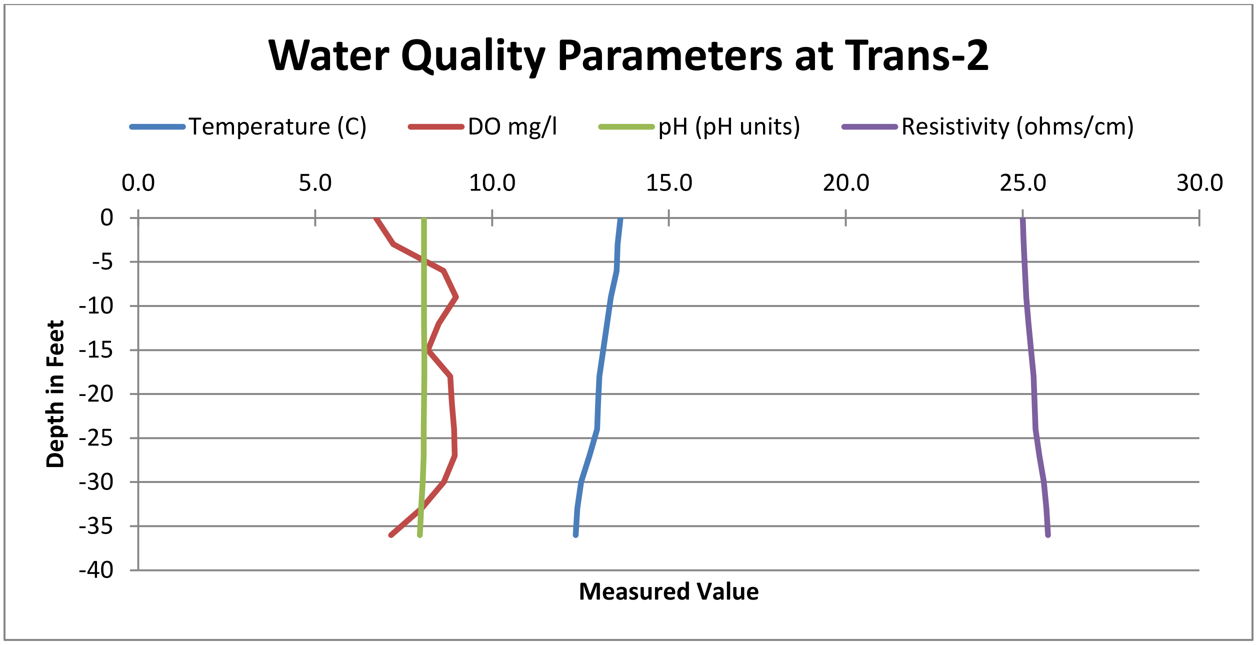


Figure 3-2. Water Column Measurements at a Shallow Water Station, Trans-2

3.4 Sediment Sample Collection

Sediment samples were collected on March 30-31, 2011 from all stations using a double Van Veen grab sampler. Samples for chemical analysis and grain size were collected from the top 5 cm of sediment while benthic infauna was collected from the entire grab (17 cm in depth). Figure 2-8 through Figure 2-11 depict the final station locations as determined in the field.

3.5 Sediment Chemistry Results

Sediment samples were analyzed for the following contaminants of concern: metals, organochlorine pesticides, PAHs, and PCB congeners. Physical measurements for TOC content, percent solids, and grain size were also performed. Results of grain size analysis were strongly correlated with depth. Sediment collected from stations that were less than 18.3 m (60 ft) in depth (Transects 6 1, 7, 2, and 8) were comprised of the greatest percentages of sand (70% or higher) and lowest percentages of silt and clay, while stations that were below 30.5 m (100 ft) in depth, were comprised of mostly silts, less than 40% sand, and higher percentages of clay. Results of grain size analyses, arranged by increasing station depths are shown in Figure 3-3, while raw data are provided in Table 3-4.

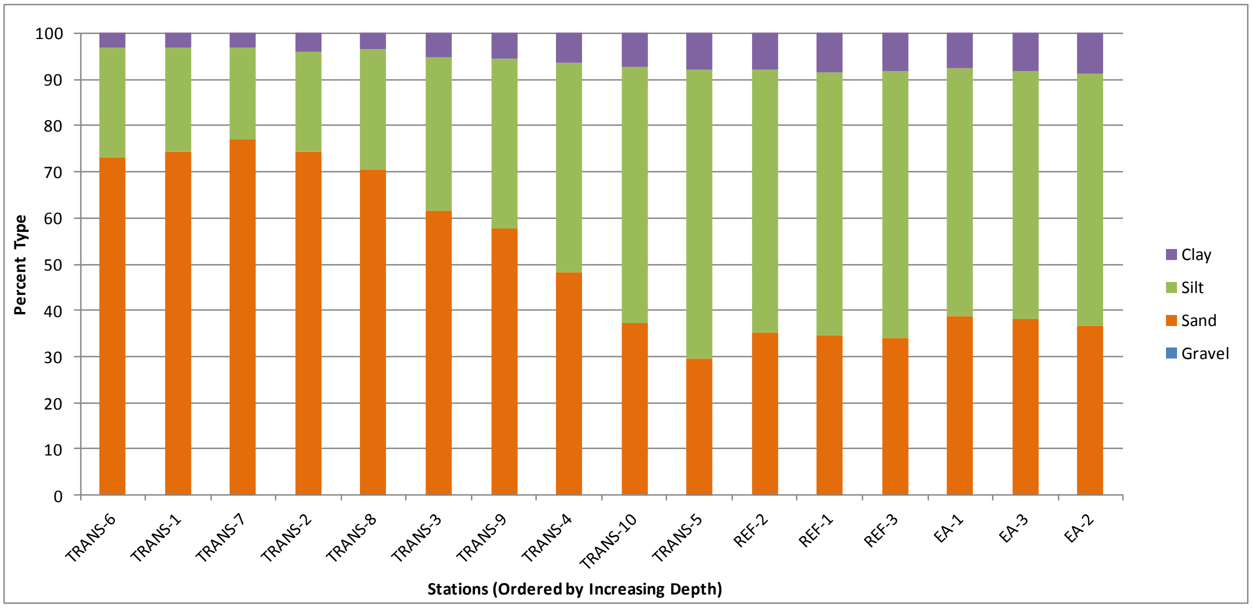


Figure 3-3. Results of Grain Size Analysis

The results of chemical analyses of the sediment samples collected from the two cable route options, the Electrode Array Area, and the Reference Area are presented in Appendix C with the ER-L and ER-M sediment quality values for each analyte. A summary table of the sediment chemistry results is provided below in Table 3-4. Concentrations of all chemicals of concern were below ER-M levels throughout the APE. All trace metals were below ER-L values with the exception of mercury at Trans-1 and Ref-2. Mercury values along the Option 1 cable route ranged from 0.033 to 0.426 mg/kg, while along the Option 2 cable route and Electrode Array Area, mercury concentrations ranged from 0.032 to 0.105 mg/kg, and 0.077 to 0.163 mg/kg, respectively. In general, concentrations of metals were comparable along both cable routes and were correlated with increasing percentages of fine-grained material. The deeper sites (Transects

4, 5, 9, 10 and electrode array and reference areas), located furthest offshore and comprised of the highest percentages of fine sediment (Figure 3-3), contained the highest concentrations of trace metals.

Several chlorinated pesticide compounds, such as dichlorodiphenyltrichloroethanes (DDTs), exceeded ER-L concentrations. As occurred with trace metals, concentrations of chlorinated pesticides were greatest in locations which had the highest percentage of fine-grained materials (silts and clays). While ER-L concentrations for total detectable DDTs were exceeded at all stations other than Trans-1, there were no ER-M exceedances (Table 3-4). Concentrations of the chlorinated pesticide 4-4’-DDD exceeded the ER-L of 2.0 µg/kg at Trans-5, Trans 10, EA-3, REF-2, and REF-3, but were well below the ER-M of 20 µg/kg. In general, chlorinated pesticide concentrations were comparable between both the Option 1 cable route and the Option 2 cable route and increased in concentration as stations increased in both depth and fine-grained sediment composition. Since the Electrode Array and Reference areas consist solely of deep water stations, average chlorinated pesticide concentrations were higher in these areas than along either of the cable routes.

Station EA-3 was the only station with a sediment concentration of total PCBs that was above the ER-L. Since no ER-Ls or ER-Ms have been established for individual PCB congeners, results were compared to ER-Ls and ER-Ms for total PCBs. As with trace metals, and chlorinated pesticides, total PCBs were strongly correlated with increasing depth and decreasing grain size. PCB concentrations between the Option 1 cable route and the Option 2 cable route were generally comparable to one another, with total PCB concentrations at all stations below the ER-L. The average total PCB concentrations in the Electrode Array and Reference Areas were somewhat higher than along either of the cable routes.

The number of ER-L exceedances along the two cable routes and the Electrode Array and Reference areas is shown in Figure 3-4. The Electrode Array and Reference areas sediments had more ER-L exceedances than either of cable routes, likely as a result of containing more fine-grained material. DDT and its breakdown products, DDD and DDE, were found at levels above the ER-L at nearly all stations. These compounds are considered to be legacy contaminants in Santa Monica Bay resulting from pesticide spraying activity on land and dumping activity in nearshore waters prior to DDT being banned in 1972.

Table 3-4. Summary of Sediment Chemistry Results

Analyte	Units	Methods	ER-L	ER-M	Option 1 Cable Route					Option 2 Cable Route					Central Electrode Array			Reference		
					TRANS-1	TRANS-2	TRANS-3	TRANS-4	TRANS-5	TRANS-6	TRANS-7	TRANS-8	TRANS-9	TRANS-10	EA-1	EA-2	EA-3	REF-1	REF-2	REF-3
					3/30/2012	3/30/2012	3/30/2012	3/30/2012	3/31/2012	3/30/2012	3/30/2012	3/30/2012	3/30/2012	3/30/2012	3/31/2012	3/31/2012	3/31/2012	3/31/2012	3/31/2012	3/31/2012
General Chemistry																				
Carbon, Total Organic	%	USEPA 9060A			0.31	0.23	0.39	0.75	0.76	0.27	0.22	0.27	0.67	0.85	0.82	0.84	0.87	0.75	0.77	0.82
Solids, Total	%	SM 2540 B			70	68.1	66.5	64.4	66.1	67.9	66.9	67.4	67.5	63.4	64.7	61.7	62.9	62.9	62.3	61.2
Particle Size																				
Gravel	%	Plumb, 1981			0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00
Sand	%	Plumb, 1981			74.36	74.40	61.45	48.15	29.63	73.21	77.05	70.58	57.61	37.33	38.83	36.73	38.25	34.73	35.31	33.93
Silt	%	Plumb, 1981			22.38	21.48	33.45	45.35	62.51	23.56	19.83	26.03	36.90	55.35	53.74	54.53	53.58	56.87	56.75	57.77
Clay	%	Plumb, 1981			3.26	4.12	5.08	6.50	7.85	3.24	3.13	3.39	5.49	7.24	7.43	8.74	8.17	8.40	7.93	8.30
Trace Metals																				
Arsenic	mg/kg	USEPA 6020	8.2	70	3.17B	3.71B	3.98B	6.66B	5.71B	4.39B	3.66B	3.87B	5.12B	5.18B	4.93B	4.91B	4.41B	4.08B	5.2B	4.37B
Cadmium	mg/kg	USEPA 6020	1.2	9.6	0.29	0.224	0.248	0.4	0.331	0.274	0.215	0.265	0.401	0.393	0.274	0.337	0.308	0.259	0.376	0.216
Chromium	mg/kg	USEPA 6020	81	370	17.4B	15.8B	17.8B	25.8B	30.6B	19.2B	17.7B	17.7B	26.4B	30.2B	33.1B	34B	32.3B	30.1B	35.9B	31.3B
Copper	mg/kg	USEPA 6020	34	270	5.79B	5.95B	5.61B	9.39B	10.9B	7.45B	4.21B	4.63B	9.27B	10.6B	10.7B	12.1B	11.2B	10.2B	11.8B	11B
Lead	mg/kg	USEPA 6020	46.7	218	5.62	5.58	7.33	10.6	11.7	7.67	7.08	7.48	11.1	11.3	10.8	11.4	10.7	9.29	11.7	10.4
Mercury	mg/kg	USEPA 7471A	0.15	0.71	0.426	0.0328	0.0572	0.0968	0.0999	0.0437	0.0319	0.0443	0.0808	0.105	0.0896	0.126	0.0771	0.0962	0.163	0.116
Nickel	mg/kg	USEPA 6020	20.9	51.6	16	13.3	12.5	16.3	17.8	17.9	13.8	14.1	16.7	17.9	17.5	16.8	16.2	15.8	18.9	15.5
Silver	mg/kg	USEPA 6020	1	3.7	0.0426B,J	0.0653B,J	0.171B	0.447B	0.541B	0.0533B,J	0.0546B,J	0.0742B,J	0.386B	0.527B	0.561B	0.712B	0.621B	0.521B	0.632B	0.609B
Zinc	mg/kg	USEPA 6020	150	410	33.6	29.9	33.4	48.1	52.6	43.7	34	33.4	46.7	53.2	51.8	51.2	48.2	46	55	48.2
Chlorinated Pesticides																				
2,4'-DDD	µg/kg	USEPA 8081A			<0.24	<0.25	<0.25	<0.26	<0.26	<0.25	<0.25	<0.25	<0.25	0.35J	<0.26	0.4J	0.48J	<0.27	0.36J	0.51J
2,4'-DDE	µg/kg	USEPA 8081A			<0.22	0.32J	0.73J	1.3	2.2	0.39J	0.26J	0.39J	1.5	2	3.2	1.6	2.8	1.8	2.9	2.4
2,4'-DDT	µg/kg	USEPA 8081A			<0.21	<0.22	<0.23	<0.23	<0.23	<0.22	<0.22	<0.22	<0.22	<0.24	<0.23	<0.24	<0.24	<0.24	<0.24	<0.25
4,4'-DDD	µg/kg	USEPA 8081A	2	20	0.42J	<0.23	0.65J	1.6	2.3	0.91	<0.24	0.44J	1.6	2.9	<0.24	1.9	3	1.7	3.1	2.6
4,4'-DDE	µg/kg	USEPA 8081A	2.2	27	1.1	1.8	5.5	11	17	3.2	1.6	2.7	10	14	26	15	25	13	21	18
4,4'-DDT	µg/kg	USEPA 8081A	1	7	<0.24	<0.25	<0.25	<0.26	<0.25	<0.25	<0.25	<0.25	<0.25	<0.26	<0.26	<0.27	<0.27	<0.27	<0.27	<0.27
Total Detectable DDTs	µg/kg	USEPA 8081A	1.58	46.1	1.52	2.12	6.88	13.9	21.5	4.5	1.86	3.53	13.1	19.25	29.2	18.9	31.28	16.5	27.36	23.51
Dieldrin	µg/kg	USEPA 8081A	0.02	8	<0.24*	<0.24*	<0.25*	<0.26*	<0.25*	<0.24*	<0.25*	<0.24*	<0.24*	<0.26*	<0.25*	<0.27*	<0.26*	<0.26*	<0.26*	<0.27*
Other Chlorinated Pesticides	µg/kg	USEPA 8081A	-	-	Across all sites, no other chlorinated pesticides were detected above reporting limits.															
PCB Congeners																				
Individual PCB congeners	µg/kg	USEPA 8270C SIM	NA	NA	Across all sites, 14 PCB congeners were detected above reporting limits. Individual PCB congeners do not have established ER-L and ER-M values.															
Total PCBs	µg/kg	Calculation	22.7	180	<0.29	<0.3	3.72	6.82	12.01	<0.3	<0.3	<0.3	3.93	9.21	13.04	13.08	36.32	16.59	8.76	14.05
Polynuclear Aromatic Hydrocarbons																				
Individual PAHs	µg/kg	USEPA 8270C SIM	-	-	Across all sites, 7 PAHs were detected above reporting limits; of these, only fluoranthene, naphthalene and pyrene have established ER-L and ER-M values. No ER-L or ER-M values were exceeded by individual PAH concentrations at any site.															
Total Detectable PAHs	µg/kg	Calculation	4,022	44,792	18.8	3.5	20.1	25.9	89.3	154	1.7	2	35	43.4	33.2	38	50.1	12.8	78.9	22.1

< - results less than the method detection limit.

B - Analyte was detected in the associated method blank.

J - Result above the method detection limit but below the reporting limit. Result is estimated.

* - The method detection limit is greater than the ER-L.

NA- ER-L and ER-M values have not been established

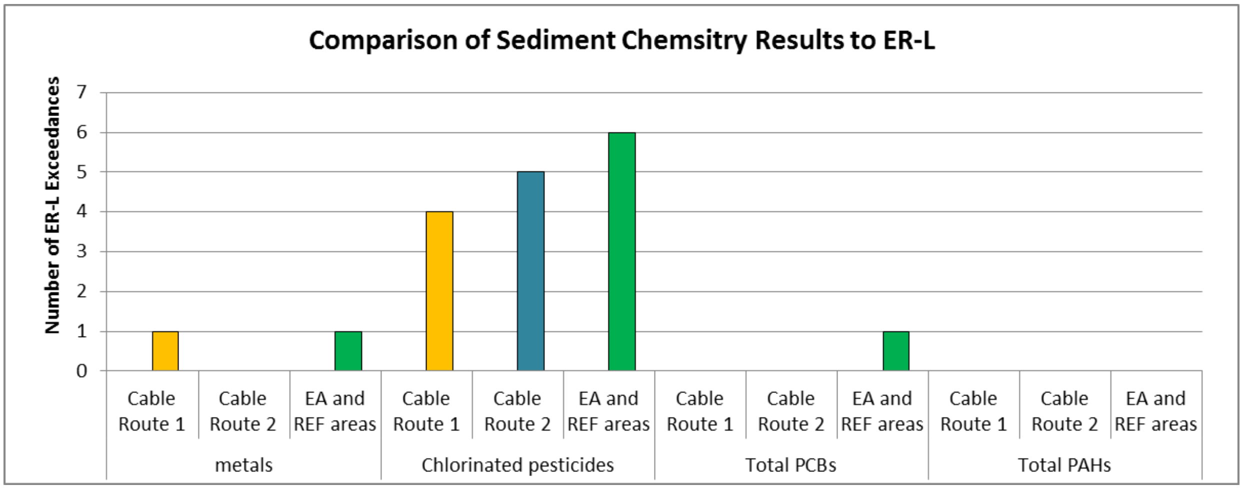


Figure 3-4. Number of ER-L Exceedances by Constituent Groups along Cable Routes and Electrode Array and Reference Areas.

3.6 Benthic Infauna Results

Benthic infauna samples were collected from each of the 16 stations: five along each of the proposed cable routes, three at the proposed electrode array location, and three at the reference location (Figure 2-1 and Figure 2-2). The complete species list and abundance for each station is provided in Appendix D. A summary of the benthic community measures for each station are provided in Table 3-5. Standard benthic community measures include total abundance, number of species, dominance index (number of species comprising 70% of the total number of species at a station), evenness (proportion of abundance of different species), Shannon-Wiener Diversity Index, and BRI. A benthic response condition is also provided for each station (refer to Section 2.2.2.2 for a description of the BRI and how it is measured). The percentage of total abundance and number of species by taxonomic group is shown in Table 3-6.

In addition, to provide perspective for the 2012 benthic infauna results, comparisons were made to Bight ’08 stations that were sampled surrounding the region of the proposed cable routes (Figure 3-5). The complete species list and abundance for each station is provided in Appendix D. A summary of the community measures for the Bight ’08 stations is provided in Table 3-7. The percentage of total abundance and number of species by taxonomic group is shown in Table 3-8.

When the BRI was evaluated for the two stations, Trans-1 and Trans-6, it was determined that the station depths were too shallow for the ranges set in the BRI calculations. Water depths for these two stations were 7.1 m (23 ft) and 5.8 m (19 ft), respectively. The shallow depth range for calculating the BRI extends from 10-35 m (33- 115 ft). For comparative purposes only, these two stations were included in the shallow range in order to calculate a benthic response condition.

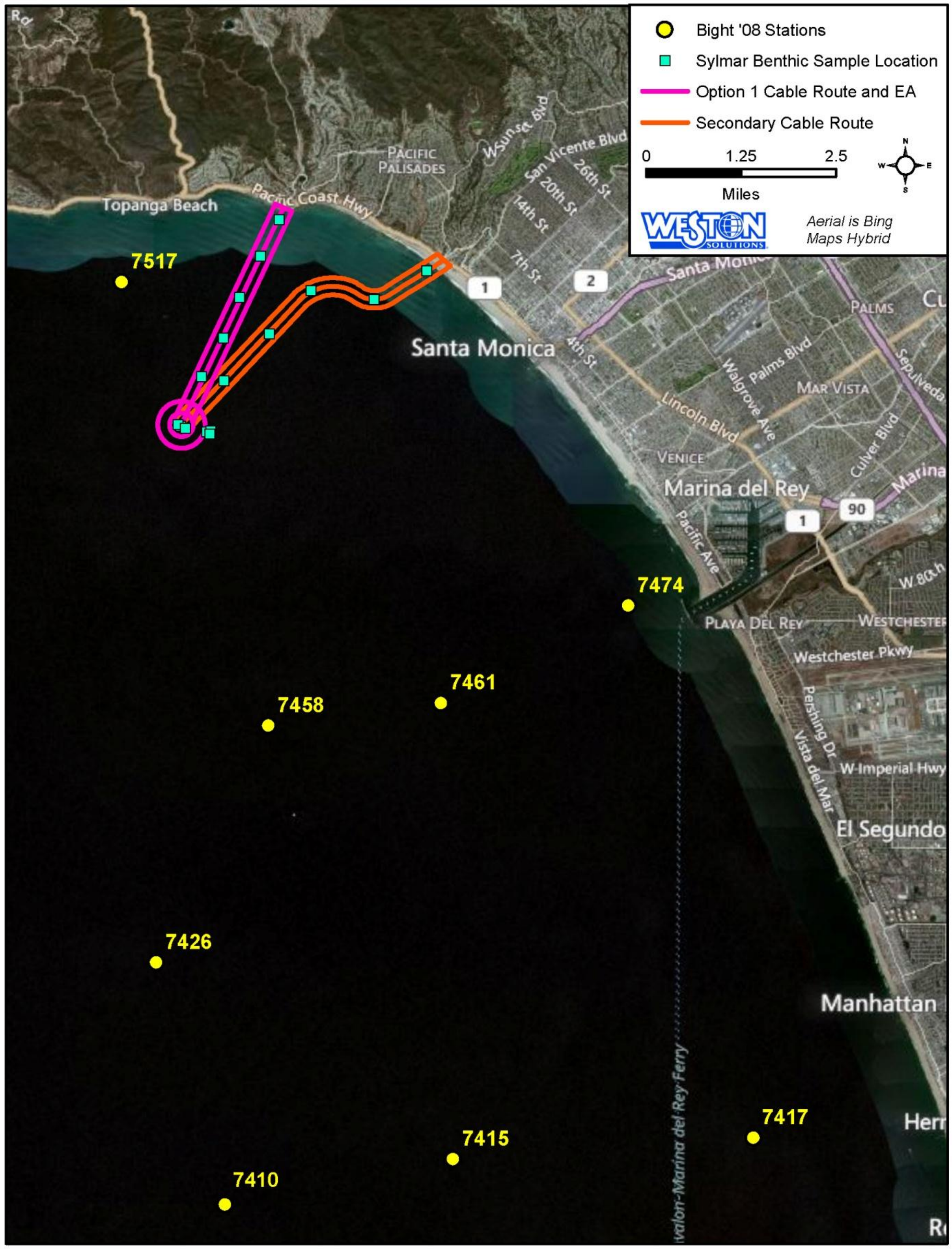


Figure 3-5. Bight '08 Stations in the Vicinity of the Area of Potential Effect

Table 3-5. Benthic Community Measures for Stations Located Within the Proposed Cable Routes, Electrode Array Area, and Reference Area

Location	Station ID	Depth (m)	Total Abundance	Number of Species	Dominance Index	Evenness	Shannon-Wiener Diversity Index	Benthic Response Index	Benthic Response Condition
Option 1 Cable Route	Trans-1	7.1	49	26	14	0.94	3.05	25.34*	Response Level 1
	Trans-2	12.2	76	39	22	0.94	3.44	18.62	Reference
	Trans-3	19.0	164	70	35	0.95	4.04	29.94	Response Level 1
	Trans-4	28.0	298	90	35	0.87	3.93	22.21	Reference
	Trans-5	38.1	414	131	58	0.93	4.55	15.05	Reference
Option 2 Cable Route	Trans-6	5.8	40	23	14	0.96	3.01	4.77*	Reference
	Trans-7	11.8	62	37	24	0.96	3.46	16.21	Reference
	Trans-8	13.5	74	27	13	0.91	3.01	10.19	Reference
	Trans-9	23.5	444	105	32	0.85	3.95	22.83	Reference
	Trans-10	37.4	480	120	47	0.89	4.27	16.57	Reference
Electrode Array Area	EA-1	48.2	208	83	36	0.89	3.92	9.88	Reference
	EA-2	48.5	300	89	37	0.90	4.02	12.21	Reference
	EA-3	48.3	311	101	42	0.91	4.21	14.95	Reference
Reference Area	REF-1	47.6	287	103	42	0.91	4.21	13.95	Reference
	REF-2	47.2	265	95	42	0.91	4.16	11.22	Reference
	REF-3	48.0	319	109	45	0.90	4.24	14.27	Reference

* Stations Trans-1 and Trans-6 were located in water depths of 7.1 m and 5.8 m, respectively. The shallow depth range for calculating the BRI extends from 10-35 m. For comparative purposes only, these two stations were included in the shallow range in order to calculate a benthic response condition.

Table 3-6. Percentage of Total Abundance and Number of Taxa by Taxonomic Group for Proposed Cable Routes, Electrode Array Area, and Reference Area

Location	Station ID	Depth (m)	Taxonomic Group									
			Percentage of Total Abundance					Percentage of Number of Species				
			Polychaetes (%)	Crustaceans (%)	Molluscs (%)	Echinoderms (%)	Minor Phyla (%)	Polychaetes (%)	Crustaceans (%)	Molluscs (%)	Echinoderms (%)	Minor Phyla (%)
Option 1 Cable Route	Trans-1	7.1	24.5	46.9	24.5	0.0	4.1	19.2	46.2	26.9	0.0	7.7
	Trans-2	12.2	52.6	25.0	13.2	0.0	9.2	39.0	34.1	12.2	0.0	14.6
	Trans-3	19.0	38.4	36.6	22.0	2.4	0.6	46.1	25.0	23.7	3.9	1.3
	Trans-4	28.0	43.6	29.2	10.7	10.7	5.7	42.7	31.3	11.5	4.2	10.4
	Trans-5	38.1	34.8	37.4	9.9	10.1	7.7	40.8	31.7	10.6	4.9	12.0
Option 2 Cable Route	Trans-6	5.8	22.5	50.0	25.0	0.0	2.5	25.0	50.0	20.8	0.0	4.2
	Trans-7	11.8	43.5	25.8	17.7	0.0	12.9	30.8	28.2	25.6	0.0	15.4
	Trans-8	13.5	10.8	59.5	21.6	2.7	5.4	17.2	37.9	27.6	6.9	10.3
	Trans-9	23.5	37.2	49.3	8.1	0.9	4.5	40.5	32.4	17.1	2.7	7.2
	Trans-10	37.4	30.2	50.6	9.0	5.2	5.0	38.8	31.3	11.9	6.7	11.2
Electrode Array Area	EA-1	48.2	30.3	26.4	10.6	26.4	6.3	34.1	29.5	17.0	8.0	11.4
	EA-2	48.5	33.3	25.3	12.0	25.0	4.3	36.8	32.6	15.8	6.3	8.4
	EA-3	48.3	36.0	24.4	13.5	19.6	6.4	40.4	27.5	15.6	5.5	11.0
Reference Area	Ref-1	47.6	33.8	28.6	12.9	18.5	6.3	36.2	28.6	16.2	6.7	12.4
	Ref-2	47.2	31.3	32.1	9.4	20.4	6.8	36.7	30.6	15.3	7.1	10.2
	Ref-3	48.0	30.4	24.1	14.1	24.1	7.2	38.7	26.1	18.0	7.2	9.9

Table 3-7. Benthic Community Measures for Stations Sampled During the Bight '08 Program

Station ID	Depth Range (m)	Total Abundance	Number of Taxa	Dominance Index	Evenness	Shannon-Wiener Diversity Index	Benthic Response Index	Benthic Response Condition
7474	5-30	194	66	26	0.87	3.63	26.1	Response Level 1
7517		782	137	35	0.81	4.00	27.2	Response Level 1
7410	31-120	257	95	38	0.90	4.11	11.1	Reference
7415		448	118	37	0.86	4.10	14.5	Reference
7417		277	90	35	0.89	4.00	16.6	Reference
7426		281	105	47	0.93	4.32	8.4	Reference
7458		309	106	42	0.90	4.20	18.4	Reference
7461		508	117	36	0.86	4.09	17.4	Reference

Table 3-8. Percentage of Total Abundance and Number of Taxa by Taxonomic Group for Bight '08 Stations

Bight '08 Station ID	Depth Range (m)	Taxonomic Group									
		Percentage of Total Abundance					Percentage of Number of Species				
		Polychaetes (%)	Crustaceans (%)	Molluscs (%)	Echinoderms (%)	Minor Phyla (%)	Polychaetes (%)	Crustaceans (%)	Molluscs (%)	Echinoderms (%)	Minor Phyla (%)
7474	5-30	65.8	13.6	1.1	16.3	3.3	56.1	18.2	15.2	3.0	7.6
7517		64.5	23.1	1.5	6.7	4.1	55.1	22.5	9.4	4.3	8.7
7410	31-120	58.6	10.8	13.1	13.5	4.1	58.9	17.9	11.6	5.3	6.3
7415		36.5	16.1	13.8	30.5	3.1	43.6	21.4	23.9	5.1	6.0
7417		58.9	15.2	8.5	14.1	3.3	53.3	20.0	16.7	3.3	6.7
7426		49.6	28.1	4.1	13.7	4.4	49.5	24.8	12.4	7.6	5.7
7458		50.3	13.3	1.0	31.7	3.7	53.8	14.2	22.6	2.8	6.6
7461		62.3	23.0	4.9	6.0	4.0	57.3	22.2	6.0	6.0	8.5

Option 1 Cable Route

The total abundance of benthic organisms at stations sampled along the Option 1 cable route ranged from 49 individuals at Trans-1 to 414 individuals at Trans-5 (Table 3-5). The number of species at all five stations ranged from 26 species at Trans-1 to 131 species at Trans-5. Both total abundance values and number of species increased with depth. The dominance index also increased the further the stations were located offshore ranging from 14 to 58. Both the Shannon-Wiener diversity index and evenness showed similar values at all five stations. BRI values were indicative of reference to low disturbance conditions (Response Level 1).

Polychaetes dominated Stations Trans-2, Trans-3, and Trans-4 representing 52.6%, 38.4%, and 43.6%, respectively, of the total abundance. Crustaceans (e.g. amphipods, shrimp, and crabs) dominated Stations Trans-1 and Trans-5 representing 46.9% and 37.4%, respectively, of the total abundance (Table 3-6). Polychaetes had the greatest diversity among all of the stations along the Option 1 cable route ranging from 39.0% to 46.1% of the species, except at Station Trans-1 where crustaceans were the most diverse with 46.2% of the species.

Option 2 Cable Route

The total abundance of benthic organisms at stations sampled along the Option 2 cable route ranged from 40 individuals at Trans-1 to 480 individuals at Trans-5 (Table 3-5). The number of species at all five stations ranged from 23 species at Trans-1 to 120 species at Trans-5. Both total abundance values and number of species generally increased with depth. The dominance index tended to generally increase the further the stations were offshore ranging from 14 to 47. Both the Shannon-Wiener diversity index and evenness showed similar values at all five stations. BRI values were indicative of reference conditions.

Crustaceans dominated Stations Trans-6, Trans-8, Trans-9, and Trans-10 representing 50.0%, 59.5%, 49.3%, and 50.6%, respectively, of the total abundance, whereas, polychaetes dominated Station Trans-7 representing 43.5% of the total abundance (Table 3-6). Polychaetes had the greatest diversity at Stations Trans-7, Trans-9, and Trans-10 representing 30.8%, 40.5%, and 38.8% of the species, respectively. At Stations Trans-6 and Trans-8, crustaceans were the most diverse representing 50.0% and 37.9% of the species, respectively.

Electrode Array and Reference Areas

The Electrode Array and Reference areas had similar benthic community measures (Table 3-5). Total abundance of benthic organisms at the Electrode Array Area ranged from 208 to 311 individuals, while the number of organisms at the reference area ranged from 265 to 319 individuals. The number of species was slightly higher at the Reference Area ranging from 95 to 109 species, whereas the number of species at the Electrode Array Area ranged from 83 to 101 species. The dominance index, evenness values, and Shannon-Wiener diversity index showed similar values among all six stations. BRI values in both areas were indicative of reference conditions.

Polychaetes were the most abundant and diverse at all three stations in the Electrode Array Area representing 30.3% (EA-1) to 36.0% (EA-3) of the total abundance and 34.1% (EA-1) to 40.4% (EA-3) of the species (Table 3-6). Polychaetes were also the most abundant and diverse at Stations Ref-1 and Ref-3 located in the reference area representing 33.8% and 30.4%, respectively, of the total abundance and 36.2% and 38.7%, respectively, of the species. At

Station Ref-2, crustaceans had the highest abundance with 32.1% of the total abundance; however, polychaetes had the greatest diversity with 36.7% of the species.

Comparison to Bight '08 Stations
The BRI values calculated for the benthic infauna samples collected along the proposed cable routes, Electrode Array Area, and Reference Area were compared to samples collected during Bight '08 in the surrounding region to determine if benthic community conditions were similar (Table 3-5 and Table 3-7). Stations Trans-1-4 and Trans 6-9, along both proposed cable routes, were compared to the two Bight '08 stations, 7474 and 7517, since these stations were located within a similar depth range of 5-30 m. Both Bight '08 stations had a benthic response condition indicating a low disturbance (Response Level 1). Two of the stations (Trans-1 and Trans-3) located on the Option 1 cable route were characterized with low disturbance conditions (Response Level 1) and two stations (Trans-2 and Trans-4) were characterized with reference conditions. All four stations located on the Option 2 cable route were indicative of reference conditions.

Both Bight '08 stations, 7474 and 7517, located in the 5-30 m depth range were dominated by polychaetes which represented 65.8% and 64.5%, respectively, of the total abundance and 56.1% and 55.1%, respectively, of the species (Table 3-8). Four of the stations located along the proposed cable routes (Trans-2, Trans-3, Trans-4, and Trans-7) had total abundances dominated by polychaetes and four stations (Trans-1, Trans-6, Trans-8, and Trans-9) had total abundances dominated by crustaceans (Table 3-6). Polychaetes had the highest diversity at all of the stations from Trans-1-4 and Trans-6-9, except at Trans-6 where crustaceans were the most diverse.

Stations Trans-5 and Trans-10, as well as the six stations located in the Electrode Array and Reference areas, were compared to six Bight '08 stations (7410, 7415, 7417, 7426, 7458, and 7477) located in similar depths ranging from 31-120 m. All of the Bight '08 stations were characterized with BRI values indicating reference conditions. Stations located in the Electrode Array and Reference area, as well as Trans-5 and Trans-10, were also characterized as having reference conditions.

All of the Bight '08 stations located within the 31-120 m depth range were dominated by polychaetes which represented 36.5% (Station 7415) to 62.3% (Station 7461) of the total abundance and 43.6% (Station 7415) to 58.9% (Station 7410) of the species (Table 3-8). All of the stations in the Electrode Array Area and two of the stations in the Reference Area (Ref-1 and Ref-3) had total abundances that were dominated by polychaetes (Table 3-6). Total abundances at Stations Trans-5, Trans-10, and Ref-2 were dominated by crustaceans. Polychaetes had the highest diversity at all of the stations located in the Electrode Array and Reference areas, as well as Trans-5 and Trans-10.

3.7 Toxicity Results

Water quality parameters were within the appropriate limits. Mean percent survival of *E. estuarius* was 96.0% in the control, which met the minimum acceptable control survival criterion ($\geq$ 90%). More than 20 amphipods were recovered at test termination from replicate 1 of sample TRANS-7. Since the number of organisms added at test initiation could not be confirmed, this replicate was dropped from statistical analysis. Toxicity was only apparent for sample REF-3, since mean percent survival was not significantly different from the control at all other stations. A summary of test results is provided in Table 3-9. The detailed report and laboratory bench sheets are provided in Appendix E.

In the ammonium chloride reference toxicant test, LC_{50} values of 54.4 mg total NH_3/L and 0.977 mg un-ionized NH_3/L were determined from survivorship at measured concentrations of 0, 12.5, 25.5, 49.3, 102, and 206 mg total NH_3/L and calculated unionized concentrations of 0, 0.366, 0.592, 0.92, 1.19, and 1.53 mg un-ionized NH_3/L. Measured total ammonia and unionized ammonia in tests conducted with project materials were below concurrent reference toxicant effect levels (LC_{50} = 54.4 mg total NH_3/L; no observable effect concentration [NOEC] = 12.5 mg total NH_3/L). Therefore, ammonia is not expected to have contributed to any toxicity found in tests using project materials. Laboratory bench sheets and summary tables of the reference toxicant tests with *E. estuarius* are provided in Appendix E.

Table 3-9. Results of Solid Phase Test Using *Eohaustorius estuarius*

Composite Area ID	**Amphipods (*Eohaustorius estuarius*)**				
	Overlying Total Ammonia Concentration (mg/L)		**Interstitial Total Ammonia Concentration (mg/L)**		**% Survival**
	Initial	**Day 10**	**Initial**	**Day 10**	
Control 1	<0.500	<0.500	<0.500	<0.500	96.0
TRANS-2	<0.500	2.52	8.77	3.45	88.0
TRANS-4	<0.500	1.86	4.82	3.75	88.0
TRANS-7	<0.500	1.11	4.42	2.57	96.3
TRANS-9	<0.500	2.02	10.4	3.99	94.0
EA-1	<0.500	<0.500	4.32	2.41	86.0
EA-2	<0.500	2.15	7.75	4.67	86.0
EA-3	<0.500	<0.500	2.64	2.10	89.0
REF-1	<0.500	1.53	3.96	2.98	93.0
REF-2	<0.500	1.22	4.13	3.12	89.0
REF-3	<0.500	2.67	5.90	6.55	*62.0

Ammonium Chloride Reference Toxicant	Total NH_3	Un-ionized NH_3	% Survival	Total NH_3		Un-ionized NH_3	
	Actual Concentration (mg/L)	Calculated Concentration (mg/L)		LC_{50} (mg/L)	NOEC (mg/L)	LC_{50} (mg/L)	NOEC (mg/L)
	Control	Control	95.0	54.4	12.5	0.977	0.366
	12.5	0.366	95.0				
	25.5	0.592	82.5				
	49.3	0.920	60.0				
	102	1.19	0.00				
	206	1.53	0.00				

*Significantly different from control.

3.8 ROV and Dive Survey Results - Biological Community and Habitat Description

ROV surveys were performed over four days from April 3 to April 6, 2012 while dive surveys were performed over the course of six days between April 9 and April 20, 2012. As a result of the arrival of gale force winds and large swell on April 11, 2012, dive surveys were postponed for safety purposes from April 11 through April 16, 2012 and resumed on April 17, 2012. Both the ROV and dive surveys used video surveillance to visually assess biological resources within the project footprint.

The ROV was used to survey the cable routes and footprint of the Electrode Array Area for biological habitat and to delineate areas warranting further observation during the dive surveys. The dive surveys were performed to assess the presence of species at specific locations evenly spaced along the cable routes and to map the extent of habitat types along those routes. The ROV routes and diver transects over the Option 1 cable route and Electrode Array Area are shown in Figure 2-8 and Figure 2-9, while the ROV routes and diver transects over the Option 2 cable route are shown in Figure 2-10 and Figure 2-11. As previously mentioned, diver transects 2 and 8 were re-located from their original locations following the ROV survey to assess rocky reef habitat. It should be noted that no kelp or eelgrass beds were observed within the project footprint.

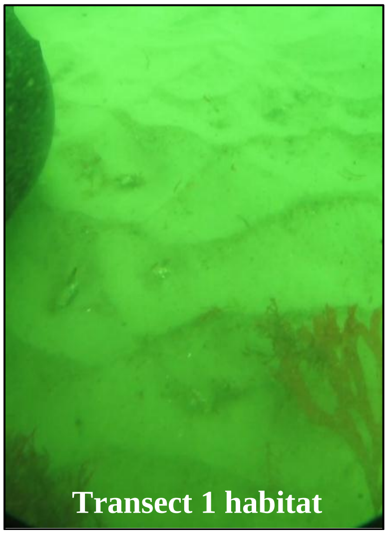
Nearshore Habitat

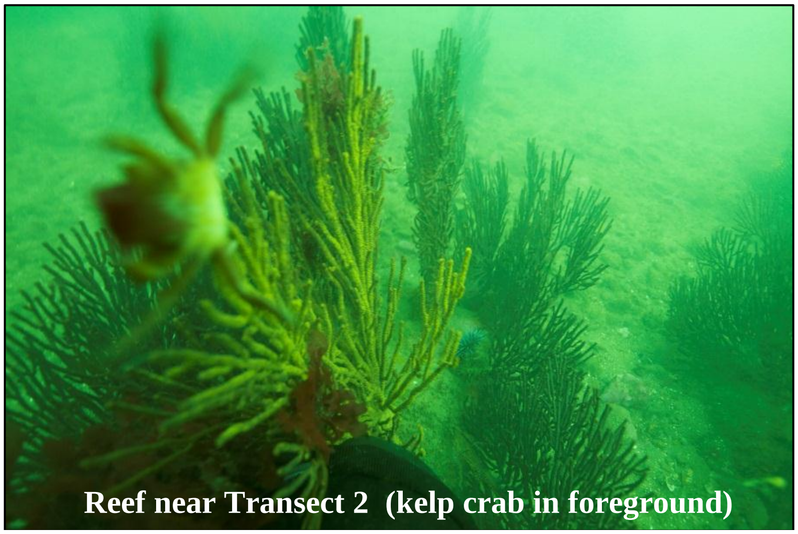
Nearshore habitat for the purpose of this report will be defined as the habitat within the APE that occurs in less than 18.3 m (60 ft) of water. This would include the area from the shoreline to approximately Transect 3 on the Option 1 cable route and from the shoreline to midway between Transect 8 and Transect 9 on the Option 2 cable route. Both ROV and diver surveys were begun outside of the surf zone in approximately 4.6- 6.1 m (15-20 ft) of water where the boats could be safely operated. Areas shallower than 4.6 m (15 ft) in depth were not surveyed, since directional drilling is planned from the land-side vault to approximately 305 m (1,000 ft) offshore. Areas shallower than 6.1 m (20 ft) of water would not be expected to be impacted by the cable installation.

Option 1 Cable Route

Nearshore habitat along the Option 1 cable route was characterized by predominantly soft bottom habitat. Coarse-grained sand that moved with tidal action was observed in the vicinity of Transect 1, creating sand ripples along the sea floor. Moderate surge in this area coupled with its proximity to the surf zone inhibited visibility during field surveys. Depth in this area ranged from approximately 5.5 to 6.7 m (18 to 22 ft) and the substrate was comprised of 100% sand and silt. The ornate tube worm, *Diopatra ornata,* was the only organism observed in the vicinity of Transect 1.

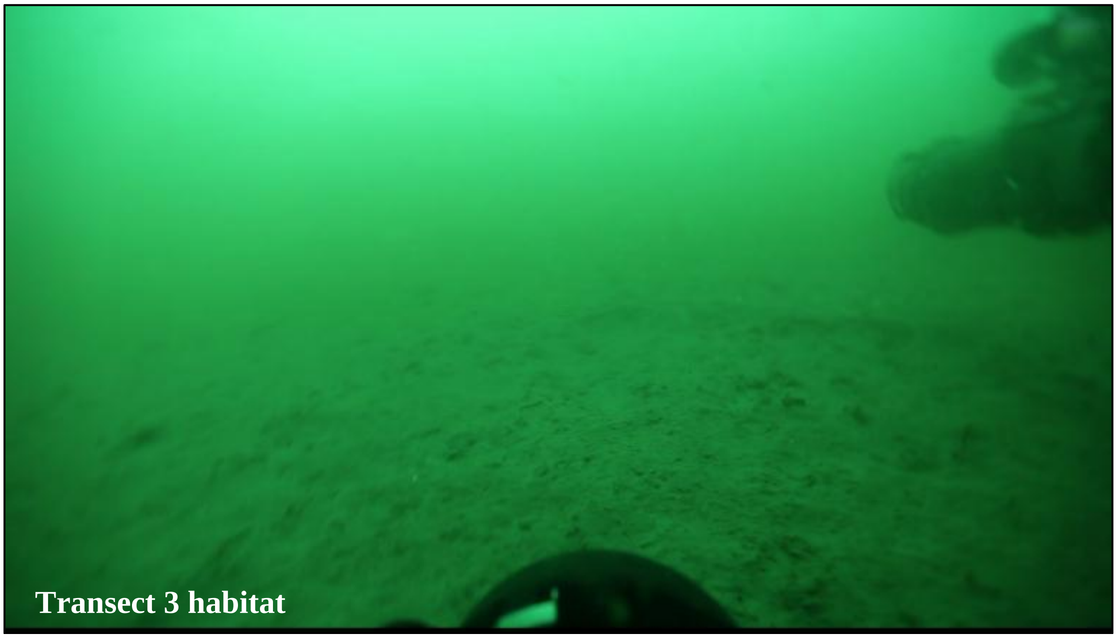
A cobble reef occurred between the Transect 1 and Transect 2 sampling locations, and extended along the cable route approximately 1,000 ft, before ending between the Transect 2 and Transect 3 sampling locations. The reef was approximately 180 to 250 ft wide and occurred at a depth ranging from 7.6 to 10.7 m (25 to 35 ft). In general, the hard substrate of the reef was mostly covered by sand and was low relief, rising no more than 0.7 to 1.2 m (2 to 4 ft) above the seafloor. The following species were observed in the reef area: bat star (*Asterina miniata*) three gorgonian species (*Muricea fruticosa*, *Lophogorgia chilensis*, and *Muricea californicus*), two crab species (*Taliepus nuttalli* and *Loxorhynchus grandis),* ornate tube worm (*Diopatra ornata*), chestnut cowry (*Cypraea spadicea*), red and purple sea urchins, (*Strongylocentrotus franciscanus* and *Strongylocentrotus purpuratus*) palm kelp (*Eisenia arborea*), and the red alga *Acrosorium uncinatum*. The soft-bottom habitat beyond the reef supported the spiny sand star, (*Astropecten armatus*), an unidentified sculpin species, and Kellet's whelk (*Kelletia kelletii*).


Transect 1 habitat

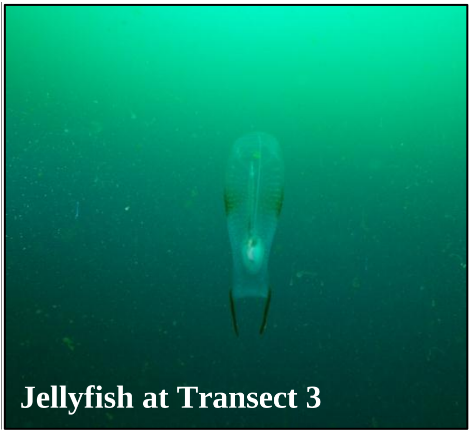

Reef near Transect 2 (kelp crab in foreground)

The habitat along the centerline of the Option 1 cable route was comprised entirely of soft bottom sediments, with the reef occurring approximately 61 m (200 ft) south of the centerline. Moving seaward beyond the reef area, the habitat returned to soft bottom sediment sparsely populated by predominantly sea pens, algal debris, tube anemones, brittle stars, and cancer crabs.

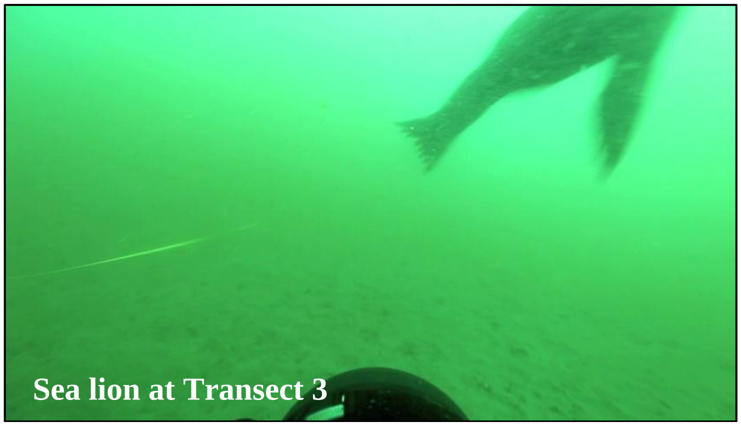
The benthic habitat at Transect 3 was comprised entirely of soft bottom material and was sparsely populated by sea pens (*S. elgongata*), tube anemones (*P. fimbriatus*), spiny sand stars (*A. armatus*), Kellet's whelks (*K. kelletii*), lizardfish (*Synodus lucioceps*), mantis shrimp (*Hemisquilla californiensis*), and cancer crabs (*Cancer sp*.). A California sea lion (*Zalophus californianus*) and a giant bell jellyfish (*Scrippsia pacifica*) were observed within the water column of Transect 3. Water depth in this area was approximately 18.3 m (60 ft).



Transect 3 habitat



Jellyfish at Transect 3



Sea lion at Transect 3

Option 2 Cable Route

The nearshore habitat along the Option 2 cable route was characterized almost entirely by soft bottom habitat. Coarse-grained sand and algal debris that moved with tidal action was observed in the vicinity of Transect 6, creating sand ripples along the sea floor and clouding visibility. Depth in this area ranged from approximately 5.8 to 7.6 m (19 to 25 ft) and the substrate was comprised of 100% sand and silt. Due to the limited visibility, no organisms were observed at Transect 6. The habitat between Transect 6 and Transect 7 is entirely soft bottom, mostly sandy substrate nearly devoid of visible organisms (one unidentified sea star species was observed in the ROV video). Habitat at Transect 7 is comprised of predominantly coarse sand and contained few organisms. Hemphill's kelp crab (*Podochela hemphilli),* Kellet's whelk (*Kelletia kelletii*), *A. armatus* and a cancer crab (*Cancer sp*.) were the only species noted by divers at Transect 7.

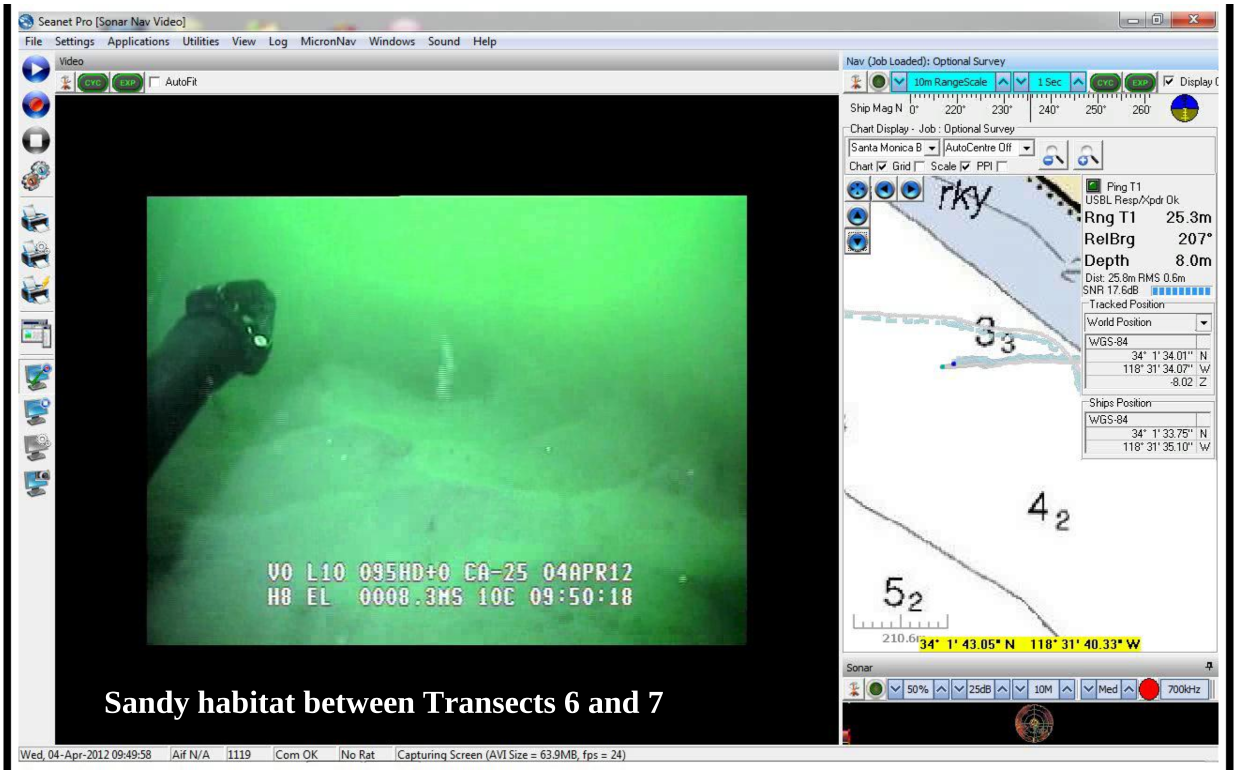


Chart ☑ Grid ☐ Scale ☑ PPI ☐

Ping T1
USBL Resp/Xpdr Ok
Rng T1 25.3m
RelBrg 207°
Depth 8.0m
Dist: 25.8m RMS 0.6m
SNR 17.6dB

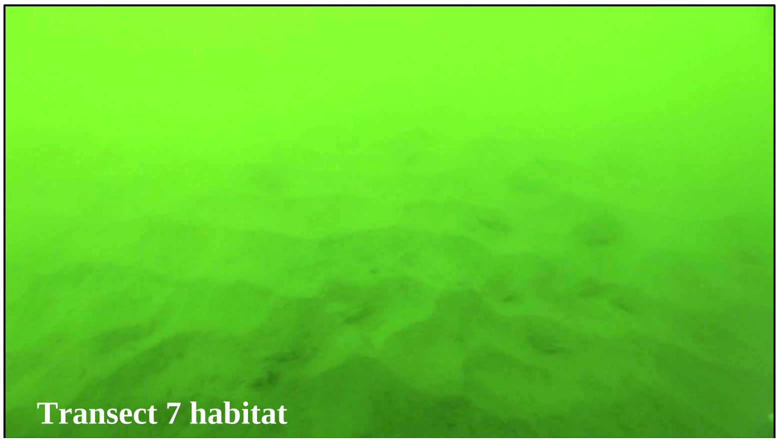
Tracked Position
World Position
WGS-84
34° 1' 34.01'' N
118° 31' 34.07'' W
-8.02 Z

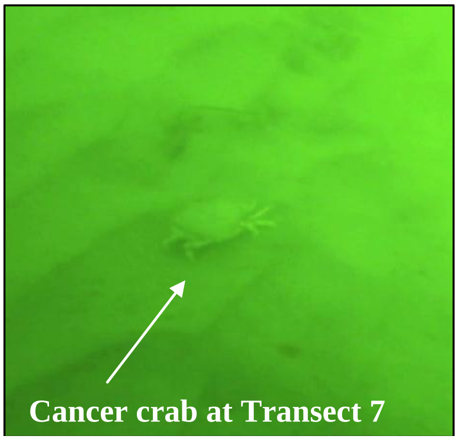
Ships Position
WGS-84
34° 1' 33.75'' N
118° 31' 35.10'' W

34° 1' 43.05" N 118° 31' 40.33" W

Wed, 04-Apr-2012 09:49:58 | Aif N/A | 1119 | Com OK | No Rat | Capturing Screen (AVI Size = 63.9MB, fps = 24)

Sandy habitat between Transects 6 and 7


Transect 7 habitat


Cancer crab at Transect 7

Habitat at Transect 8 included a small reef that was approximately 15 m (50 ft) in diameter and was located in approximately 7.6 m (25 ft) of water. Sandy, soft bottom habitat comprised the remaining area in Transect 8 outside of the reef. Sea pens and cancer crabs were observed in the sandy habitat.

The reef, which rose approximately 3m (10 ft) from the seafloor, was predominantly covered by gorgonian sea fans (*Lophogorgia chilensis* and *Muicea californica*) with small patches of open rock. Sessile invertebrates such as strawberry anemones (*Corynactis californica*), orange cup coral (*Balanophyllia elegans*), and hydroid species were observed on the reef as well as other more mobile invertebrates such as keyhole limpets (*Megathura crenulata*) and California sea cucumbers (*P. californicus*). Small amounts of various red algas (*Acrosorium uncinatum*, *Chondracanthus corymbiferus*, *Rhodymenia californica*, *Botyglossum farlowianum*, and *Gracilaria sp*.) and one species of brown algae (*Dictyota sp*.) were observed growing on the rocky substrate. Additionally, six fish species, including Garibaldi (*Hysypops rubicundus*), rubberlips surfperch (*Rhacochilus toxotes*), kelp bass (*Paralabrax clathratus*), barred sand bass (*Paralabrax nebulifer*), opaleye perch (*Girella nigricans*), and an unidentified perch species, were observed swimming along the reef. The egg case of a swell shark was also observed on the reef.

Reef at Transect 8

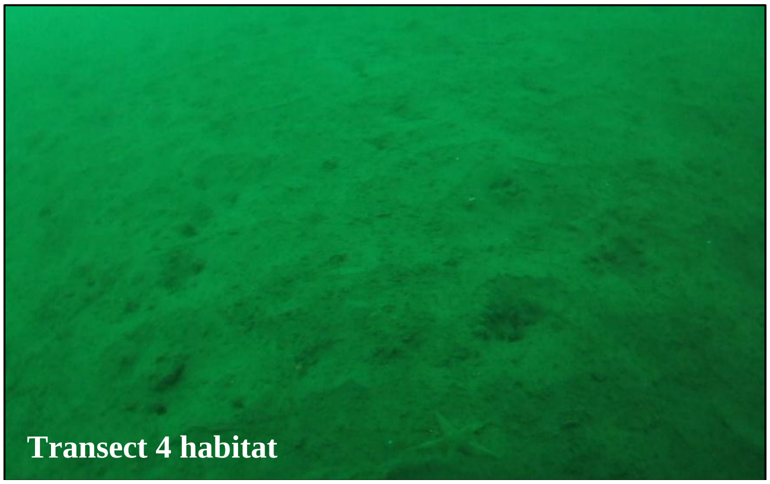
Cancer crabs mating in Sandy habitat at Transect 8

Offshore Habitat

Offshore habitat for the purpose of this report is defined as the habitat within the APE that occurs in greater than 60 feet of water. This would include the area from approximately Transect 3 to Transect 5 on the Option 1 cable route and from midway between Transect 8 and Transect 9 to Transect 10 on the Option 2 cable route. It also includes the Electrode Array and Reference areas.

Option 1 Cable Route

Offshore habitat along the Option 1 cable route was characterized entirely by soft bottom habitat. The deeper offshore sediments contained higher percentages of fine-grained material (silts and clays) than the coarse-grained sands that typified the nearshore environment (Figure 3-3). The seafloor in the vicinity of Transect 4 was sparsely populated by invertebrates such as spiny sea stars (*A. armatus*), sea pens (*S. elongata*), sea slugs (*Pleurobranchia californica*) and tube anemones (*P. fimbriatus*). Holes that were likely made by shrimp and/or polychaete worm species were also prevalent throughout the Transect 4 area and between Transect 4 and Transect 5.


Transect 4 habitat


***P. californicus* at Transect 4**

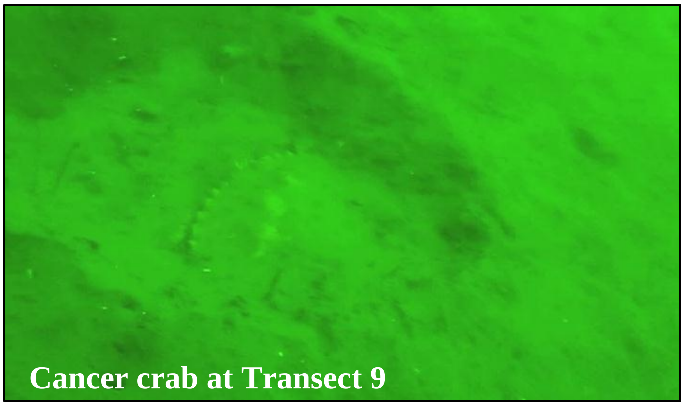
At Transect 5, the density of sea pens increased substantially while the density of spiny sea stars decreased (*A. armatus*) over what had been observed at Transect 4. A large plastic trash barrel, that appeared to have been in the water for a considerable amount of time, was found in Transect 5. Depths in this area ranged from approximately 28 m (92 ft) at Transect 4 to 38.1 m (125 ft) at Transect 5. Brittle stars (*Amphioda sp.*, and *Ophiura sp.*), polychaete worms (unidentified sp.), speckled sandabs (*Citharichthys stigmaeus*), sea cucumbers (*P. californicus*), and white sea urchins (*Lytechinus anamesus*) were also observed at Transect 5.


Trash barrel at Transect 5


S. elongata at Transect 5

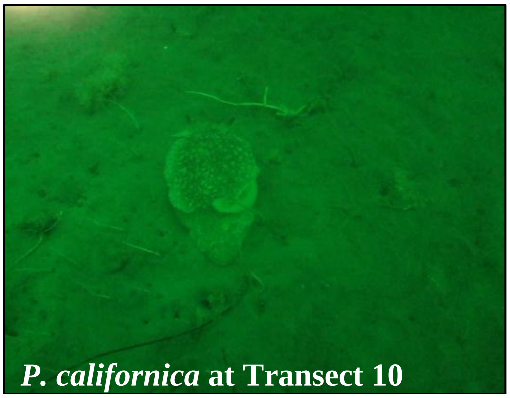
Option 2 Cable Route
Offshore habitat along the Option 2 cable route was similar to offshore habitat along the Option 1 cable route, and was characterized entirely by soft bottom substrate. The seafloor in this area was comprised of a higher percentage of fine-grained materials than the sandier nearshore environment (Figure 3-3). Transect 9 was sparsely populated by sea pens (*S. elongata*), tube anemones (*P. fimbriatus*), and several species of gastropods, including California cone snails (*Conus californicus*), Kellet's whelks (*K. kelletii*), and unidentified nudibranch species. Holes that were likely made by shrimp and/or polychaete worm species were also prevalent throughout the area from Transect 9 to Transect 10. Water depths from Transect 9 to Transect 10 ranged from 23.4 to 37.5 m (77 to 123 ft).


Tube anemone at Transect 9


Cancer crab at Transect 9

At Transect 10, brittle stars (*Amphiodia* sp. and *Ophiura* sp.), polychaete worm species, and sea pens (*S. elongata*) were the dominant fauna observed. Spiny sand stars (*A. armatus*), warty sea cucumbers (*Parastichopus parvimensis*), chestnut cowries (*Cypraea spadicea*), and colonies of bryozoans (*Thalamoporella californica*) were also present. Substrate at Transect 10 consisted of over 60% silts and clays.

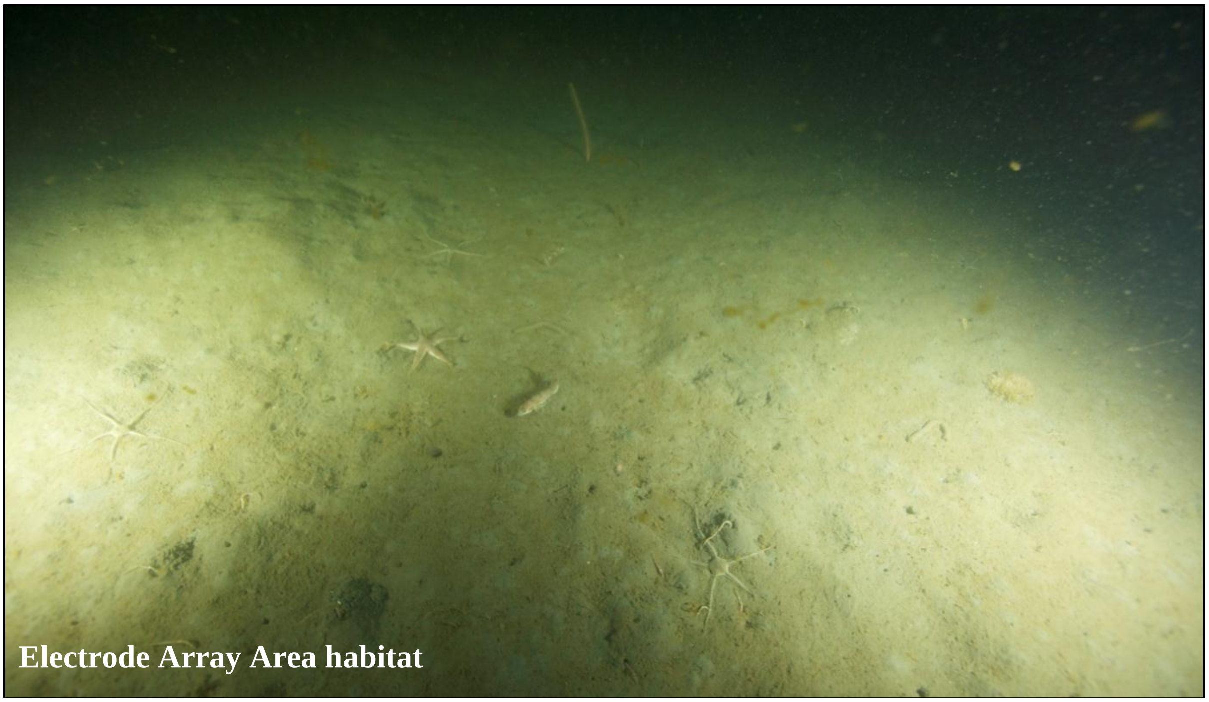
Brittle stars and bryozoan colony at Transect 10



***P. californica* at Transect 10**

Electrode Array Area

The soft bottom substrate in the Electrode Array Area was comprised of greater than 60% silts and clays. Almost no visible light reached the seafloor in this area, which averaged 48.2 m (158 ft) in depth. Observed fauna in this area included sea pens (*S. elongata*), brittle stars (*Amphiodia sp*. and *Ophiura sp*.), polychaete worm species, sea cucumbers (*P. californicus* and *P. parvimensis*), spiny sand stars (*A. armatus*), bryozoans (*Thalamoporella californica*), lizard fish (*Synodus lucioceps*), sea slugs (*Pleurobranchia californica*), cancer crabs (*Cancer sp*.), mantis shrimp (*Hemisquilla californiensis*), and egg casings from a moon snail (*Polinices lewisii*).



Electrode Array Area habitat

Sea slug and sea pens in Electrode Array Area habitat

3.8.1 Observed Species

Lists of species observed along the Option 1 Cable Route, Option 2 Cable Route, and Electrode Array Area are provided in Table 3-10, Table 3-11, and Table 3-12. The species contained in these lists were compiled by divers and through review of ROV and diver videos. Additional species observed in the vicinity of the project area included brown pelicans (*Pelecanus occidentalis*), Brandt's cormorant (*Phalacrocorax penicillatus*), California gulls (*Larus californicus*), western gulls (*Larus occidentalis*), and unidentified tern species.

Table 3-10. Observed Species along Option 1 Cable Route

Common Name	Scientific Name	Habitat Where Observed
Vertebrates		
Lizard fish	*Synodus lucioceps*	Soft bottom
Sculpin	Unidentified sculpin species	Soft bottom
California sea lion	*Zalophus californianus*	In water column over soft bottom
Speckled sanddab	*Citharichthys stigmaeus*	Soft bottom
Invertebrates		
Bat Star	*Asterina miniata*	Reef
Brittle star	*Amphiodia sp*	Soft bottom
Brittle star	*Ophiura sp*	Soft bottom
Brown gorgonian	*Muricea fruticosa*	Reef
California golden gorgonian	*Muricea californica*	Reef
California sea cucumber	*Parastichopus californicus*	Soft bottom and Reef
Cancer crab	*Cancer sp.*	Soft bottom
Chestnut cowry	*Cypraea spadicea*	Reef
Kelp crab	*Podochela hemphilli*	Reef
Jellyfish	*Scrippsia pacifica*	Water column
Kellet's whelk	*Kelletia kelletii*	Soft bottom
Kelp crab	*Taliepus nuttalli*	Reef
Mantis shrimp	*Hemisquilla californiensis*	Soft bottom
Moon snail (egg casing)	*Polinices lewisii*	Soft bottom
Nudibranch	*Hermissenda crassicornis*	Soft bottom
Orange anemone	*Urticina sp*	Soft bottom
Ornate tube worm	*Diopatra ornata*	Soft bottom
Purple sea urchin	*Strongylocentrotus purpuratus*	Reef
Red gorgonian	*Lophogorgia chilensis*	Reef
Red sea urchin	*Strongylocentrotus franciscanus*	Reef
Sea pen	*Stylatula elongata*	Soft bottom
Sea slug	*Pleurobranchia californica*	Soft bottom
Sheep crab	*Loxorhynchus grandis*	Reef
Spiny sand star	*Astropecten armatus*	Soft bottom
Strawberry anemone	*Corynactis californica*	Reef
Tube dwelling anemone	*Pachycerianthus fimbriatus*	Soft bottom
White sea urchin	*Lytechinus anamesus*	Reef

Table 3-10. Observed Species along Option 1 Cable Route

Common Name	Scientific Name	Habitat Where Observed
Algae		
Red algae	*Acrosorium uncinatum*	Reef
Palm kelp	*Eisenia arborea*	reef

Table 3-11. Observed Species along Option 2 Cable Route

Common Name	Scientific Name	Habitat Where Observed
Vertebrates		
Garibaldi (juv)	*Hysypops rubicundus*	Reef
Perch (no id)	Unidentified perch sp.	Reef
Rubberlips surfperch	*Rhacochilus toxotes*	Reef
Swell shark (egg case)	*Cephaloscyllium ventriosum*	Reef
Kelp bass	*Paralabrax clathratus*	Reef
Barred sand bass	*Paralabrax nebulifer*	Reef
Opaleye perch	*Girella nigricans*	Reef
Invertebrates		
Brittle star	*Amphiodia sp*	Soft bottom
Brittle star	*Ophiura sp*	Soft bottom
California Cone Snail	*Conus Californicus*	Soft bottom
California Golden Gorgonian	*Muricea californica*	Reef
California Sea cucumber	*Parastichopus californicus*	Reef and Soft bottom
Cancer Crab	*Cancer sp.*	Soft bottom and near Reef
Chestnut Cowry	*Cypraea spadicea*	Soft bottom
Hemphill's Kelp Crab	*Podochela hemphilli*	Reef and soft bottom near Reef
Hermit crab	*Pagurus sp.*	Soft bottom
Hydroid sp.	*Unidentified hydroid colony*	Reef
Kellet's Whelk	*Kelletia kelletii*	Soft bottom
Keyhole Limpet	*Megathura crenulata*	Reef
Moon Snail (egg casing)	*Polinices lewisii*	Soft bottom
Nudibranch (no id)	Unidentified nudibranch sp.	Soft bottom
Orange cup coral	*Balanophillia elegans*	Reef
Razor Clam	*Siliqua patula*	Soft bottom
Red Gorgonian	*Lophogorgia chilensis*	Reef
Rock Scallop	*Crassadoma gigantea*	Reef
Sea Pen	*Stylatula elongata*	Soft bottom
Sea star	*Unidentified sea star species*	Soft bottom
Sea slug	*Pleurobranchia californica*	Soft bottom
Spiny Sand Star	*Astropecten armatus*	Soft bottom
Tube dwelling Anemone	*Pachycerianthus fimbriatus*	Soft bottom
Warty sea cucumber	*Parastichopus parvimensis*	Soft bottom
Wavy turban	*Lithopoma undosum*	Soft bottom

Table 3-11. Observed Species along Option 2 Cable Route

Common Name	Scientific Name	Habitat Where Observed
Bryozoan	*Thalamoporella californica*	Soft bottom
Algae		
Red algae	*Acrosorium uncinatum*	Reef
Red algae	*Chondracanthus corymbiferus*	Reef
Red algae	*Rhodymenia californica*	Reef
Red algae	*Botyglossum farlowianum*	Reef
Red algae	*Gracilaria sp.*	Reef
Brown algae	*Dictyota spp.*	Reef

Table 3-12. Observed Species along Electrode Array Area

Common Name	Scientific Name	Habitat Where Observed
Invertebrates		
Brittle star	*Amphiodia sp*	Soft bottom
Brittle star	*Ophiura sp*	Soft bottom
California Sea cucumber	*Parastichopus californicus*	Soft bottom
Cancer Crab	*Cancer sp.*	Soft bottom
Mantis shrimp	*Hemisquilla californiensis*	Soft bottom
Moon Snail (egg casing)	*Polinices lewisii*	Soft bottom
Sea Pen	*Stylatula elongata*	Soft bottom
Sea slug	*Pleurobranchia californica*	Soft bottom
Spiny Sand Star	*Astropecten armatus*	Soft bottom
Tube dwelling Anemone	*Pachycerianthus fimbriatus*	Soft bottom
Warty sea cucumber	*Parastichopus parvimensis*	Soft bottom
Bryozoan	*Thalamoporella californica*	Soft bottom

3.8.2 Special Status Species

Four special status species were observed within the vicinity of the study area, all were species of marine mammals: California sea lion (*Zalophus californianus)*, minke whale (*Balaenoptera acutorostrata)*, grey whale (*Eschrichtius robustus*), and common dolphin (*Delphinus delphis*). Terns were also observed within the vicinity of the study area; however, the observer could not determine from a distance the species.

Additional special status species that are known to occur within Santa Monica Bay, but were not observed during field activities, are listed in the literature review document (Appendix A). This list includes state and federally endangered, threatened, or otherwise protected birds, cetaceans, pinnipeds, fish, sea turtles, and invertebrates.

3.8.3 Benthic Habitat Characterization

The approximate overall percentages of soft bottom and hard bottom (reef) habitat for each of the project areas are shown in Table 3-13. It should be noted that these percentages are based upon direct observation only from ROV and dive surveys. Due to the large size of the APE and reduced visibility during the surveys, only a portion of the cable routes and electrode array were assessed.

The Option 1 cable route contained a low-relief cobble reef that was approximately 305 m (1,000 ft) in length and occurred south of the centerline of the proposed cable route in approximately 7.6- 10.7 m (25-35 ft) of water. Aside from this reef, the rest of the benthic habitat along the Option 1 cable route was soft bottom, comprised of sand, silt and clay. The Option 2 cable route contained a small reef that was approximately 15.3 m (50 ft) in diameter, rising approximately 3 m (10 ft) above the seafloor. This small reef was the only hard substrate along the Option 2 cable route and comprised less than 1 percent of the cable route’s total length. The entire Electrode Array Area was comprised solely of soft-bottom substrate.

Table 3-13. Type of Benthic Habitat Observed along Cable Routes and Electrode Array Area

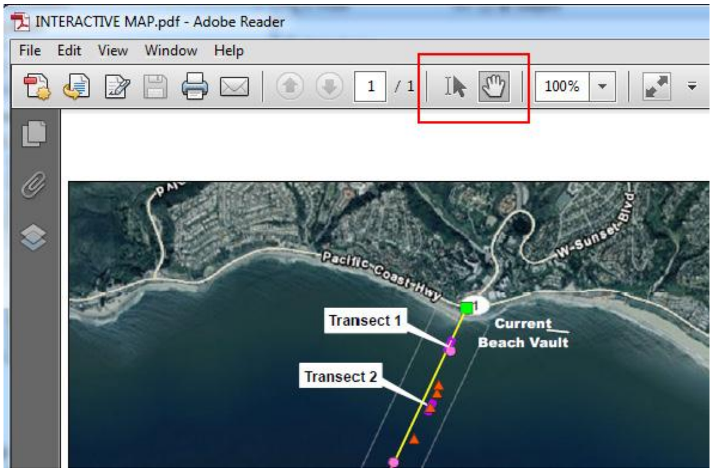
Project Area	Nearshore (depth 0- 60 ft)		Offshore (depth >60 ft)	
	Soft Bottom Substrate (%)	Hard Bottom Substrate (%)	Soft Bottom Substrate (%)	Hard Bottom Substrate (%)
Option 1 Cable Route	90	10	100	0
Option 2 Cable Route	99	1	100	0
Electrode Array Area	NA	NA	100	0

3.9 Observed Human Uses within the Area of Potential Effect

During the field sampling and surveys, human activities that were observed within close proximity to the APE included recreational fishing, surfing, sailing, motor boating, and parasailing. Surfing and parasailing activities occurred in the nearshore area within approximately 305 m (1,000 ft) of the shoreline, whereas recreational fishing, sailing and boating occurred in both nearshore and offshore waters of the APE. No submerged pipes, cables, or other types of human infrastructure were observed during the ROV and dive surveys.

3.10 Summary of Results - Interactive Map

An interactive map that is linked to a summary page with habitat descriptions, site photos, data from water quality, water chemistry, sediment chemistry and benthic infauna is provided in Figure 3-6. To access the interactive map links, use the Select (arrow) or Pan (hand) tool in Adobe Reader, as shown in the red box of the screen shot to right, to click on a transect area within the map. This action will open the appropriate summary page describing the transect area.



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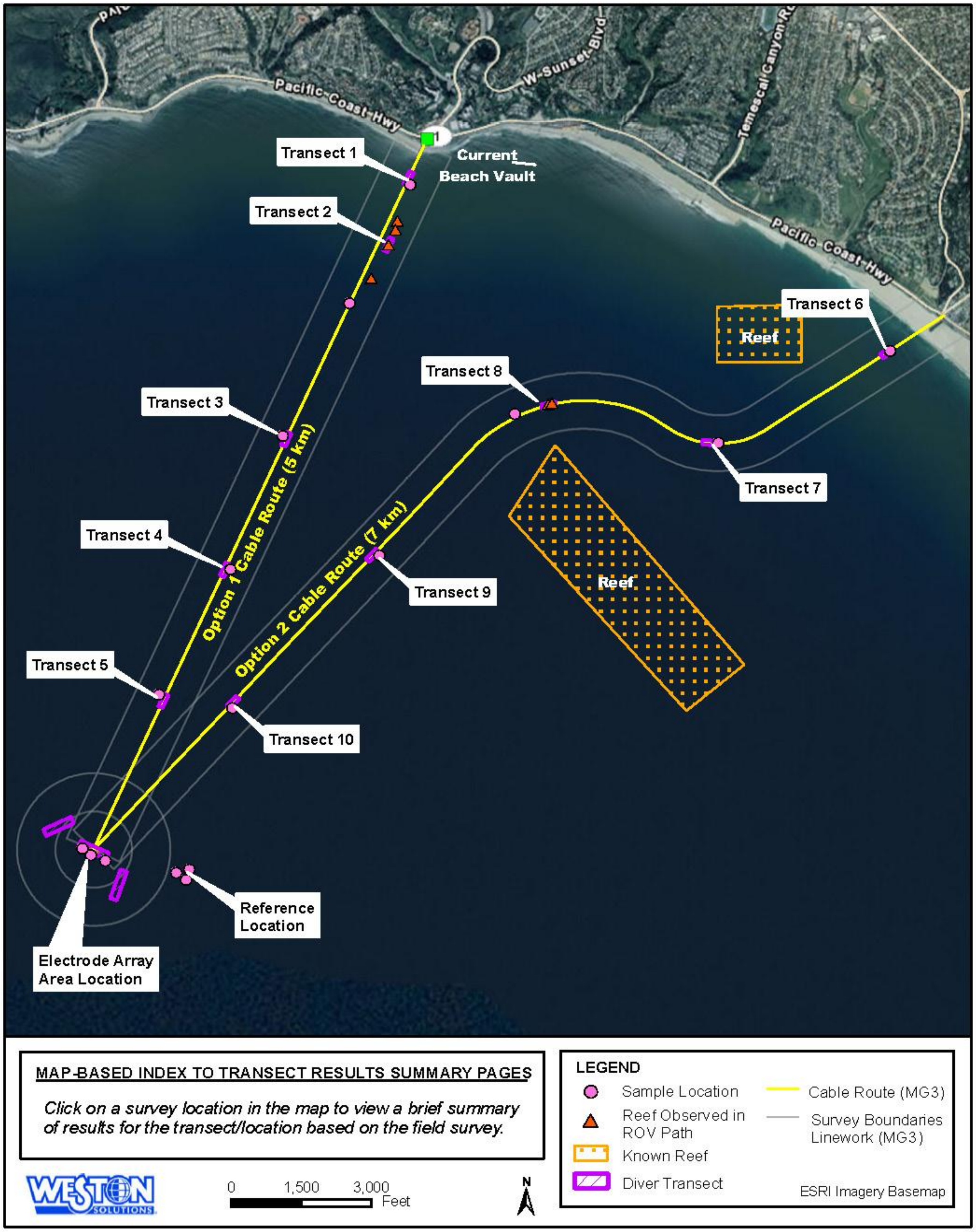

Figure 3-6. Interactive Map with Links to One-Page Summaries of Study Transects/Locations

4.0 DISCUSSION

The discussion compares the marine biological resources and habitat quality between the two optional cable routes, compares the biological resources within the APE to those of Santa Monica Bay, and determines potential short-term and long-term impacts of the project on the local marine environment. Measures to avoid, minimize, and mitigate potential impacts to biological resources and human uses are also discussed.

4.1 Comparison of Biological Resources between Optional Cable Routes

Field surveys showed that physical and chemical water quality parameters, concentrations of chemicals of concern in sediments, toxicity, and benthic infaunal community condition did not differ between optional cable routes. Option 1 cable route contained a 61 m by 305 m (200 ft by 1,000 ft) rocky reef, while Option 2 cable route included a much smaller 15 m by 15 m (50 ft by 50 ft) reef. In both cases, the optional cable routes were otherwise comprised of sandy soft bottom habitat within the APE. Additionally, the Electrode Array Area solely contained soft bottom habitat. For both cable routes, rocky reef areas could be avoided by routing the cables around the outcroppings. The results of bathymetric surveys, including sub-bottom profiling, will provide detailed maps of the bottom that can be used to route cables. There is one primary difference between the optional cable routes – Option 2 cable route is approximately 2,000 m (1.24 mi) longer than that of Option 1 because Option 2 was routed to avoid two artificial reefs. Therefore, the Option 2 route would require the installation of more cable, which would involve disturbance of a greater area of soft bottom habitat than Option 1. As described in greater detail in the impact analysis, placement of cables are projected to only result in a temporary disturbance to habitat because cables will be buried approximately 1 m below the seafloor. This would allow the recolonization of the area by the benthic community.

4.2 Comparison of Biological Resources between Area of Potential Effect and Santa Monica Bay

The vast majority of Santa Monica Bay is comprised of soft bottom sandy habitat, with the largest areas of rocky reefs occurring at the southern and northern ends of the bay in addition to localized patch reefs. Accordingly, the bay supports a benthic and demersal community that is largely characteristic of sandy bottom habitats throughout the majority of the area. Similarly, the APE was found to contain predominantly soft bottom habitat with a minor amount of rocky reef habitat. Habitat within the APE was observed to support a benthic and demersal community that was consistent with soft bottom habitats within the larger bay. Additionally, the rocky reef habitats of the APE supported distinct biological communities, with gorgonians being one of the most prevalent taxa observed. The water column and surface waters within the APE provides similar foraging, migratory, and overall habitat characteristics as that of the majority of Santa Monica Bay, therefore, it is reasonable to assume that similar marine and avian species will have the potential to occur within the APE.

Given that Santa Monica Bay is located at the terminus of a highly urbanized watershed, the Bay has been subjected to point and non-point inputs of pollutants, resulting in detectable levels of contaminants of concern within the sediments. It has been estimated that 90% of the surface sediments of the bay are contaminated (Schiff, 2000); however, observed sediment toxicity is far less common. Similarly, sediments sampled within the APE had detectable levels of contaminants of concern; however, the concentrations of these chemicals were largely below levels expected to cause adverse biological effects. Accordingly, sediment toxicity was only observed in one sample, which was located within the Reference Area, and benthic infaunal community condition was indicative of reference or at most low levels of disturbance, similar to what has been found throughout other areas of the bay.

The multiple lines of evidence assessed showed that the overall habitat and sediment and water quality conditions within the APE are consistent with the conditions of the majority of Santa Monica Bay. The most recent regional surveys conducted in the Southern California Bight (Bight ’08) indicate that conditions in Santa Monica bay are broadly similar to those in the APE for a given depth strata. In comparison to the Bight ’08 Survey results, samples collected in the APE were of comparable grain size and TOC for those stations collected from the Inner Shelf sites in Santa Monica Bay. Bight ’08 samples consisted of primarily silt and sand with the proportion of fine-grain sediments increasing with depth. These regional conditions were similar to those observed in the APE.

Grain size and TOC concentration can have a dramatic influence on concentrations of a number of constituents, particularly organics and metals. Although concentrations of some constituents increased with depth, in general they were lower than those reported in the Bight ’08 Survey for a given depth. Several Bight ’08 stations in Santa Monica Bay had constituent concentrations above the ER-L, but no concentrations were above the ER-M. All samples collected from the Inner Shelf, which are more comparable to the APE, had metals detected below the ER-L.

Toxicity and concentrations of chlorinated pesticides, PCBs, and PAHs in the Santa Monica Bay Bight ’08 samples were also low and generally similar to those observed in the APE. In addition, there were no marine biological resources that were found to be unique or distinct to the APE as compared to the larger bay or the Southern California Bight as a whole. These similarities between sediments within the APE and those found region-wide suggest that impacts within the APE would be expected to have population-level impacts in proportion to the relative size of the APE to the overall bay.

4.3 Impact Analysis

This section evaluates short- and long-term impacts to sediment and water quality, the biological community, and human uses that could result from project construction and ongoing operation within the APE. Mitigation measures (MM) are suggested to avoid, minimize, and mitigate potential project impacts.

4.3.1 Short-term Project Impacts

Short-term potential project impacts within the marine environment are considered to be those impacts associated with the construction of the electrode array and placement of the submarine cables. Construction activities are anticipated to involve the use of vessels and heavy equipment and disturbance of the sea floor, which could impact benthic organisms and water quality due to the suspension of sediments and potential release of contaminants. Additionally, increased vessel operations and use and lowering of equipment through the water column could have the potential to temporarily impact swimming biota, as well as birds, that transit, forage, or reside in the region. These potential impacts are anticipated to be highly localized to the APE, temporary as they will only extend throughout the period of construction, and less than significant with mitigation.

4.3.1.1 Sediment and Water Quality (SWQ)

As defined in Section 13030 of the California Water Code, water quality inputs of concern include discharges that create pollution, contamination, or nuisance or that release toxic substances deleterious to humans, fish, bird, or plant life. The use of vessels during construction operations can increase the potential for localized accidental spills of hazardous chemicals, such as oil; however, this risk is no greater than ongoing recreational and commercial vessel operations within the region. Additionally, small spills would be unlikely to cause a significant adverse effect to water or sediment quality because wave action and current dynamics within Santa Monica Bay would disperse and dilute potential inputs, reducing concentrations below levels expected to have toxic effects on biota (California State Lands Commission, 2010).

MM SWQ-1: To reduce potential for accidental spills and discharges that could impact water and sediment quality during construction, the following best management practices (BMPs) are recommended:

- Discharge of hazardous materials during construction activities into the study area shall be prohibited.
- A comprehensive spill prevention plan shall be developed that documents that management practices that vessels will enact to limit the potential for accidental spills.
- An environmental protection plan shall be developed that addresses issues related to storage and handling of fuel, waste disposal, vessel operation, and field policies.
- All debris and trash shall be disposed in appropriate trash containers on land or on construction barges by the end of each construction day.

Construction activities, including the placement of electrodes and laying of cables, also have the potential to result in the suspension of sediments within the APE. Sediment suspension could increase turbidity and contaminant concentrations within the water column. Increases in turbidity would only last for the duration of immediate construction activities, reducing light penetration to the seafloor. Reductions in light penetration are most relevant to photosynthetic organisms, such as algae; however, observations of the biological habitat and community showed that the benthos is predominantly comprised of soft bottom habitat with very low levels of algal cover. Additionally, reduced light levels could also impact species that rely on visual cues for foraging, such as motile invertebrates, fish, and mammals. It is unlikely that construction activities would increase turbidity beyond levels commonly encountered during high wave events and storms; therefore, the impact of construction on turbidity would be both short term and within the natural level of variability. Sediment resuspension also has the potential to increase the concentrations of contaminants in the water column; however, this potential impact is likely to be minimal since concentrations of contaminants of concern measured within the APE were below the thresholds for likely toxicity (i.e., ER-Ms) for all analytes. There were a limited number of analytes, such as DDT, mercury, and total PCBs, that were between the ER-L and ER-M (i.e., concentrations that have some potential for biological effects); however, bioassay tests of the sediments did not show evidence of toxicity within the APE. These contaminants occurred at concentrations that are typically found in Santa Monica Bay, largely due to legacy inputs of pollutants, and, therefore, resuspension would not be expected to result in an increase in the distribution of contaminants of concern above baywide background levels. Additionally, sediment suspension would not necessarily result in increased bioavailability of contaminants in the water column since contaminants are often bound to sediments and quickly settle following disturbance events and may not substantially increase contaminant concentrations in the overlying water (Chadwick et al., 1999). By using mitigation measures that minimize sediment suspension, short term impacts on sediment and water quality would be less than significant.

MM SWQ-2: Utilize cable installation methodologies that minimize suspension of sediments into the water column, to the extent practicable, including:

- Performing tunneling from the shoreline to 300 m offshore to install cables in order to limit disturbance of the seafloor in the nearshore environment.
- Use plowing and immediate back filling of trenches once the cables have been laid for the APE extending from 300 m offshore to the electrode array.

4.3.1.2 Biological Community

Placement of the concrete electrode vaults and cables on the seabed will be confined to areas with soft bottom habitat, and, therefore, are not expected to adversely affect sensitive habitats or essential fish habitat, such as kelp forests and rocky reefs. Additionally, installation of the cables in the nearshore environment (i.e., within 305 m (1,000 ft) of the shoreline) will be accomplished using directional drilling, avoiding impacts to the intertidal and shallow subtidal environment and associated biota. Within deeper portions of the APE, cables will be installed using trenching and burial. Both electrode and cable installation would result in impacts to nonmotile or slow moving benthic species, including epifauna and infauna. Installation of the electrode vaults would result in a permanent loss of soft bottom habitat and replacement with hard bottom habitat, while cable installation would only result in a temporary disturbance to the habitat and associated community. Since the benthic community is highly disturbance adapted and can re-colonize the soft bottom habitat following cable burial, placement of the cables will only result in a temporary impact to slow moving and non-motile benthic species.

MM BIO-1: Use the results of detailed bathymetric surveys to ensure that electrode array placement and cable routing avoids sensitive habitats and essential fish habitat, such as kelp forests and rocky reefs.

MM BIO-2: Perform pre-construction surveys, as required by resource and regulatory agencies, to determine if final project construction plans will impact sensitive and protected marine resources.

MM BIO-3: Utilize cable installation methodologies that minimize disturbance and permanent habitat alteration of benthic habitat, to the extent practicable, including:

- Performing tunneling from the shoreline to 305 m (1,000 ft) offshore to install cables in order to limit disturbance of the intertidal zone and rocky reefs in the nearshore environment.

- Use plowing and immediate back filling of trenches once the cables have been laid for the APE extending from 305 m (1,000 ft) offshore to the electrode array to restore soft bottom habitat.
- Bury cables to a depth of 1 m (3.3 ft), to the extent practicable, to limit potential for biological interaction during burrowing and foraging.

Project construction is not anticipated to result in adverse population-level impacts to the biological community since the benthic species observed within the APE consists of common species found throughout Santa Monica Bay and the Southern California Bight. Special status species observed, or that have the potential to occur, within the APE included highly motile species that can avoid construction activities, such as pinnipeds, cetaceans, and birds. Given the small footprint of the project relative to Santa Monica Bay, the project is not likely to interfere substantially with the movement or foraging of any native or migratory marine or avian species. However, vessels could collide with marine mammals or sea turtles, resulting in a potential “take” of special status species, which would be a significant impact. Therefore, it is recommended that vessels transporting equipment and supplies to the site and performing construction activities follow mitigation measures to minimize this potential impact.

MM BIO-4: Implement standard marine mammal and sea turtle avoidance mitigation measures, including:

- Requiring vessels involved in construction activities maintain a steady course and speed.
- Avoidance of the immediate areas with marine mammals or sea turtles whenever possible.
- Requiring the presence of a biological monitor on vessels during construction activities.
- Training construction and vessel crews to recognize and avoid marine mammals and sea turtles prior to initiation of project construction activities.
- Reporting of collisions with marine wildlife promptly to federal and state resource agencies.

Construction activities may result in additional noise in the marine environment. Many marine mammals depend on acoustics to communicate and understand their environment and excessive underwater noise could impact their ability to feed and interact. In extreme cases, high levels of noise could result in impairment or injury. Heightened noise levels may be caused by operation of vessels in the APE, trenching, and installation of vaults. Noise levels are likely to be within the range of those caused by other human uses frequently occurring within the area, such as the transit of large power boats; therefore, this impact is anticipated to be less than significant.

4.3.1.3 Human Uses

Impacts to human activities, such as diving, commercial and recreational fishing, surfing, and recreational boating, due to construction activities are expected to be temporary and constrained to immediate areas where work is being performed. Human uses, such as surfing, swimming, and shorefishing, are most pronounced in the nearshore area. Since directional drilling will be used to avoid these areas, project construction should not result in a significant impact to these human activities. Offshore construction activities may limit the use of the APE by divers, fisherman, and boaters, but only in the immediate vicinity of ongoing activities. Additionally, existing data reviews and field surveys did not detect human infrastructure that could be damaged or impacted within the APE. Therefore, by limiting the duration of construction to the extent practicable and implementing best management practices that ensure public safety, construction-related impacts to human uses of the marine environment are anticipated to be less than significant.

4.3.2 Long-term Project Impacts

Long-term potential project impacts could result from the generation of electromagnetic fields, production of chlorine gas, habitat modification, and entanglement of fishing gear with vaults and exposed cables. Potential impacts to sediment and water quality, the biological community, and human uses are discussed as follows.

4.3.2.1 Sediment and Water Quality

Once the electrode system construction has been completed, the system is unlikely to result in resuspension of sediments that could impact water quality. Routine maintenance activities would not require excavation or disturbance of sediments. In the event that one or more of the cables required repair or replacement, excavation could result in sediment resuspension and potential short term impacts to water quality as previously discussed.

MM SWQ-2: Utilize cable installation methodologies that minimize suspension of sediments into the water column, to the extent practicable, as previously described.

Operation of the existing electrode system has been reported to generate chlorine gas as a byproduct of the electrolysis process, and the proposed conceptual electrode array has been modeled to produce up to 140 kg (309 lbs.) of chlorine per year. Chlorine is an oxidizing biocide that is non-selective in terms of the organisms that it has the potential to affect. Free chlorine (chlorine gas dissolved in water) is toxic to fish and aquatic organisms at concentrations greater than 0.01 mg/L. However, its dangers are relatively short-lived because it reacts quickly with other substances in water or dissipates as a gas into the atmosphere. When chlorine gas is dissolved in water, it hydrolyses rapidly to yield hypochlorous acid, which is also an effective biocide. If water contains large amounts of decaying materials, free chlorine can combine with organics to form compounds called trihalomethanes (THMs). Some THMs in high concentrations are carcinogenic to people, and unlike free chlorine, THMs are persistent and have the potential to impact biota for longer durations. While chlorine gas and its bi-products have the potential to adversely impact biota, there have been no reports of higher levels of marine biota mortality in the vicinity of the existing electrode as compared to other areas of Santa Monica Bay. Additionally, the existing electrode vaults support fish and invertebrate communities that are consistent with hard bottom substrates within Santa Monica Bay.

MM SWQ 3 – Utilize electrode materials and design elements that limit the production of chlorine gas to the maximum extent practicable.

4.3.2.2 Biological Community

The electrode system would not emit noise, and therefore would not disturb biological resources. Additionally, the submarine electrode system facilities would not impede the movement of native or migratory species, since the submarine cables and vaults or others structures would be laid on or beneath the ocean floor; therefore the primary potential impact resulting from the operation of the electrode system is the generation of EMFs that could impede foraging and navigation of marine species.

Electromagnetic Fields

Operation of the electrode array is anticipated to be limited to approximately 50 hours per year (0.57% of the year), with discrete operation events lasting for durations not to exceed 160 minutes. During grounding events, the electrode array has been modeled to produce EMFs that are below human health and safety standards, but are at levels that have been reported to be detectable by marine organisms.

Navigation and prey detection are the two most commonly reported uses of EMFs by marine organisms. Of the majority of literature reviewed, detection thresholds for steady DC electric fields ranged from 10^{-6} to 10^{-3} V/m (Gradient Corporation, 2006). These fields primarily affect fish and mainly the elasomobranchs (skates, rays, and sharks). Elasmobranchs are reported to have a higher potential for sensitivity to EMFs resulting in either attraction or avoidance within near proximity to the source of the EMF. Evidence of shark bites on submarine optical telecommunications cables was associated with electric fields between 1 and 6.3 µV/m (Gill, 2005). Additionally, Gill described studies demonstrating attraction by European eels (*Anguilla anguilla*) and the prawn (*Crangon crangon*). Additional evidence of shark attacks on undersea cables was reported for dogfish (*Mustelus canis*), stingray (*Urolophus halleri*), blue shark (*Prionace glauca*), and bonnet head sharks (*Sphyrna tiburo*) (Fischer and Slater, 2010). Gill (2005) suggested that electric fields emanating from undersea cables have the potential to be detected by electrosensitive species. At levels that approximate the bioelectric fields of natural prey there is the potential for these species to be attracted to them; however, Gill further stated that whether the species would be attracted or repelled is unknown at this time.

The electric field generated by the proposed 88-vault electrode array is predicted to be 1.077 V/m at a position of 1 cm above the vault gravel surface, at maximum in a worst case scenario when only six of eight electrode sections are functioning. Even at this worst case scenario, the strength of the field is below the International Commission on Non-Ionizing Radiation Protection (ICNIRP) pre-standard International Electrotechnical Commission (IEC) 62344 of 1.25 V/m to protect biota. The strength of the field decreases exponentially with distance from the electrode array, and was modeled by CESI to be 5.6 e^{-2} V/m (0.056 V/m) at a distance of 6.4 m (21 ft) from the electrode vault surface (i.e., at a depth of 40 m (131 ft)). At these levels, species with electrical sensory abilities, such as elasmobranchs, would be able to detect the field, since these species have been reported to detect electric fields as weak as 1 nV/m (Fisher and Slater, 2010). While predicted strength of the electric field is within the detection limits of select marine species, the strength is below reported thresholds for clearly harmful effects on fish, including electronarcosis and paralysis, which were detected at fields greater than 15 V/m (Balayev, 1980; Balayev and Fursa, 1980).

The magnetic field generated by the proposed 88-vault electrode array is predicted to be approximately 10 microTesla (µT) at the sea surface, which is far below the IEC limit of 500 µT (5 gauss [G]). The most sensitive organisms to magnetic fields include eels, which have sensitivities as low as a few µT (1 x 10^{-6} tesla). Other organisms that are sensitive to magnetic fields and use them for navigation include sea turtles, salmonids, elasmobranchs, whales, and dolphins (reviewed by Fisher and Slater, 2010). Sensitive species included the common dolphin

(*Delphinus delphis*), Risso's dolphin (*Grampus griseus*), Atlantic white-sided dolphins (*Lagenorhynchus acutus*), finwhale (*Balaenoptera physalus*), and the long-finned pilot whale (*Globicephala malaena*) (Kischvink et al., 1986). While infrastructure-induced magnetic fields have been reported to be detectable by a number of marine species, evidence is less clear that the fields are adversely affecting navigation.

Magnetic fields have been shown to delay embryonic development in sea urchins and fish (Cameron et al., 1993; Zimmerman et al., 1990; Levin and Ernst, 1997), and alter the development of cells, influence circulation, gas exchange, development of embryos, and orientation (reviewed by Fisher and Slater, 2010). Static magnetic fields, ranging from 10 µT to 0.1 T, can cause a delay in sea urchin embryo development (Levin and Ernst, 1997). Magnetic fields have also been shown to affect development of salmonid embryos and elicit orientation responses in embryos. While there have been detectable effects, experiments using lobster, the blue mussel, prawns, crab, and flounder showed no effects on survival).

The electric and magnetic fields generated by the proposed 88-vault electrode array operating at 3,650 A, while detectable by marine organism, are modeled to be far less than the fields modeled for the existing electrode array at current operating levels. Therefore, the operation of the proposed electrode array would be anticipated to have a diminished potential to impact the surrounding biota as compared to the existing system that has been in operation for more than 40 years.

MM BIO-5: Incorporate design elements and operating procedures that minimize the generation of electric fields so that field strengths are less than the ICNIRP pre-standard of 1.25 V/m.

MM BIO-6: Incorporate design elements and operating procedures that minimize the generation of magnetic fields so that field strengths are less than the IEC limit of 500 µT.

Habitat Loss

Placement of the concrete electrode vaults on the seabed will be confined to areas with soft bottom habitat, and, therefore, are not expected to adversely affect sensitive habitats or essential fish habitat, such as kelp forests and rocky reefs. The placement of the 7.5-m (24.6 ft) diameter by 1.95-m (6.4 ft) tall vaults will result in the loss of soft-bottom habitat that supports benthic infaunal, epifaunal, and demersal species. Cables connecting the electrode arrays within the Electrode Array Area are anticipated to be exposed, further altering the soft bottom habitat in this area. The vaults will replace the soft bottom habitat with hard bottom structure that will provide increased habitat heterogeneity and hard substrate that can aggregate and support a more diverse assemblage of marine algae, invertebrates, and fish than sandy bottom habitat alone.

MM BIO-1: Use the results of detailed bathymetric surveys to ensure that electrode array placement and cable routing avoids sensitive habitats and essential fish habitat, such as kelp forests and rocky reefs.

MM BIO-2: Perform pre-construction surveys, as required by resource and regulatory agencies, to determine if final project construction plans will impact sensitive and protected marine resources.

4.3.2.3 Human Uses

The proposed placement of the electrode array approximately 5 km (3.1 mi) offshore and at a depth of 45.7 m (150 ft) greatly reduces the potential for direct human interactions, primarily through diving. The current electrode system is located only 1.8 km (1.1 mi) from shore and at a depth of 15 m (50 ft), which is well within the ranges of depths and distances from shore where SCUBA and free diving activities are most common. In the electrode array's current location, there have been no reports of adverse impacts of the system on human health while diving. Moving the electrode array further offshore will decrease the potential for direct human interaction as well as health and safety concerns. Furthermore, the burial of subsea cables, achieved through a combination of horizontal drilling and trenching and filling, will reduce the potential for direct human interactions during swimming, surfing, diving, or fishing. Therefore, implementation of MM BIO-3 would also reduce potential human health and safety risks.

The concrete vaults and exposed cables of the electrode array have the potential to adversely affect commercial fishing due to the potential for entanglement of trawl nets during bottom fishing. However, the electrode array is anticipated to confined to an area of approximately 196,000 m^2, assuming an approximately 500 m (1,640 ft) diameter for the electrode array, which would result a minor reduction in the trawlable area of Santa Monica Bay, and would not be expected to impact recreational hook and line fishing. The use of surface buoys and inclusion of the electrode array location on navigational charts, as has been done for the existing electrode array, would greatly reduce the potential for impacts to commercial and recreational fishing, since the immediate area could be avoided during trawling.

MM HU-1: Mark the position of the electrode array using surface buoys and notify the U.S. Coast Guard and other responsible entities of the position and as-built characteristics of the electrode array and any other related infrastructure that could entangle fishing gear.

The generation of an EMF during electrode operation has the potential to increase corrosion of marine and onshore human infrastructure. The potential for corrosion is affected by the strength of the electric field, the duration in which the electrode is operating, and the proximity of metallic and potentially corrodible infrastructure to the electric field. In CESI's study that assessed the "Impact of the Electrodes on Other Facilities", it was noted that metallic infrastructure within in a 5-km (3.1 mi) radius of the electrode array would be the most likely to be affected by corrosion. While there have been no reports of increased corrosion for metallic objects within the vicinity of the existing electrode array, the proposed electrode system is being designed to have a maximum design value of 3,650 A, which is greater than the existing electrode system operational current of 3,100 A. Positioning the proposed electrode array at an approximate distance of 5 km (3.1 mi) offshore would reduce the potential for increased corrosion since metallic infrastructure in the project vicinity is would be exposed to leakage currents below 0.02 A/m^2 in all areas except in the immediate vicinity of the shoreline near Topanga State Park.

MM HU-2: Monitor metallic infrastructure in immediate coastal areas that have the potential to be exposed to leakage currents greater than 0.02 A/m^2, and use corrosion minimization measures to reduce corrosion risk.

4.4 Conclusion

The biological resources encountered within the APE were consistent with those reported to occur within sandy and rocky bottom areas of Santa Monica Bay. While the habitat of the APE was not unique, it does have the potential to support special status species, as evidenced by the observation of four marine mammals as well as a tern species during biological reconnaissance surveys. Therefore, mitigation measures are recommended that limit the potential for "take" of protected species during project construction. These measures would be incorporated regardless of the alternative cable route selected, since habitat and sediment and water quality conditions were equivalent between routes.

Construction activities would be expected to have temporary impacts on marine resources and human uses, since impacts on water quality, potential increased noise levels, vessel operation, and human uses, such as fishing and boating, would only occur over a limited time period of several months within the APE. These potential impacts are anticipated to be highly localized to the APE, temporary as they will only extend throughout the period of construction, and less than significant with mitigation.

Long-term potential project impacts could result from the generation of EMFs, production of chlorine gas, habitat modification, and entanglement of fishing gear with vaults and exposed cables. By positioning the electrode approximately 5 km (3.1 mi) offshore and incorporating design elements that limit the strength of EMFs, impacts on human infrastructure, such as corrosion, and direct human interactions during diving, will be reduced to levels that are less than significant. Additionally, by limiting the use of exposed cables, there will be less potential for direct interaction with biota with electrosensory capabilities and entanglement of fishing gear. Habitat modification due to the placement of concrete vaults on soft-bottom habitat cannot be avoided; however, these structures have the potential to provide hard substrate that has been shown to support marine biota based on assessments of the existing marine electrodes. The production and release of chlorine gas may be a potential environmental concern; however, the use of design elements that limit its production in conjunction with further studies that model the potential for elevated concentrations would be helpful in better assessing this potential risk.

In conclusion, the construction and operation of the proposed electrode would be anticipated to reduce potential impacts to marine resources relative to the current operating electrode system. Since there have been no long-term impacts reported for the current operating subsea system, it is reasonable to assume that the new system, with its upgraded design elements, would have minimal effects on the marine environment.

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APPENDIX B

New or Upgraded Electrode Design and Study, Feasibility Analysis for New Electrode Array Location, Electric Field and Voltage Gradient Studies, and Magnetic Field Study

Client Burns and McDonnell - Brea Office – CA United States

Subject Task 1 “New or Upgraded Electrode Design and Study” and task 11 ” Feasibility Analysis for New Electrode Array Location” –FINAL REPORT

Order B&McD – Doc. No. EC-1 (09-03-2011) – Prot. CESI B1025003

Notes

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REVISIONS HISTORY

Revision number	Date	Protocol	List of modifications and/or modified paragraphs
00	05-30-2012	B2016070	First emission

1 DESCRIPTION OF THE ACTIVITY AND GENERAL CONSIDERATIONS

Scope of the work is the consultancy about the review of the present sea electrode of the Pacific Direct Current Intertie, located about 1,570 m offshore S. Monica, CA, and the analysis and proposal of a new location and the design of a new electrode, in the case the present one cannot withstand the new operational requirements.

This report reviews the existing DC Electrode, identifies a new suitable location for the placement of a new electrode and provides preliminary design for this electrode, including drawings, technical specification, preliminary structural report and foundation assessment.

Such activities are also mentioned as “Task 1 - New or Upgraded Electrode Design and Study” and “Task 11 - Feasibility Analysis for New Electrode Array Location”.

Present plant configuration is bipolar, with ±500 kV rated voltage and 3,100 A rated current per each pole. The total rated power is therefore 3.1 GW.

The plant has been working since 1970 and it was upgraded/expanded several times [12]:

- 1970: voltage = ± 400 kV, current = 1,800 A, power = 1.44 GW
- 1982: voltage unchanged = ± 400 kV, current upgraded to 2,000 A, power = 1.6 GW
- 1985: voltage upgraded to ± 500 kV, current unchanged = 2,000 A, power = 2.0 GW
- 1989: voltage unchanged = ± 500 kV, current upgraded to 3,100 A, power = 3.1 GW

Despite thefact that the rated current was increased from an initial value of 1,800 A to the present one of 3,100 A, no assessment of the behavior of the electrode with such an increased current has been carried out, as far as it is known.

The current could be further increased in the future; as the requested lifetime of the new electrode is 40 years, it is reasonable to take it into account by designing the electrode not on the basis of today’s operations, but on the basis of future operations. This led to consider the maximum current design value of 3,650 A.

The electrode, during regular operation of the PDCI is subject to a very low current, which is the difference of the DC current flowing through the two poles (“unbalance current”). With older converters it could be estimated as lower than 3% of rated line current. With today’s converters it can be estimated as lower as 1% of rated current.

Basically the electrode is subject to a high current in case of failure of one pole, or of one 500 kV DC line conductor. In this case the link can still work (transmitting 50% of rated power, in the so-called “monopolar” scheme, with ground return). The current will then flow through one line conductor, and will return flowing through the ground (and the sea) in between the electrodes associated one to each conversion station (Sylmar station, electrode of S. Monica - and Celilo station, electrode of Rice Flats).

In order to minimize any negative impacts related with the ground return, the link is operatedin this way for a limited time, during which the switch to the so-called “metallic return” is made, i.e. the use of the other line conductor, instead of the sea/ground (of course if the fault is due to a converter, and not to an overhead line failure) as return path.

The electrode, therefore, has to be designed taking into account that it will be used for a limited time, and not for continuous service. The detailed description of the operating conditions during electrode service is called “Duty Cycle”; its definition, and the maximum number of allowed Duty Cycles per year gives the total allowed electric charge dispersed, that characterizes the effect of the electrode in terms of corrosion.

As the direction of electrode current depends on which pole is lost, the electrode must be able to work indifferently as anode or cathode, with no damage and with no (or limited) impact on its lifetime. Therefore configurations which are intrinsically not reversible will not be considered throughout this report.

The sea link develops into the Pacific Ocean; the measured electrical conductivity of seawater is 5.09 S/m, corresponding to a resistivity of 0.1965 Ωm. Assuming, a limit of electric field into seawater of 1.25 V/m, as stated by the only applicable guideline (IEC PAS 62344 - “General guidelines for the design of ground electrodes for high-voltage direct current (HVDC) links” [1]), a current density of about 6.3 A/m^2 over the active electrode surface can be assumed. A rough estimate of the minimal required surface with the design current, and without taking into account any redundancy, is 3,650 A / 6.3 A/m^2 = 580 m^2.

The electrode will therefore be characterized by a very large dispersing surface.

2 TASK 1 “NEW OR UPGRADED ELECTRODE DESIGN AND STUDY” - DESCRIPTION OF THE SUBTASKS

	Subtasks
a	-Review existing DC Electrode. -Provide a new or an upgraded submarine electrode.
b	-Is the existing site appropriate for the electrode expansion?
c	-Propose a design
d	-Design corrosionresistant. -R< 0.5 ohms
e	-Ensure safety and reliability. -Incorporate protective elements.
f	-Enclose electrode elements. -Design for safe levels of voltage gradients.
g	-Provide drawings, reports, etc -Estimate life of upgraded electrode array.
h	-Recommend a long term solution to prevent contact

2.1 Subtask 1a

The existing DC electrode was installed 45 years ago. Its design rated current is 1,800 A. It is located about 1,600 m offshore S. Monica. It is being operated since 1989 at a current of 3,100 A with no substantial expansions or upgrades.

For the reasons stated in chapter 2.1.1, nor the electrode or its location are suitable for the new operational parameters adopted by LADWP for the PDCI.

In particular the electrode is very old, so the state of the concrete vault, after 45 years of immersion in seawater is likely to be deteriorated. Furthermore the internal silicon-iron bars were repositioned during maintenance activity, and the electric field in the vicinity of the concrete box exceeds the recommended value during operation even when the electrode is operated with the original current value. For these reasons the design of the electrode must be considered inadequate. An upgrade could potentially be taken into consideration if the location was compatible with the new operational parameters, but the analysis of corrosion risks (see Task 5) leads to conclude that the original site is incompatible with the new operational parameters.

Therefore the recommended solution is the construction of a new electrode, in a new location, more distant from the shoreline than the actual one.

As the rated parameters have significantly changed with respect to the original values, we also recommend to thoroughly check the operational behavior of the other electrode, located in Oregon.

The new location selection is described in Task 11.

2.1.1 Analysis of the present electrode adequacy

The present electrode was designed according to the following main parameters:

- Rated current: 1,800 A
- 24 vaults, 2 SiCrFe rods per vault
- Electrode subdivided into six sections, each one composed by 4 vaults
- Vaults form a linear array; vaults are unevenly spaced to achieve uniform current sharing (spacing between side vaults is smaller than between central ones)

<u>Electric field values</u>

When the current is 1,800 A,a 2.5 V/m calculated value of electric field (immediately outside vault holes) is reported ([10], pag. 476). All the following estimates are based on the assumption that ALL the six sections of the electrode workperfectly.

- Present operation at 3,100 A gives an electric field of 2.5 * (3,100/1,800) = 4.305 V/m
- Future operation at 3,410 A will give an electric field of 2.5 * (3,410/1,800) = 4.736 V/m
- Future operation at 3,650 A could give an electric field of 2.5 * (3,650/1,800) = 5.07 V/m

All these values exceed whatstated by IEC PAS 62344 [1] (the range is 1.25-2 V/m). Consequently the present electrode even when operated within the design current of 1,800 Adoes not comply with the pre-standard; to achieve the compliance it should be operated at a lower current than the design one.

In particular,

- to achieve 1.25 V/m, it should be derated at 1,800 * (1.25/2.5) = 900 A
- to achieve 2.0 V/m, it should be derated at 1,800 * (2.0/2.5) = 1,440 A

It was clarified that in the past the electrode was subject to maintenance, and, during this activity the position of the bars has been changed with respect to the original one, rotating them of 90° along their vertical axis, and positioning them at the same vertical level. This choice significantly altered the distribution offield inside and outside the vaults, therefore the field level in accessible areas are likely to be higher than 2.5 V/m, even with the original current of 1,800 A. Therefore an even greater de-rating level should be adopted.

Location

In a cited paper [8], some interesting design considerations related to the risk of corrosion are reported. The conclusion is that, on the basis of original design parameters, the electrode must be located a minimum of 0.74 km far from a 1-inch steel pipe on land, and 2.4 km from the nearest submarine cable or pipe. At present the minimum distance from the electrode to the shoreline is 1,580 m, which is less than 2.4 km, but of the same order of magnitude. Increasing the rated current, the minimum separation distances (only taking into account the corrosion) increase with the cubic root of the current ; thusapplying the same rule, the original 2.4 km would become more than 3 km. Note that electric field and potential vary on the basis of different laws that could imply even longer minimum distances. Anyway, the current location does not seemfit for such an upgraded electrode operation. This considerations will be detailed within Task 5 report.

Electrode design

The electrode is built using a number of SiCrFerods, suspended inside concrete vaults (2 rods per each vault). Such rods are commercially known as “Corrpro® Durichlor 51™ Solid Silicon Cast Iron Anodes, type E”, and their main data are reported below:

- Diameter: 3” (76 mm),
- Length: 60” (1,524 mm),
- Bare weight: 110 lbs (49.9 kg),
- Area: 4 ft^2 (0.37 m^2)

In the original design, each rod carries an average current of 1,800 A / 48 rods = 37.5 A/rod, and the average current density on its external surface is 37.5 A / 0.37 m^2= 101.35 A/m^2. This value is about 4-10 times higher than that suggested by technical data sheets of commercial SiCrFe rods (which, of course, is recommended for continuous operations). With a sea water resistivity of 0.2 Ωm, the value of electric field around the rod is 101.35 A/m^2* 0.2 Ωm = 20 V/m, which means that such area must be secluded, to prevent living beings to reach the active parts of electrode.

Anyway, a current upgrade would even increase such values (for example, a current of 3,650 A would imply electric fields exceeding 40 V/m). Such values can only be limited by changing the design: one possible solution could be to significantly increase (double) the number of vaults; another solution could be to use larger rods, allowing a more limited increase of number of vaults.

The following sentence, taken from the IEC PAS 62344 [1], page 28, should be remarked: “According to one source of information, the normal current density of SiCrFe rods is 25 A/m^2 and it is indicated that this material cannot withstand current reversals. This statement is, however, contradicted by facts: the Santa Monica electrode operates with a rated current density of 106 A/m^2 for the rated current 1,800 A and the electrode is reversible! The Santa Monica electrode has a strict limit of 14 h for the rated current 1,800 A, but 1,410 A (83 A/m^2) is indicated as a continuous current rating.”.

Therefore apparently the S. Monica electrode, in its original design, seems to be severely overstressing SiCrFe rods, even though experience shows that rods worked well over 40 years of operations, also under increased current values.

Conclusion

The electrode as it is does not comply with the statements of the IEC PAS 62344 [1]as regards to the emitted electric field. To comply with, it has to be derated or expanded. The location was reasonably adequate for the present rated parameters, while it seems unfit for the new proposed ones. The selected material, according to the literature, should have suffered damages, while experience has shown that it performed quite well. A reasonable explanation for this surprisingly long lifetime could be that over the years the real electrode usage has been well below design operational limits.

2.2 Subtask 1b

No. The existing site is not appropriate for the electrode expansion, see above. The detailed motivations, related both to the risk of corrosion of small and long metallic objects are reported in detail in Task 5.

2.3 Subtask 1c

The proposed design is based on a number of fiberglass-reinforced concrete cylindrical boxes, positioned on the seabed in a circle having a diameter of 420 m. The center of such circle is located 5 km offshore, in the point indicated as “CESI 5 km offshore”.
Each cylindrical reinforced concrete box, 4.0 m internal diameter by 1.95 m high, has a concrete base slab, 7.5 m diameter by 0.4 m high, resting directly on the seabed.
The concrete reinforcement is made of GRFP (Glass Reinforced Fiber Polymer) bars to avoid the corrosion and interaction with electric fields.
Preliminary structural and geotechnical verifications of the concrete box have been carried out.

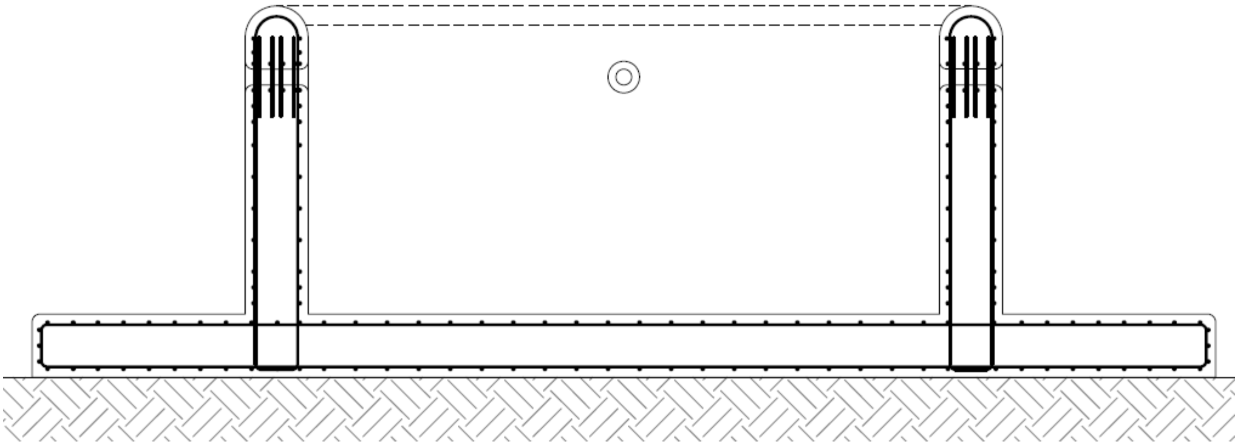

Fig. 1-1: Concrete Box – Reinforcement detail

Preliminary Structural Design

The structure is designed to meet or exceed the minimum requirements of the following reference standards:

- ACI 318-89: Building Code Requirements for Structural Concrete and Commentary;
- ACI 357-84: Guide for the Design and Construction of Fixed Offshore Concrete Structures;
- ACI 440-06: Guide for the Design and Construction of Structural Concrete Reinforced with FRP Bars.

For the design two conditions are considered:

- box lifting and
- box operation on the sea floor.

Four lifting holes symmetrical to two orthogonal axes are provided in the side wall of the box.

The structure design considers the following:

- Durability requirements and
- Strength and serviceability requirements.

Structure's exposure category is C2 (reference standard ACI 318-89, Chapter 4 – Durability Requirements, Table 4.2.1 Exposure categories and classes): concrete exposed to moisture and an external source of chlorides from deicing chemicals, salt, brackish water, seawater, or spray from these sources. Reinforcement is realized by GFRP bars.
Design strength of a member, is referred to flexure, axial load and shear.

Detail of the design is provided in Appendix 2 – PRELIMINARY Structural DEsign REPORT.

Preliminary Geotechnical Design

A preliminary verification of bearing capacity and sliding has been carried out.

Design is based on the following codes:

- API RP 2A Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design (API, 2007)*;
- API RP 2GEO Geotechnical and Foundation Design Considerations, (API, 2011);
- ASCE7-10 Minimum Design Loads for Building and Other Structures (ASCE, 2010).

Geotechnical investigations for the project are currently underway, but no site specific data are available at this time. The preliminary assessments have been conducted considering two representative soil profiles: soft clay and medium dense sand. Verifications shall be revisited when reliable geotechnical data are available, prior to finalizing foundation design.

The main forces acting on the foundation are the gravity loads from the vault self weight, metocean forces from waves and currents, and seismic actions arising during an earthquake.

The 100 year return period wave and current loads were considered per API practice. Seismic loading was computed considering ASCE 7-10, using a Risk Category of III. The required factors of safety were 2.0 in bearing and 1.5 in sliding for self weight and metocean conditions. These factors of safety were relaxed for seismic conditions.

The most critical case is the foundation on sand. The foundation has been dimensioned to maintain a factor of safety greater than 1.5 for the 100 years hydrodynamic loads. Wave loading is critical.
This foundation will experience minor horizontal displacement (maximum 5 cm) during the design earthquake, but is verified for vertical bearing capacity.
The same 7.5 m diameter foundation on clay is verified with factors of safety well in excess of the API requirements.
The foundation solution selected is a flat slab resting directly on the seabed. This solution has been chosen for several reasons:

- comparatively low cost;
- no interaction with electric fields;
- ease of installation;
- good performance for existing Sylmar Electrode System.

For installation considerations the foundation will not penetrate the seabed.

Detail of the design is provided in Appendix 1 – Preliminary Foundation Assessment.

The structure of the boxes, of their suggested manufacturing, of their electrical connections to feeding cables is described inAppendix 5 – Preliminary TECHNICAL SPECIFICATION.

2.4 Subtask 1d

To achieve the requested resistance to corrosion, adequate materials must be selected. Two solutions could be used, in line of principle: electrode based on graphite/coke and electrodes based on titanium coated meshes. Within this report the first one will be described only. The combined use of graphite bars immersed within coke is reported in literature to be highly corrosion resistant.

The electrode can be operated in two ways:

- Normal operations, i.e. all eight sections (88 boxes) are in operation, or
- Special (or emergency) operations, when, for any reason (testing or a physical damage to the submarine cables), two opposite sections are lost, and the electrode is operated using just six sections (66 boxes). The electrode is designed to be redundant, i.e. it is oversized to enable its operations also in this unfavorable condition.

The requested resistance of the electrode (i.e. electrode plus cable running from the shore vault to the electrodes) must be lower than 0.5 Ω: the numerical simulations performed on the new electrode (see Task 3) led to determine a resistance of the electrode alone (i.e. the equivalent resistance presented by the water around the boxes) varying from a lower bound of 2.57 mΩ and an upper bound of 4.23 mΩ for the electrode in normal operations (88 boxes in operations), and from a lower bound of 2.83 mΩ and an upper bound of 4.49 mΩ for the electrode in special operations (66 boxes working). Such very low values can be explained due to the large dispersing electrode surface (1,106 m^2, while the dispersing surface of the old electrode, i.e. the total surface of the 48 silicon-iron bars, was approximately 17.5 m^2).

The global resistance of the complete electrode (meaning cables + seawater resistance as measured at Sunset Vault) can be obtained by adding to the previous values the equivalent resistance of cables (working at high temperature, i.e. 90°C), and it is varying from a lower bound of 0.114 Ω and an upper bound of 0.116Ω for the electrode in normal operations (88 boxes in operations), and from a lower bound of 0.151 Ω and an upper bound of 0.153Ω for the electrode in special operations (66 boxes working). The highest value is 0.153 Ω as worst case, and this is well below the design requirement of 0.5 Ω.

Also the "test" resistance was determined, i.e. the equivalent resistance that can be measured between the two cables starting from the Sunset Vault, and feeding two opposite section of the electrode: the equivalent resistance of the electrode alone (i.e. between the two groups of 11 boxes each) is around 14 mΩ; the global resistance can be obtained by adding the equivalent resistance of cables (working in this case at 20°C), and its estimated value was 1.414Ω.

2.5 Subtask 1e

The electrode was designed in such a way that the value of electric field over the surface of the gravel is technically compliant, meeting the lower limit of the recommendation from IEC (i.e. 1.25 V/m). The electrode, differently from the present one, does not need special protective elements to ensure its safety.

2.6 Subtask 1f

See subtask 1e. The safe levels of electric field are reached through a proper dimensioning of the dispersing surface, much larger than that of the present electrode. Numerical computations that were performed to verify the dimensioning are described in Task 3, together with the results.

2.7 Subtask 1g

Drawings are reported in Appendix 3 – Preliminary electrode design plans and sections and Appendix 4 – Preliminary electrode design reinforcement details.
The estimated life of the new electrode must be guaranteed by the Contractor on the basis of the selected material. In any case the proposed technology makes it possible to reach the requested value of 40 years.

2.8 Subtask 1h

There is no need to prevent contact, as explained in Subtask 1e.

3 TASK 11 (FEASIBILITY ANALYSIS FOR NEW ELECTRODE ARRAY LOCATION)

In the original Task Scope Statement *"LADWP is considering relocating the electrode array in the ocean, in the south/east direction, in alignment with San Vicente Blvd., approximately 1.5 miles north of the Santa Monica Municipal Pier. This option would avoid cable system construction along Pacific Coast Highway.*
Consultant shall perform a preliminary and generalized feasibility study to analyze the effects of installing a new electrode array at this new location. In particular the analysis shall consider effects to nearby Santa Monica Municipal Pier. LADWP needs a determination if this option is feasible."

This Task has completely changed from its original intent: to select a different location for the new electrode (as the current one resulted inadequate due to its limited distance from the shoreline). During the Kick-Off meeting (K.O.M.) two further possible electrode locations were presented: the first one 5 km offshore from Chautauqua Blvd (subject of Task 11, labeled "Alternate Electrode Location"), and the second one 5 km more offshore than the current electrode location, and along the same direction of the old submarine cable path (labeled "Possible New Electrode Site"). The locations, labeled as "K.O.M. locations", are reported below. Such proposed locations are even more inadequate than the current one, as the distance from the shoreline is more or less the same as the original location, and closer to the beach of Santa Monica (very populated, popular for tourists, and saturated with many underground metallic infrastructures).

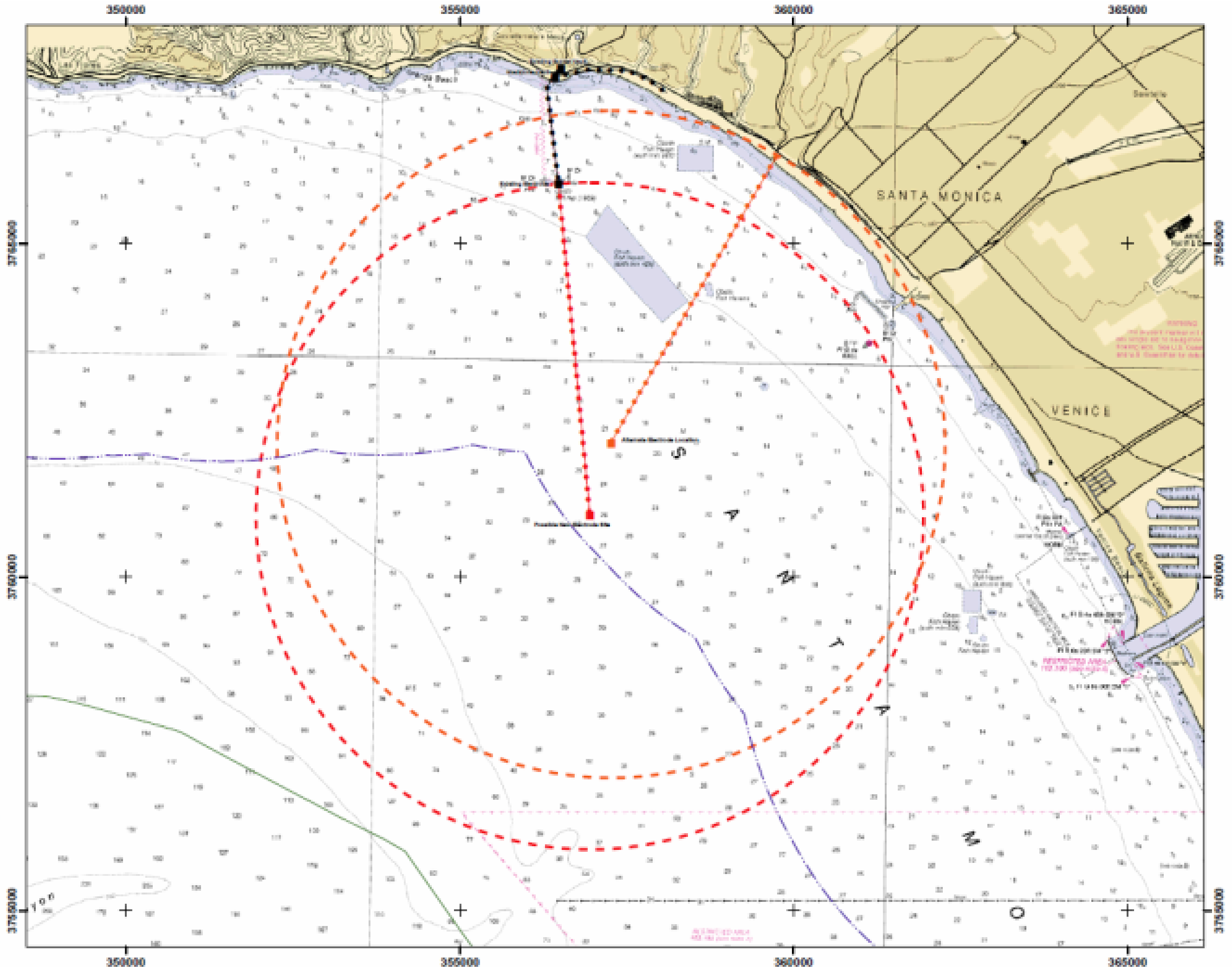

Fig. 11-1: Kick-Off meeting proposed locations

Furthermore, this possible location proposal, in our opinion, presents the drawback of significantly reducing the distance between the electrode and the most significant infrastructures that could be impacted (for example, but not limited to, Marina del Rey harbor, Scattergood power station, LA international airport “KLAX”, the oil refinery located close to the airport, the commercial harbor, etc.), and many pipelines, see above. This reduction is apparent from the above map, where Marina del Rey harbor can be seen on the right side of the map, together with the present position of the electrode, and of the proposed possible new location. Another fact that leads to consider a different location was reported in ref. [6]; the Authors stress the fact that local geology is extremely complex, the number of faults is high, and the area of the cities of Los Angeles and Santa Monica is characterized by the presence of highly saline underground waters (which can be a preferential return path for the current dispersed by the electrode). In other terms, the inland, far from being homogenous, has an electrical behavior that can lead to “concentrate”, in a quite unpredictable way, current dispersed from the electrode in the area where most large industrial plants are located.

The conclusion drawn in [6] is: “In any case there will be a tendency to concentrate current inland which, when rising upwards in the crust, will encounter pipelines and other buried metallic structures. The amount of current which will be impressed upon pipelines lying on the earth along the shore is difficult to estimate”. The paper was presented in 1968, before the construction of the PDCI. In 1970, such conclusion revealed substantially correct after the measurements described in [7], reporting some “unexpected” behavior of the measured values with respect to the distance from the electrode. In other terms, a number of sites are reported to have measured values higher than in other measurement stations closer to the electrode (even though the highest values are relatively close to the electrode).

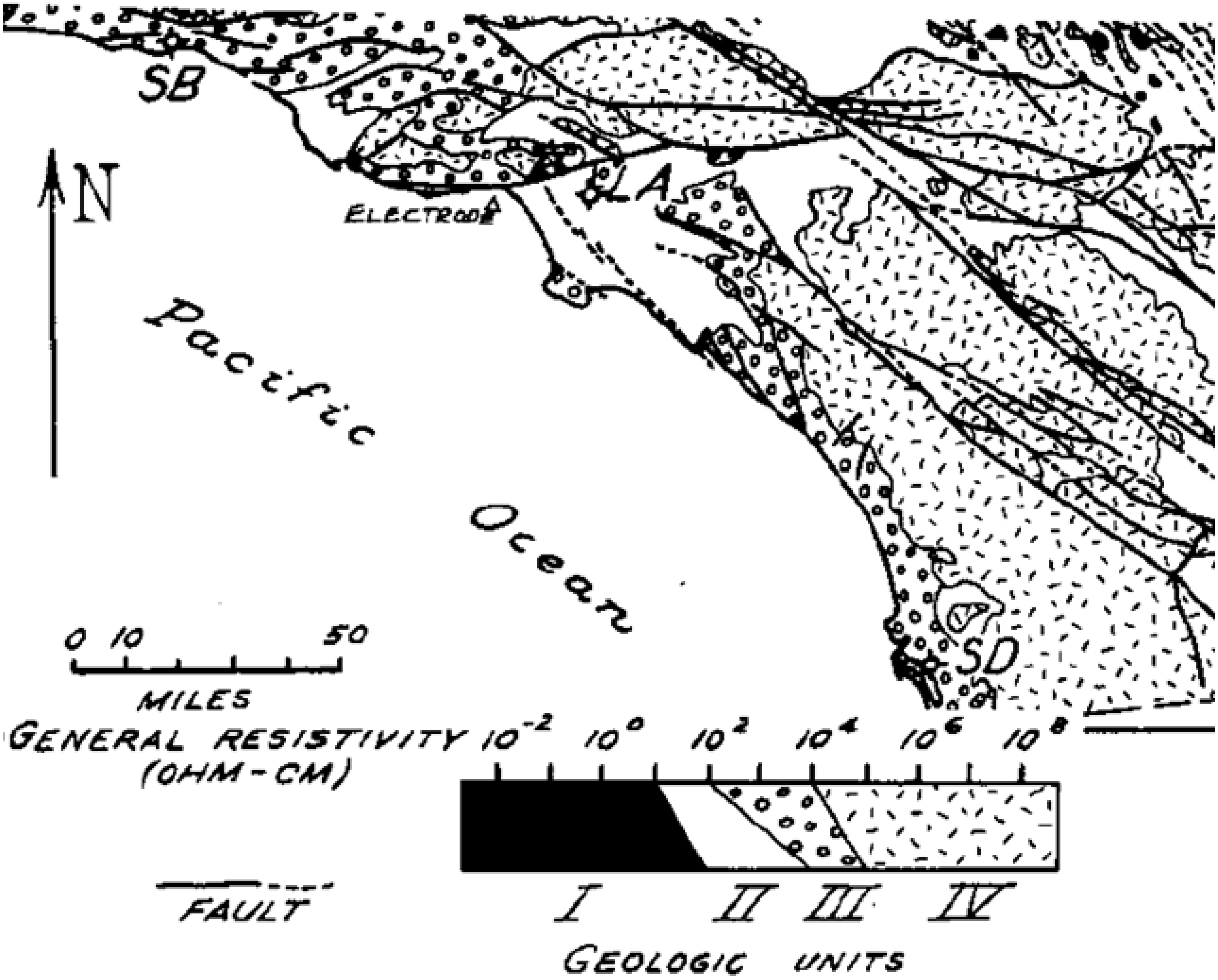

Fig. 11-2: Geological-resistivity map of area surrounding sea electrode (from ref. [6])

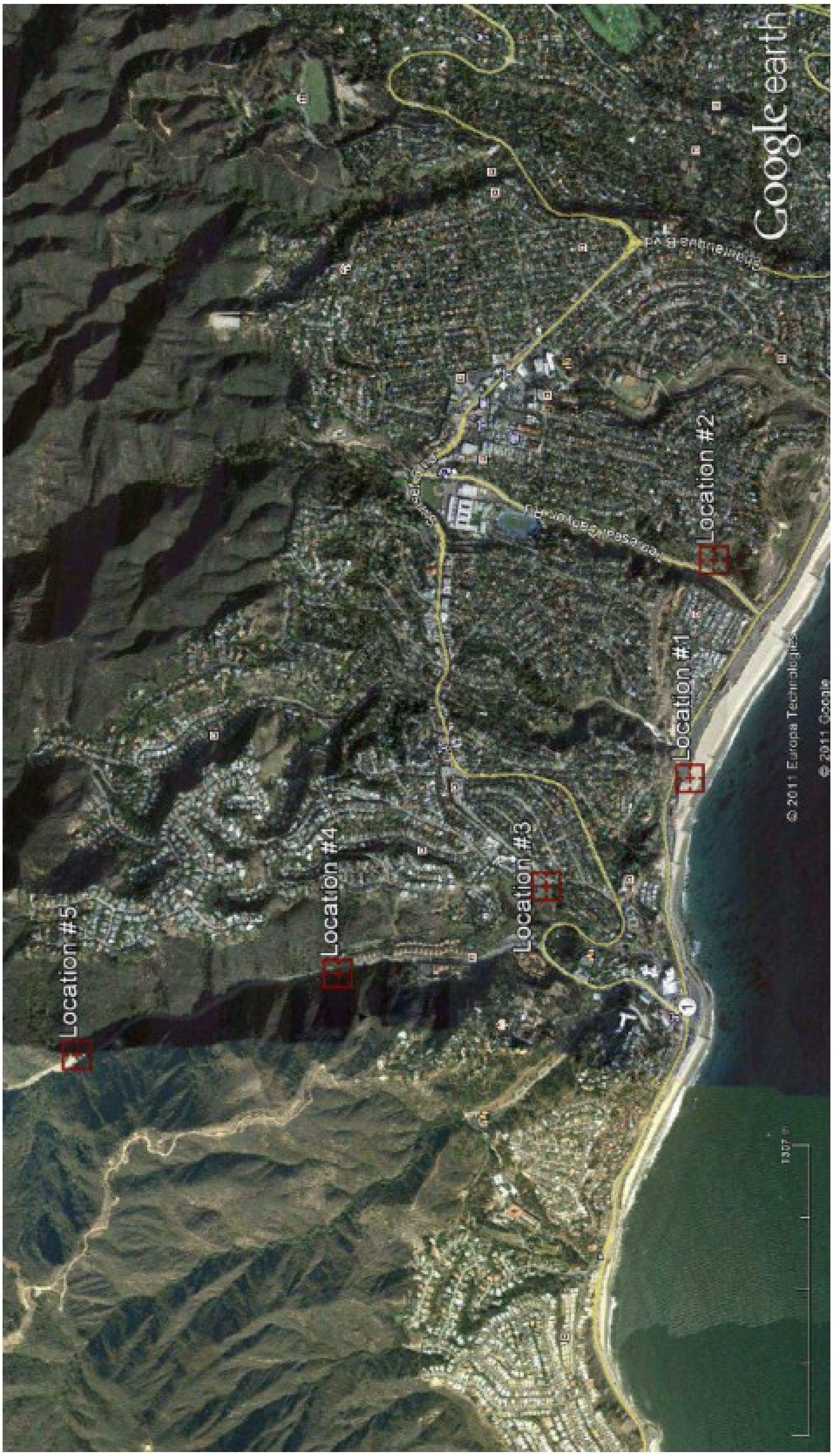

Fig. 11-3: Selected location for resistivity measurements

Another consideration leading to similar conclusion can be made on the basis of the measurements of electrical resistivity performed on-site in five different locations (Fig. 11-3, above) on the 13th of September, 2011. Results are reported in Tab. 11-1, below:

Location	Soil Type	Location - GPS		Pin Spacing[ft]	Resistance [Ω]	**Soil Resistivity [Ω m]**
1	Sand	34° 2.3142' N	118° 32.6286' W	5	6,56	**62,8**
1	Sand	34° 2.3142' N	118° 32.6286' W	10	3,94	**75,5**
1	Sand	34° 2.3142' N	118° 32.6286' W	15	2,41	**69,2**
2	Fine soil	34° 2.2662' N	118° 31.9938' W	5	1,22	**11,7**
2	Fine soil	34° 2.2662' N	118° 31.9938' W	10	0,65	**12,4**
2	Fine soil	34° 2.2662' N	118° 31.9938' W	15	0,35	**10,1**
3	Fine soil	34° 2.6646' N	118° 32.9436' W	5	1,10	**10,5**
3	Fine soil	34° 2.6646' N	118° 32.9436' W	10	0,68	**13,0**
3	Fine soil	34° 2.6646' N	118° 32.9436' W	15	0,59	**16,9**
4	Fine soil	34° 3.1602' N	118° 33.2064' W	5	3,58	**34,3**
4	Fine soil	34° 3.1602' N	118° 33.2064' W	10	1,42	**27,2**
4	Fine soil	34° 3.1602' N	118° 33.2064' W	15	0,85	**24,4**
5	Fine soil	34° 3.7740' N	118° 33.4434' W	5	3,31	**31,7**
5	Fine soil	34° 3.7740' N	118° 33.4434' W	10	1,66	**31,8**
5	Fine soil	34° 3.7740' N	118° 33.4434' W	15	1,04	**29,9**

Tab. 11-1: Soil superficial resistivity measurements

Note: the upper ground layer presents a comparatively high value of electrical conductivity. This layer is where pipelines are buried. It is important to be extremely careful and to adopt conservative security coefficients, as the upper ground layer, located above the aforementioned highly saline underground basins, could form a path where stray currents tend to concentrate, and to have a significantly adverse impact on pipelines corrosion process.

Therefore, for the sake of safety, the new electrode should be located as far as possible from the part of coast characterized by relatively high conductivity (clearly indicated in white in Fig. 11-2, above).

It is apparent that moving the electrode southwestwards improves the situation.

All the aforementioned considerations requires a location as described in Fig. 11-4 below. Two alternative paths could be developed, and they are marked in green:

1) a path initially following the present right of way (r.o.w.), then moving southwestwards towards the selected area for the new electrode location, or
2) a completely new and straight path.

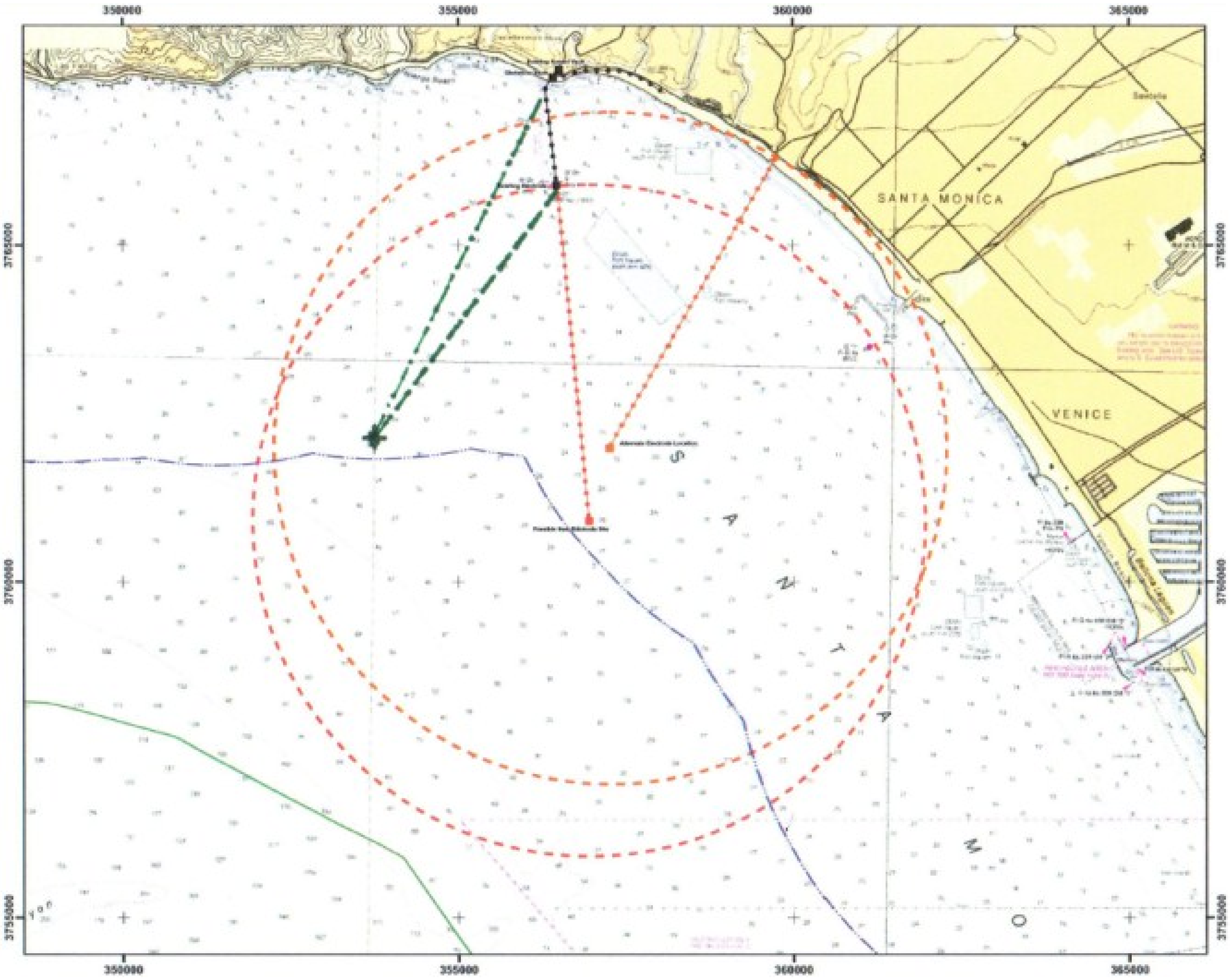

Fig. 11-4: Alternative CESI proposals

These locations, which CESI put forward just after the K.O.M., provide a good compromise, fulfilling all the above mentioned requirements. Note that the blue line represents the 3 NM (nautical miles) limit, beyond which a Federal authorization is required to build infrastructures. To better reflect upon the different choices, all data were inserted in Google Earth, and the configurations are clearly exposed in Fig. 11-5, 11-6 and 11-7.

The different paths are marked according this color coding:

1) CESI proposed path, initially following the present r.o.w., then moving straight southwestwards, towards the selected new electrode location: **light blue**
2) CESI proposed completely new straight path, leaving the shore and directed towards the selected electrode location: **orange**
3) Kick-Off meeting proposals: **red**

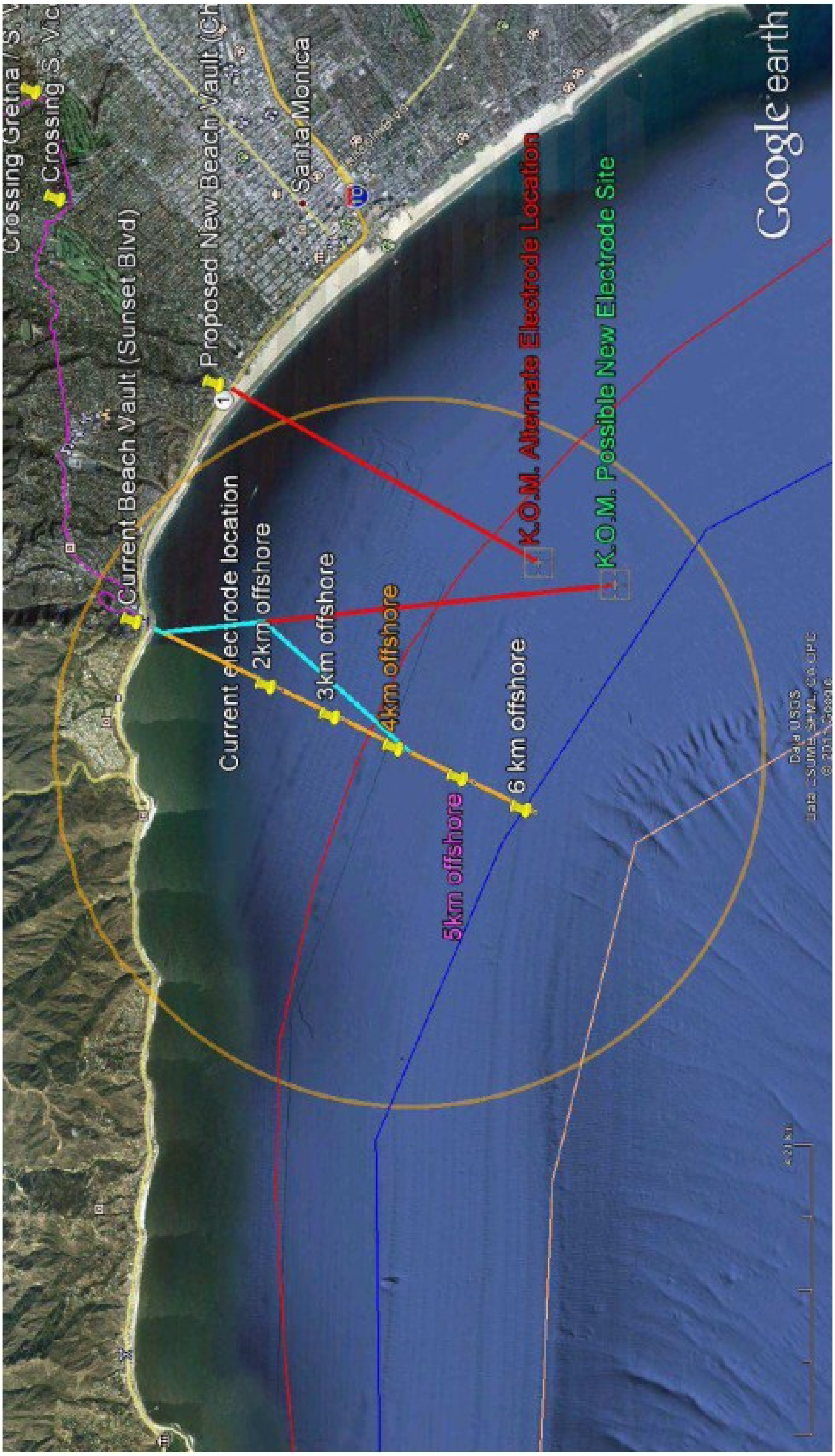

Fig. 11-5: CESI proposed solution: orange circle, radius 5km, centered on “4km” site

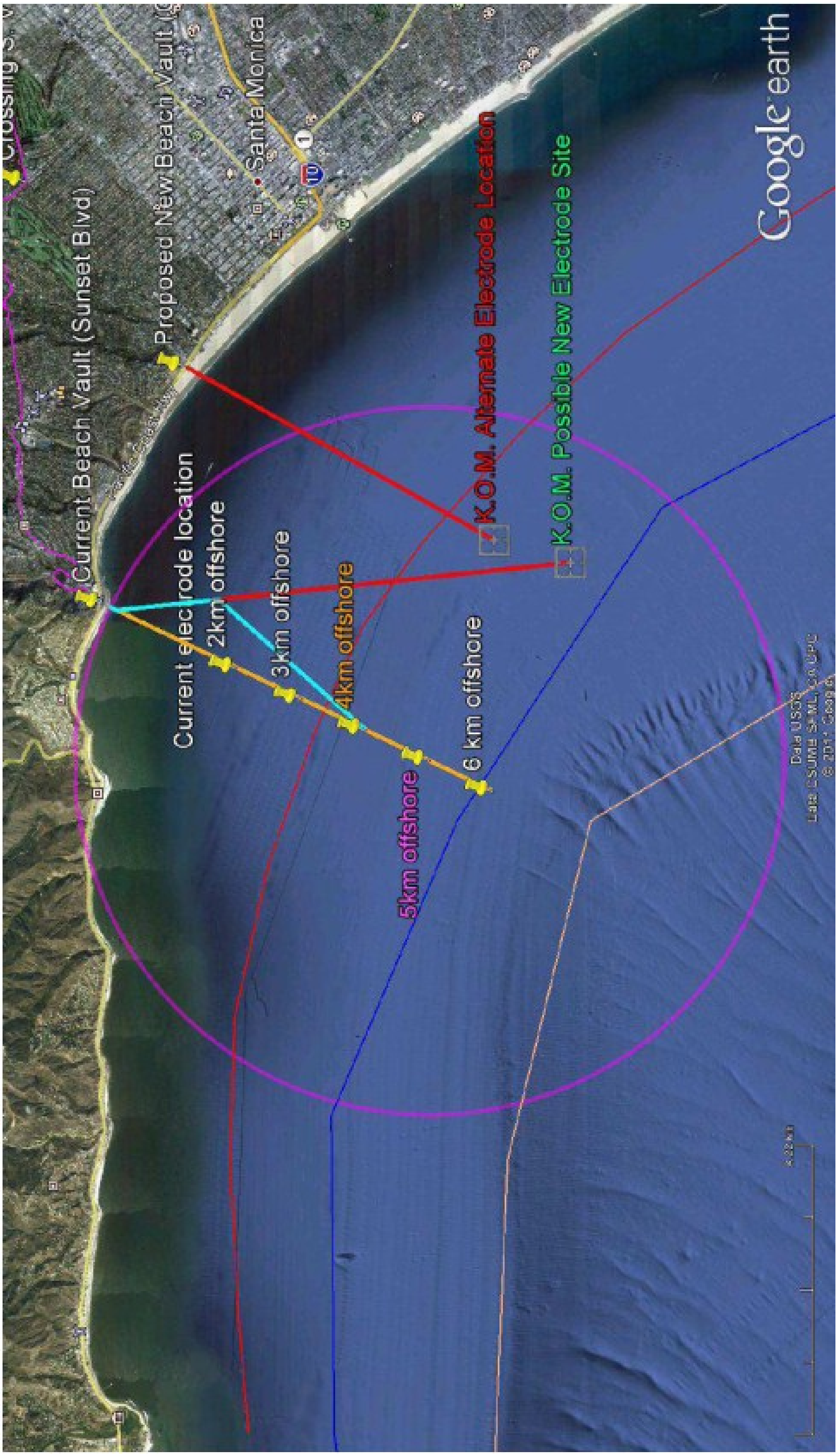

Fig. 11-6: CESI proposed solution: pink circle, radius 5km, centered on “5km” site

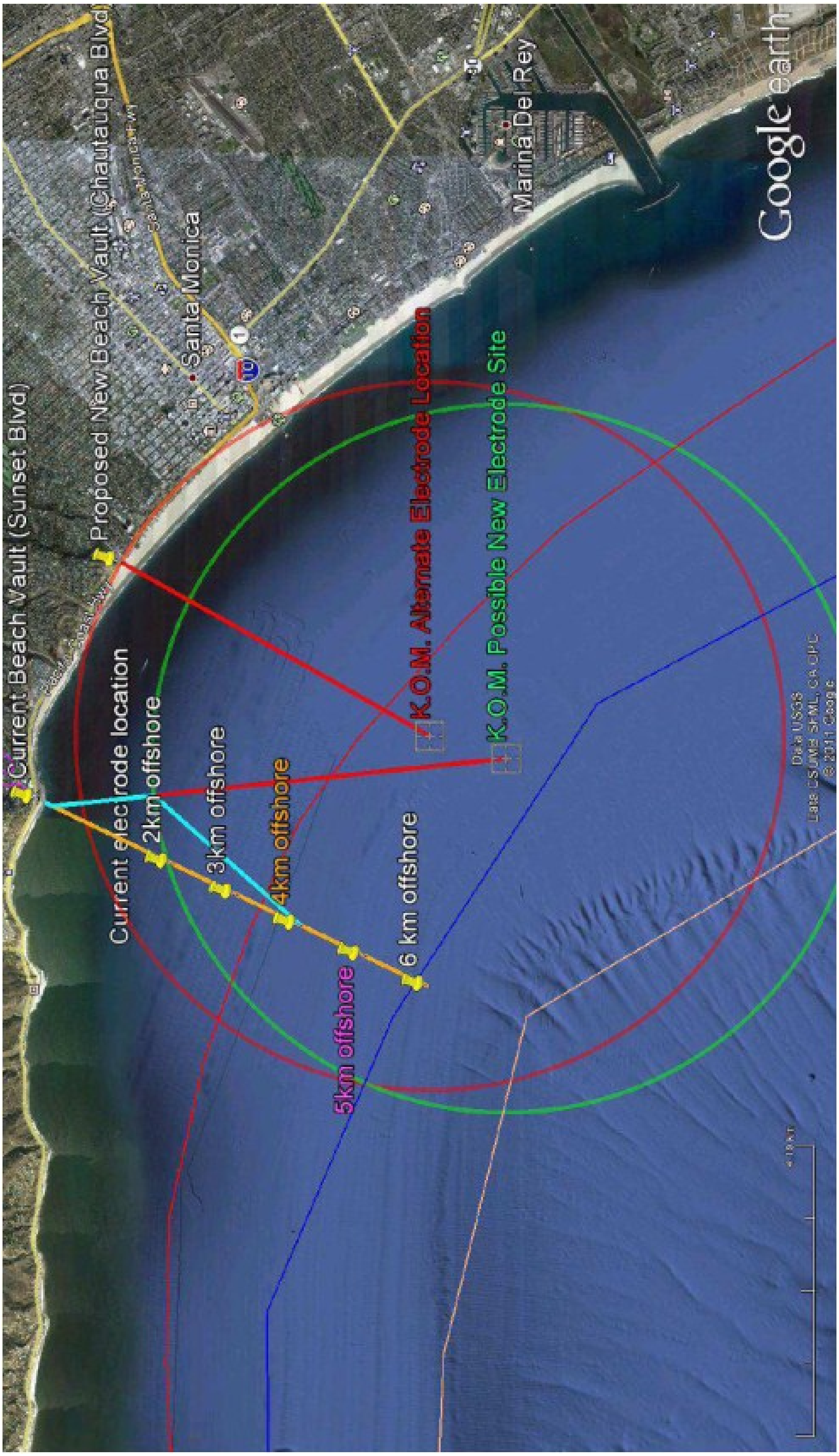

Fig. 11-7: Kick-Off meeting proposals: red & green circles, radius 5km, centered on both sites

CONSIDERATIONS ABOUT DEPTH:

One of the parameters that may impact the difficulty to build the electrode is the site depth; the depth of the proposed locations is thus considered here. Note that all data reported in this chapter were determined using Google Earth, and they must therefore be considered as approximate, merely indicative and not certified.

Current electrode location: .... 14 m

"K.O.M. Alternate Electrode Location": .... 40 m
"K.O.M.Possible New Electrode Site": .... 48 m

"CESI 4km offshore":... 39 m
"CESI 5 km offshore":.. 48 m

Other locations present even greater –and thus hardly acceptable– depths, such as:
"CESI 6 km offshore":.. 57 m

Basically the depths of the two "K.O.M. proposed locations" are similar to CESI'slocations (40 vs. 39, and 48 vs. 48 m). Such depths are high, as they exceed the usual limit (30 m) of respectively 10 and 20 m. These values could make it difficult to build electrodes there, in particular if the selected type of electrode requires many submarine activities, such as the creation of ballast, etc. On the contrary, if the electrode can be installed by using ready-to-install modules, then the only needed submarine activity is the electrical connection among the modules and their feeding cables. In this latter case, even depths greater than 30 m could be accepted.

CONSIDERATIONS ABOUT DISTANCE:

Distance from (and location of) the closest point on the shoreline to:

- Current electrode location:.................................... 1,570 m (Sunset Blvd./Pacific Highway)

- "K.O.M. Alternate Electrode Location":................... 4,620 m (S. Monica Beach)
- "K.O.M.Possible New Electrode Site":.................... 5,610 m (S. Monica Beach)

- "CESI 4km offshore": .... 3,730 m (Topanga Beach)
- "CESI 5 km offshore": .... 4,600 m (Topanga Beach)

It is obvious that every new proposal significantly increases the distance from the shoreline with respect to the present value. One "K.O.M. proposed location" and one CESI proposal are equivalent. Note that the closest point on the shoreline deriving from the "K.O.M. proposed locations" is in the area declared in [6] as characterized by a very high electrical conductivity.

Distance from Marina del Rey Harbor to:

- Current electrode location:.................................... 11,360 m

- "K.O.M. Alternate Electrode Location":................... 9,140 m
- "K.O.M.Possible New Electrode Site":.................... 9,280 m

- "CESI 4km offshore": .... 12,170 m

- “CESI 5 km offshore”: .... 12,360 m

CESI’s proposed locations slightly increase the distance from Marina del Rey Harbor with respect to the present value; “K.O.M. proposed locations” would reduce it of about 2 km.

Distance from KLAX airport to:

- Current electrode location: .... 16,200 m

- “K.O.M. Alternate Electrode Location”:................... 13,570 m
- “K.O.M.Possible New Electrode Site”:.................... 13,500 m

- “CESI 4km offshore”: .... 16,750 m
- “CESI 5 km offshore”: .... 16,800 m

CESI’s proposed locations slightly increase the distance from KLAX airport with respect to the present value; “K.O.M. proposed locations” would reduce it of about 2.7 km.

Distance from Scattergood Power Station to:

- Current electrode location: .... 16,620 m

- “K.O.M. Alternate Electrode Location”:................... 13,400 m
- “K.O.M.Possible New Electrode Site”:.................... 13,060 m

- “CESI 4km offshore”: .... 16,640 m
- “CESI 5 km offshore”: .... 16,485 m

CESI’s proposed locations minimally increase the distance from Scattergood Power Station with respect to the present value; “K.O.M. proposed locations” would reduce it of more than 3 km.

Distance from the Santa Monica Pier to:

- Current electrode location: .... 5,500 m

- “K.O.M. Alternate Electrode Location”:................... 4,700 m
- “K.O.M.Possible New Electrode Site”:.................... 5,520 m

- “CESI 4km offshore”: .... 6,925 m
- “CESI 5 km offshore”: .... 7,470 m

CESI’s proposed locations significantly increase (of 1.5-2 km) the distance from the Santa Monica Pier with respect to the present value; “K.O.M. proposed locations” in one case leaves it unchanged, while in the other case would reduce it of about 0.8 km.

As a conclusion, “K.O.M. proposed locations” present a distance from the most sensitive coastal infrastructures of the area that is similar (or even smaller) than that of the present electrode.

CONSIDERATIONS ABOUT POTENTIALLY IMPACTED INFRASTRUCTURES:

Even though at this stage a complete knowledge of all the potentially affected infrastructures in the area is still missing, the data collected from the National Pipeline Mapping System has shown that there is a gas transmission pipeline that follows the Sunset Blvd., which reaches the Pacific Highway and goes westwards along the shoreline. This infrastructure can be assumed to be the most likely to be affected by stray currents, unless there are other pipelines, at this stage still unknown to us, located into the sea and even closer to the electrode. Note that no data about the pipe is available (diameter, thickness, coating, if it is buried or inserted inside an underground trench, etc.); potentially it could even be non metallic (plastic pipe), and thus not affected by corrosion.

In the case of selecting the “CESI 5 km offshore” configuration, the minimum distance from such a pipeline could be assumed equal to the distance from the electrode and the shoreline, which is about 4,600 m (Topanga Beach area). This value, according with the results described within Task 5 report, should lead to an acceptable value of leakage current along the pipe.

The “K.O.M. Possible New Electrode Site” would keep a minimum distance of 5,610 m, but, as seen before, it would reduce the distances from a number of other infrastructures.

It is worth remembering that just now the distance from the operating electrode and the closest point on this gas pipeline is about 1,570 m, which is the distance from the electrode and the Sunset Blvd.

In any case, such pipeline(s) will have to be monitored throughout the operational life of the new electrode, and, if necessary, mitigating measures will have to be taken, such as to insert insulating joints along the pipe, or improving the cathodic protection devices.

The offshore displacement of the electrode will reduce the distance with respect to the submarine Tele-communications Cable marked in green in the left bottom angle of Fig. 11-1. If the cable is a fiber optics one it should not be impacted by noise injection due to the current discharged by the electrode. Vice versa, if it is a copper telephone cable, the potential impact of the stray currents on it will have to be assessed. In any case, the minimum distance between the cable and CESI proposed sites is similar to the distance between it and “K.O.M. Possible New Electrode Site”.

FINAL CONSIDERATIONS:

A number of different locations has been considered:

1) submarine plateau, depth about 86 m, located about 20 km westwards Malibu (approx. coordinates: lat. 34.000773°N, long. 119.031015°W);
2) area located about 10-11 km offshore, depth about 30 m, at the same latitude of the city of Oxnard (approx. coordinates: lat. 34.189507°N, long. 119.372704°W);
3) “K.O.M. Alternate Electrode Location”, see Fig. 11-1, 11-5, 11-6, 11-7;
4) “K.O.M. Possible New Electrode Site”, see Fig. 11-1, 11-5, 11-6, 11-7;
5) “CESI 4km offshore” see Fig. 11-4, 11-5, 11-6, 11-7;
6) “CESI 5 km offshore” see Fig. 11-4, 11-5, 11-6, 11-7.

The first two ones are located very far from the present location; location 1 is extremely deep; location 2 is even more distant and the site is unfit.

The third and the fourth ones do present the drawbacks discussed before, in terms of reduction of distance with respect to problematic areas.

The fifth and the sixth ones, in our opinion, are the best choices.

According to the data and the computations presented in Task 5report, the recommendation is to locate the new electrode nearby the site named “CESI 5 km offshore”, see Fig. 11-8, below. In case of need (unfit seabed, etc.) the location could be slightly moved a few hundred meters towards the “K.O.M. Possible New Electrode Site”, along the straight line connecting the two aforementioned sites. Of course it is necessary to carefully check that the electrode remains within the 3 NM line, taking into account that the electrode can have an approximate max. size of 200-500 m. During our activity we focused on the straight right of way coming from the shore next to the intersection of the Sunset Blvd. with the Pacific Coast Highway.

All considerations done are based on the aforementioned yearly charge value of Duty Cycles of 120 kAh/yr. If a heavier Duty Cycle should ever be required (higher current and/or greater number of cycles per year) it will be necessary to re-evaluate the compliance of the site to the new operational parameters.

In any case, at the end of the construction, all the impacts of the electrode over the area (for example, but not limited to, corrosion effects, noise injection on telecommunication systems, etc.) will have to be assessed through proper measurements like the one performed in 1970 [7], and, if required, of continuous measurement within the most critical areas, especially for the aspects related to corrosion.

In particular it is recommended to periodically verify the risk of corrosion for the pipelines immediately adjacent to the shoreline, for a length of at least 2-3 km on either sides of the points of the shore that are closer to the electrode (in other terms, from the intersection of Entrada Drive with the PCH (East) up to the intersection of Big Rock Drive with the PCH (West)).

Fig. 11-8: Final recommended location for the electrode and the two proposed cable routes

At the end of the activities related to Task 11, the Client accepted as final location for the new PDCI electrode the candidate location named “CESI 5 km offshore”.

Our scope of work is limited to the study and design of the electrode and its submarine feeding cables following the straight route marked as “OPTION 1”.

4 BIBLIOGRAPHY

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5 APPENDIX 1 – PRELIMINARY FOUNDATION ASSESSMENT

5.1 Introduction

The Los Angeles Department of Water and Power (LADWP) is planning the replacement of the existing Sylmar neutral return Electrode System. Work will include the replacement of the neutral return overhead lines as well as the underground and sub-sea electric cables that run from the Sylmar Converter Station to the Pacific Ocean (Sylmar Electrode System). The submarine portion of the new system will include a 5 km offshore cable system leading to a circular array of 88 grounding electrodes. Each electrode is contained in a submarine vault formed by a cylindrical concrete box. This study presents preliminary dimensioning of the vault foundations.

The main forces acting on the foundation are the gravity loads from the vault self weight, metocean forces from waves and currents, and seismic actions arising during an earthquake. The assessment of loads has been based on API recommendations for metocean conditions and ASCE-7 criteria for seismic design.

Geotechnical investigations for the project are currently underway, but no site specific data are available at this time. The preliminary assessments have been conducted considering two representative soil profiles: soft clay and medium dense sand. Verifications shall be revisited when reliable geotechnical data are available.

Foundation verifications have been performed according to API recommendations for shallow foundations. Load combinations and factors of safety have been adopted from this code.

5.2 Selection of foundation system

The foundation solution selected is a flat slab resting directly on the seabed. This solution has been chosen for several reasons:

- no interaction with electric fields;
- ease of installation; and
- good performance for existing Sylmar Electrode System.

The other option would be to place the vaults on pile foundations, or to utilize a shallow foundation combined with skirts. These solutions have been rejected for the following reasons:

- driven steel pipe piles are the most common offshore foundation method, this system is not compatible with the system function (not electrically neutral);
- driven concrete piles are not common offshore, particularly in the design water depth; and
- skirted foundations are also frequently used, particularly where foundations must resist horizontal loading. Skirts are either steel plate or concrete walls. Steel skirts are excluded for electrical neutrality, concrete walls for lack of penetration force (low self weight of empty vault).

5.3 Design basis

5.3.1 Reference codes

The preliminary design has been based on the following codes:

- API RP 2A Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design (API, 2007)*;
- API RP 2GEO Geotechnical and Foundation Design Considerations, (API, 2011);
- ASCE7-10 Minimum Design Loads for Building and Other Structures (ASCE, 2010).

5.3.2 Structure and foundation

The submarine vaults are reinforced concrete cylinders, nominally 4.8 m outer diameter, 4.0 m internal diameter and 1.95 m high, with a concrete base slab, 7.5 m diameter by 0.4 m high, resting directly on the seabed..
The interior of the vault contains a 0.5 m thick layer of coke restrained by a 0.85 m thick layer of gravel. The structure is shown in Figure 5.1.

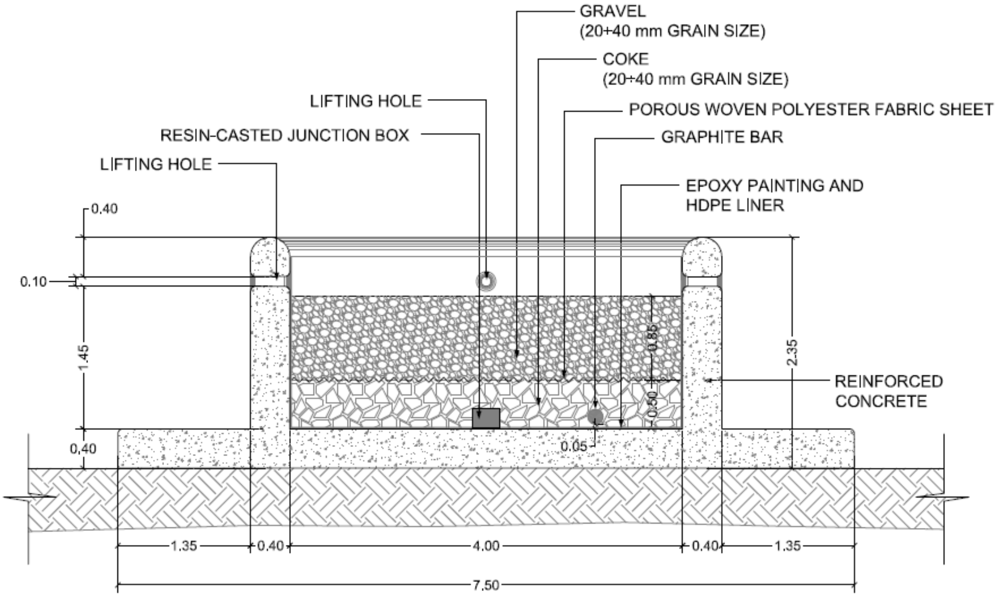

Figure 5.1: Submarine Vault

Table 5.1 gives the main dimensions of the structure, and the calculation of the weights of the various components. The total weight in air is 928.73 kN, while the submerged unit weight is 474.55 kN. The center of gravity (COG) is in the center of the structure, 0.73 m above the bottom of the foundation slab.

Table 5.1: Dimensions and Masses of Vault

Item	Do (m)	Di (m)	H (m)	γ (kN/m^3)	γ' (kN/m^3)	W_{air} (kN)	W_{water} (kN)
slab	7.5		0.4	25	15	441.79	265.07
coke	4		0.5	4	-6	25.13	-37.70
gravel	4		0.85	18	8	192.27	85.45
wall	4.8	4	1.95	25	15	269.55	161.73
					Total	**928.73**	**474.55**

5.3.3 Metocean conditions

Metocean conditions are based on API RP 2A recommendations for Southern California. The following design values are considered:

• Max wave height	13.7 m (45 ft);
• Wave period	13 s
• Max surface current	1.50 m/s (3 kt)
• Max wave velocity	1.84 m/s

Following API, the design environmental conditions are defined for a 100 year return period.

5.3.4 Seismic design criteria

Seismic design criteria are defined according to ASCE 7-10. Mapped spectral acceleration values are referred to the MCER are:

SS	2.0 g
S1	0.75 g

In the absence of geotechnical data Site Class D is assumed. The site coefficients are:

Fa	1.0
Fv	1.5

Design spectral response parameters are:

SDS	1.33 g
SD1	0.75 g

The structures are considered Risk Category III, leading to a seismic importance factor Ie of 1.25.

Given the nature of the structure, small gravity base on flat slab, and the extreme flexibility of the connections to the cable system, the foundation is considered to be very ductile in terms of structural response. We intend that compliant horizontal displacements during a seismic event would not compromise function of the system. To represent this in the design, a response modification coefficient R = 8 is chosen, in analogy to a moment resisting frame for a non-building structure.

5.3.5 Geotechnical conditions

No site specific data is available at this time. Preliminary verifications have been performed considering the two representative soil profiles given in Table 5.2.

Table 5.2: Representative Soil Profiles

PROFILE	SUBMERGED UNIT WEIGHT (kN/m^3)	DRAINED FRICTION ANGLE (Degrees)	UNDRAINED SHEAR STRENGTH (kPa)
Soft Clay	8.0	-	25
Medium dense sand	8.0	30	-

5.3.6 Load Combinations

The load combinations considered are shown in Table 5.3.

Table 5.3: Load Combinations

LC	DEFINITION	ABBREVIATION
1	Dead load	D
2	Dead + wave	D + W
3	Dead + current	D + C
4	Dead + earthquake (vertical down)	D + E
5	Dead + earthquake (vertical up)	D – E

Where

- D dead load
- W wave load
- C current load
- E seismic action

5.3.7 Acceptance criteria

The API RP 2A factors of safety for shallow foundations are applied:

Bearing	2.0
Sliding	1.5

Sliding criteria are relaxed for the case of seismic loading, with consideration of anticipated displacements.

5.4 Load conditions

5.4.1 Dead load

Dead load is computed as the buoyant weight of the structure (Table 3.1). The dead load is 928.73 kN.

5.4.2 Hydrodynamics loads

Hydrodynamic loads on the structure were computed using the Morison equation:

$$F = F_D + F_I = C_D \frac{w}{2g} AU|U| + C_M \frac{w}{g} V \frac{\delta U}{\delta t} \qquad (3\text{-}1)$$

where

- F hydrodynamic force vector per unit length, normal to the axis of the member
- FD drag force vector per unit length
- FI inertia force vector per unit length
- CD drag coefficient
- w weight density of water
- g acceleration of gravity
- A projected area normal to the cylinder axis per unit length (=D for cylinders)
- V displaced volume of cylinder
- U component of velocity vector of the water normal to the axis of the member
- |U| absolute value of U
- CM inertia coefficient
- δU/δt local acceleration vector of the water normal to axis of the member
- C_D and C_M were conservatively taken as 1.4 and 2.0, respectively (Techet, 2004).

5.4.2.1 Wave Load

Design wave height and period were based on the API criteria for Southern California, specifically maximum wave height 13.7 m, period 13 s.

Induced fluid velocity at structure level was computed using the procedure of the Coastal Engineering Manual (USACE, 2008) as:

$$u = \frac{a g k}{\sigma} \frac{\cosh k(kx - \sigma t)}{\cosh(kh)} \sin(kx - \sigma t) \qquad (3\text{-}2)$$

Where

u	fluid particle velocity: 1.84 m/s
a	wave amplitude: 6.85 m
g	acceleration of gravity: 9.81 m/s^2
k	wave number ($2\pi/L$): 0.03 m^{-1}
σ	angular frequency ($2\pi/T$): 0.48 rad/s where T=period
h	total water depth: 50 m
z	depth below quiescent fluid surface: 45 m

For the design conditions the wave length is of the order of 230 m. The maximum horizontal water particle velocity is 1.84 m/s. Considering the point of maximum velocity (acceleration equal to zero), the hydrodynamic force on the structure is 116.60 kN.

5.4.2.2 Current Load

The 100 year current is estimated to be 1.50 m/s at the surface. Conservatively, the same velocity has been applied at the structure level. The resulting force is 77.49 kN.

5.4.3 Seismic actions

5.4.3.1 Horizontal Action

The horizontal seismic action is computed using the ASCE 7-10 equivalent lateral force procedure. Base shear E_H is computed as:

$$E_H = C_S \; W \qquad (3\text{-}3)$$

where

- CS seismic response coefficient
- W seismic weight

Seismic response coefficient is computed as:

$$C_S = \frac{S_{DS}}{\left(\frac{R}{I_e}\right)} \qquad (3\text{-}4)$$

where

- R is response modification factor
- I_e importance factor

The seismic weight for the horizontal direction is the structure weight in air (mass/g) plus the hydrodynamic added mass (M_a). The added mass simulates the hydrodynamic forces arising from moving the structure through a stationary body of water. Added mass is computed following Sarpkaya and Isaacson (1980) as:

$$M_a = K \; \rho \; V \qquad (3\text{-}5)$$

where

K	coefficient, taken as 1.0 for cylindrical object
ρ	mass density of the seawater: 10.15 kN/m^3
V	enclosed volume of structure: 52.96 m^3

The horizontal action is computed as:

Structure mass	92.9.t
Added mass	53.7 t
Seismic mass	146.6 t

The horizontal seismic action is computed as:

S_{DS}	1.33 g
R	8
I_e	1.25
C_s	0.21
W	1466.26 kN
E_H	304.71 kN

5.4.3.2 *Vertical Seismic Action*

Vertical seismic actions are computed as:

$$E_V = 0.2\, S_{DS}\, W \tag{3-6}$$

Note that added mass is not considered for the vertical direction. In this case both the water and the structure move with the seafloor, and there is not a relative displacement between structure and fluid.

The vertical action is computed as:

S_{DS}	1.33 g
W	928.73 kN
E_V	247.04 kN

5.4.4 Summary of Loading Conditions

The individual loads are combined and reduced to foundation level in Table 5.4.

Table 5.4: Loading Conditions for Foundation Verifications

LC	Description	F_V (kN)	F_{Hs} (kN)	z (m)	M (kNm)	e (m)
1	D	474.55	0.00	0.00	0.00	0.00
2	D+W	474.55	116.60	1.18	137.01	0.29
3	D+C	474.55	77.49	1.18	91.05	0.19
4	D+E	721.60	304.71	0.79	239.53	0.33
5	D-E	227.51	304.71	0.79	239.53	1.05

5.5 Foundation verifications

5.5.1 Methodology

Verifications are performed using the conventional bearing capacity formulas provided by API RP 2GEO for shallow foundations directly at the mudline. Dynamic loading from wave, currents and earthquake are considered pseudo statically.

Given the high levels of seismic acceleration, the direct foundation on sand is expected to be critical for sliding verification under earthquake conditions. In this case small displacements may occur. The calculation of the displacements is described in Chapter 5.6.

5.5.1.1 Foundation Capacity on Clay

Bearing Capacity - Clay

Bearing capacity of a shallow foundation on cohesive soil with uniform shear strength is computed using the Brinch Hansen formulation (API, 2011):

$$Q_d = (S_u \ N_c \ K_c)\, A' \qquad (4\text{-}1)$$

where

Q_d	maximum vertical load at failure for undrained conditions
S_u	undrained shear strength
N_c	dimensionless constant equal to 5.14
A’	effective foundation area depending on load eccentricity
K_c	correction factor for effects of load inclination and foundation shape

Overturning moments are addressed using the Meyerhof effective area method. For a circular foundation, the effective area is composed of two circular arc segments as shown in Figure 5.2(API, 2011).

The reduced area is evaluated as an equivalent rectangle with dimensions B’ x L’. The pertinent dimensions are as follows:

$$A' = 2s = B'L' \qquad (4\text{-}2)$$

$$L' = \left(2s\sqrt{\frac{R + e_2}{R + e_1}}\right)^{\frac{1}{2}} \qquad (4\text{-}3)$$

$$B' = L'\sqrt{\frac{R - e_2}{R + e_2}} \qquad (4\text{-}4)$$

$$s = \frac{\pi R^2}{2} - \left[e_2 \sqrt{\left(R^2 - e_2{}^2\right)} + R^2 \arcsin\left(\frac{e_2}{R}\right)\right] \qquad (4\text{-}5)$$

where

R	foundation radius
e_1, e_2	eccentricity (M/V) in perpendicular and parallel directions, respectively

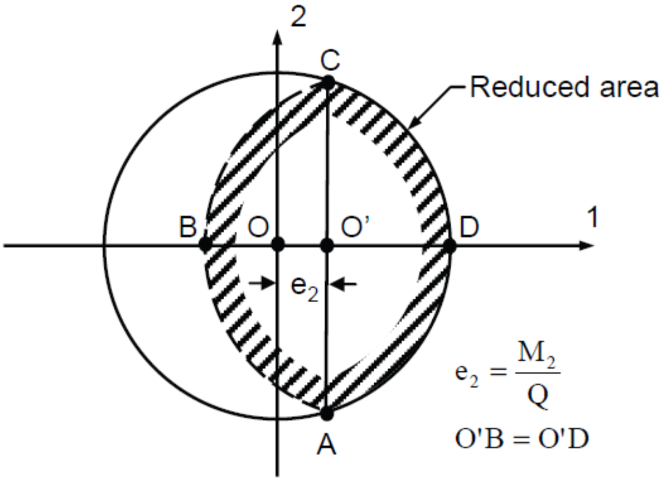

Figure 5.2: Eccentrically Loaded Circular Footing

The correction factor K_c is written as follows:

$$K_c = 1 + s_c + d_c - i_c - b_c - g_c \qquad (4\text{-}6)$$

where

s_c	shape factor
d_c	depth factor
i_c	load inclination factor
b_c	base inclination factor
g_c	ground surface inclination factor

The foundation is located at the mudline, thus d_c is zero. Similarly, the base is horizontal with respect to a horizontal seabed, thus b_c and g_c are also zero. Shape and load inclination factors are:

$$s_c = 0.18\,(1 - 2i_c)\left(\frac{B'}{L'}\right) \qquad (4\text{-}7)$$

$$i_c = \frac{1}{2} - \frac{1}{2}\sqrt{\left[1 - \frac{H'}{S_u\,A'}\right]} \qquad (4\text{-}8)$$

where

H′	horizontal load

Sliding Resistance - Clay

The ultimate sliding resistance Hd for a surface foundation on clay is computed as:

$$H_d = S_{u0}\,A \qquad (4\text{-}9)$$

where

S_{u0}	undrained strength of soil at base of foundation
A	total foundation area

5.5.1.2 Foundation Capacity on Sand

Bearing Capacity - Sand

Drained bearing capacity is considered for the foundation on sand. For a surface footing, the ultimate vertical load may be expressed as (API, 2011):

$$Q_d{}' = \frac{1}{2}\gamma' \, B' \, N_\gamma \, K_\gamma \, A' \qquad (4\text{-}10)$$

where

γ'	submerged unit weight of sand
B′	effective foundation width
N_γ	dimensionless bearing capacity factor
K_γ	correction factor for effects of load inclination and foundation shape
A′	effective foundation area depending on load eccentricity

Effective foundation area and foundation width are defined using the Meyerhof approach defined above.

The bearing capacity factor is an empirical function of drained friction angle ϕ':

$$N_\gamma = \frac{3}{2}\left[\exp(\pi \tan\phi') \text{ x } \tan^2\left(45+\frac{\phi'}{2}\right) - 1\right] \tan(\phi') \qquad (4\text{-}11)$$

The correction factor K_γ is defined as:

$$K_\gamma = i_\gamma \; s_\gamma \; d_\gamma \; b_\gamma \; g_\gamma \qquad (4\text{-}12)$$

where terms i, s, d, b and g have the same meaning as above.

Depth, base slope and seabed slope terms for this case are unity. The inclination and shape factors are defined as:

$$i_\gamma = \left[1 - 0.7\left(\frac{H}{Q}\right)\right]^5 \qquad (4\text{-}13)$$

$$s_\gamma = 1 - 0.4 \, i_\gamma \frac{B}{L'} \qquad (4\text{-}14)$$

where

H	horizontal load
Q	vertical load

Sliding Resistance - Sand

The ultimate sliding resistance Hd′ for a surface foundation on sand is computed as:

$$H_d{}' = Q \tan\delta \qquad (4\text{-}15)$$

where

δ soil-foundation interface friction angle, taken as 2/3 ϕ'.

5.5.1.3 Sliding in Seismic Conditions

The area in question is subject to strong seismic ground motion. This is problematic for surface footings on sand, as the seismic action exceeds the available soil resistance. This is not unusual for submarine structures; the soil resistance is a fraction of the submerged unit weight of the structure (W′ tan δ) while the seismic action is a function of the total seismic mass (Cs x total weight + hydrodynamic added mass).

In the bearing capacity verifications, the maximum horizontal force applied to the foundation is limited to the ultimate sliding resistance. This is considered an acceptable approximation for preliminary design. Displacements are assessed separately.

5.5.2 Verifications for clay

The results of the verifications for clay are reported in the table below.

Table 5.5: Verifications for clay – Bearing capacity

Bearing capacity - Clay											
LC	e (m)	B' (m)	L' (m)	sc	dc	ic	bc	gc	kc	Qc	FS
1	0.00	6.65	6.65	0.18	0.00	0.00	0.00	0.00	1.18	6698.81	14.12
2	0.29	6.13	6.37	0.16	0.00	0.03	0.00	0.00	1.13	5683.08	11.98
3	0.19	6.30	6.47	0.17	0.00	0.02	0.00	0.00	1.15	6020.99	12.69
4	0.33	6.06	6.33	0.14	0.00	0.09	0.00	0.00	1.06	5196.75	7.20
5	1.05	4.80	5.53	0.11	0.00	0.13	0.00	0.00	0.98	3346.98	14.71

Table 5.6: Verifications for clay – Sliding

Sliding - Clay						
LC	e (m)	B' (m)	L' (m)	Q	V	FS
1	0.00	6.65	6.65	2208.93	0.00	Infinite
2	0.29	6.13	6.37	2208.93	116.60	18.94
3	0.19	6.30	6.47	2208.93	77.49	28.51
4	0.33	6.06	6.33	2208.93	304.71	7.25
5	1.05	4.80	5.53	2208.93	304.71	7.25

5.5.3 Verifications for sand

The results of the verifications for sand are reported in the table below.

Table 5.7: Verifications for sand – Bearing capacity

Bearing capacity - Sand																			
LC	e (m)	B' (m)	L' (m)	sq	dq	iq	bq	gq	kq	sg	dg	ig	bg	gg	kg	Nq	Ng	p'0	Qc	FS
1	0.00	6.65	6.65	1.56	1.00	1.00	1.00	1.00	1.56	0.55	1.00	1.00	1.00	1.00	0.55	18.40	15.07	0.00	18208.82	38.37
2	0.29	6.13	6.37	1.31	1.00	0.52	1.00	1.00	0.68	0.82	1.00	0.39	1.00	1.00	0.32	18.40	15.07	0.00	8609.50	18.14
3	0.19	6.30	6.47	1.38	1.00	0.65	1.00	1.00	0.90	0.75	1.00	0.55	1.00	1.00	0.41	18.40	15.07	0.00	11829.73	24.93
4	0.30	6.08	6.36	1.20	1.00	0.34	1.00	1.00	0.41	0.90	1.00	0.21	1.00	1.00	0.19	18.40	15.07	0.00	5006.45	6.94
5	0.30	5.31	6.36	1.23	1.00	0.34	1.00	1.00	0.43	0.89	1.00	0.21	1.00	1.00	0.19	18.40	15.07	0.00	3754.92	16.50

Table 5.8: Verifications for sand – Sliding

Sliding - Sand						
LC	e (m)	B' (m)	L' (m)	Q	V	FS
1	0.00	6.65	6.65	182.16	0.00	Infinite
2	0.29	6.13	6.37	182.16	116.60	1.56
3	0.19	6.30	6.47	182.16	77.49	2.35
4	0.30	6.06	6.33	276.99	304.71	0.91
5	0.30	4.80	5.53	87.33	304.71	0.29

5.5.4 Summary of factors of safety

The summary of the factors of safety for the verifications is reported in the table below.

Table 5.9: Summary of factors of safety

LC	Clay		Sand	
	Bearing capacity	Sliding	Bearing capacity	Sliding
1	14.12	Infinite	38.37	Infinite
2	11.98	18.94	18.14	1.56
3	12.69	28.51	24.93	2.35
4	7.20	7.25	6.94	0.91
5	14.71	7.25	16.50	0.29

As shown in Table 5.9, in the case of direct foundation on clay all the verifications are satisfied.

As expected, the sliding verification for direct foundation on sand under seismic conditions is not verified thus small displacements may occur. The calculation of the expected displacements is given in Chapter 5.6.

5.6 Displacements in seismic condition

5.6.1 Methodology

The factor of safety against sliding in seismic conditions is less than unity for the foundation on sand, thus some movement may be expected. The entity of displacements was computed using the Newmark method. The foundation is represented as a rigid-plastic friction block having a known yield or “critical” acceleration. The critical acceleration is defined as the acceleration required to overcome frictional resistance and initiate sliding on the seabed (tanδ). The model is subject to a recorded earthquake accelerogram, and the ensuing motion is computed. The analysis was performed using the USGS software Newmark (Jibson and Jibson, 2003).

5.6.1.1 Evaluation of Displacements

A set of 860 earthquake time histories regarding the California State were selected for the analysis. The records were scaled to the design peak ground acceleration ($S_{DS}/2.5 = 0.5$ g).The estimated horizontal structure displacements were computed by integrating the portions of the acceleration time histories exceeding the threshold acceleration (tan δ).

The average displacement from the 860 time histories is less than 1 cm. The maximum displacement is about 5 cm. This magnitude of displacements is considered acceptable.

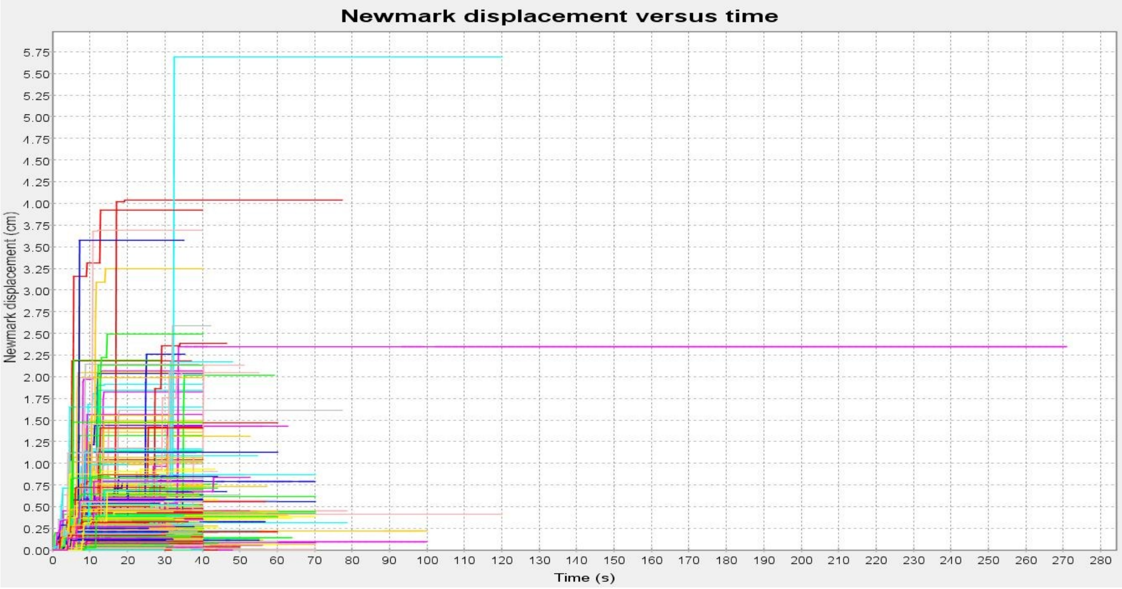

Figure 5.3: Results of Newmark Analysis – Foundation on Sand

5.7 References

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6 APPENDIX 2 – PRELIMINARY STRUCTURAL DESIGN REPORT

6.1 Introduction

In this paragraph the design of the concrete “basin” is inserted.

The internal cylindrical cavity diameter of concrete “basin” is 4.0 m.

Into the “basin” there is a layer of coke and a layer of gravel.

Two different load configurations are considered in the design:

- basin lift and drop into the sea water;
- basin operating phase under the sea water.

6.2 Design standards

The structure is designed to meet or exceed the minimum requirements of the following reference standards:

- ACI 318-89: Building Code Requirements for Structural Concrete and Commentary;
- ACI 357-84: Guide for the Design and Construction of Fixed Offshore Concrete Structures;
- ACI 440-06: Guide for the Design and Construction of Structural Concrete Reinforced with FRP Bars.

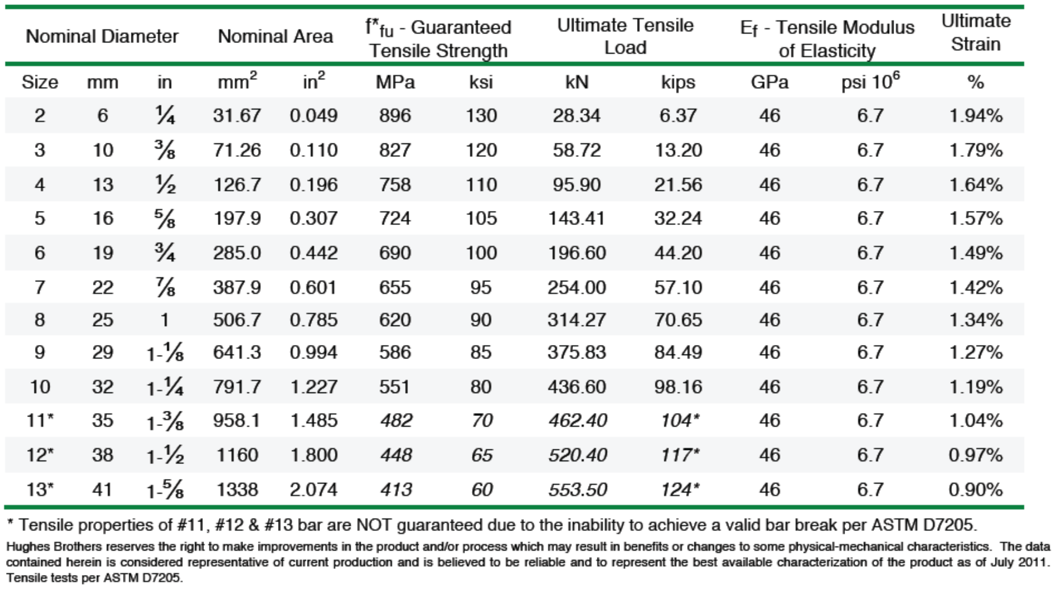
6.3 Materials

The materials listed in this section are the preferred materials/grades/sizes for design purposes. See the Drawings and Specifications for the project requirements for construction.

6.3.1 Concrete

- Density: 150pcf
- Young’sModulus: E = 4.3x10E6 psi
- Poisson’s Ratio: $\upsilon = 0.20$
- Coefficient of thermal expansion: $\alpha = 5.5\text{x}10^{-6}/^{o}\text{F}$

6.3.2 *GFRP reinforcement*



Nominal Diameter			Nominal Area		f^*_{fu} - Guaranteed Tensile Strength		Ultimate Tensile Load		E_f - Tensile Modulus of Elasticity		Ultimate Strain
Size	mm	in	mm^2	in^2	MPa	ksi	kN	kips	GPa	psi 10^6	%
2	6	¼	31.67	0.049	896	130	28.34	6.37	46	6.7	1.94%
3	10	⅜	71.26	0.110	827	120	58.72	13.20	46	6.7	1.79%
4	13	½	126.7	0.196	758	110	95.90	21.56	46	6.7	1.64%
5	16	⅝	197.9	0.307	724	105	143.41	32.24	46	6.7	1.57%
6	19	¾	285.0	0.442	690	100	196.60	44.20	46	6.7	1.49%
7	22	⅞	387.9	0.601	655	95	254.00	57.10	46	6.7	1.42%
8	25	1	506.7	0.785	620	90	314.27	70.65	46	6.7	1.34%
9	29	1-⅛	641.3	0.994	586	85	375.83	84.49	46	6.7	1.27%
10	32	1-¼	791.7	1.227	551	80	436.60	98.16	46	6.7	1.19%
11*	35	1-⅜	958.1	1.485	*482*	*70*	*462.40*	*104**	46	6.7	1.04%
12*	38	1-½	1160	1.800	*448*	*65*	*520.40*	*117**	46	6.7	0.97%
13*	41	1-⅝	1338	2.074	*413*	*60*	*553.50*	*124**	46	6.7	0.90%

* Tensile properties of #11, #12 & #13 bar are NOT guaranteed due to the inability to achieve a valid bar break per ASTM D7205.

Hughes Brothers reserves the right to make improvements in the product and/or process which may result in benefits or changes to some physical-mechanical characteristics. The data contained herein is considered representative of current production and is believed to be reliable and to represent the best available characterization of the product as of July 2011. Tensile tests per ASTM D7205.

6.4 Durability requirements

The structure category exposure is C2, which means that concrete is exposed to moisture and an external source of chlorides from de-icing chemicals, salt, brackish water, seawater, or spray from these sources.

Max w/cm	0.40;
Min f_c’	5000 psi;

6.5 Gravityloads

General design criteria for dead and live loads are given in this section.

6.5.1 *Material self-weight*

Dead loads have been calculated using the following assumed densities:

Concrete (normal weight):	150 pcf
Gravel:	95pcf
Gravel (saturated):	110pcf
Coke:	30pcf

6.5.2 *Live load*

The live load is due to the weight of the materials contained within the structure:

- 20” of coke;
- 33” of gravel.

Live loads have been calculated using the following equation:

$$\omega_{LL} = \rho \cdot h$$

Coke: $\omega_{LL,COKE} = 30\ lb/ft^3 \cdot 1.64\ ft = 49.2\ lb/ft^2 = 0.049\ kip/ft^2$

Gravel: $\omega_{LL,GRAVEL} = 95\ lb/ft^3 \cdot 2.78\ ft = 264.1\ lb/ft^2 = 0.264\ kip/ft^2$

6.6 Required strength

The required strength is determined by the following equations.

- $U = 1.4(D + F)$ (1)
- $U = 1.2(D + F) + 1.6(L)$ (2)

During the lifting phase the fluid action is null *(F=0)*.
During the operating phase, the hydrostatic pressure is self-balanced*(F=0)*.

The dead load is due to structural weight, computed automatically by the FE modelling software.

The required strength must be higher than the forces resulting, from the following different load combinations:

- (1)
    - M_u = 2.5 kip-ft/ft

For shear check, the load applied at the lifting holes,is considered equal to:

- V_u = 85.0 kips

- (2)
    - M_u = 5.6 kip-ft/ft

For shear check, the load applied at the lifting holes,is considered equal to:

- V_u = 105.0 kips

6.6.1 Flexure

Flexure[ACI 318-05]			
Factored moment atsection	M_u	5,6	[kip·ft]
Specified compressive strength of concrete	f_c'	5	[ksi]
Design tensile strength of FRP	f_{fu}	70	[ksi]
Factor function of compressive strength	β_1	0,85	[-]
Modulus of elasticity of FRP	E_f	6500	[ksi]
Ultimate strain concrete	ε_{cu}	0,003	[-]
FRP reinforcement ratio producing balanced strain conditions	ρ_{fb}	0,0112	[-]
Height of the web	h	15,8	[in]
Width of the web	b	39,4	[in]
Diameter of reinforcing bar	d_b	0,5	[in]
Number of tension reinforcing bars	n_b	10	[-]
Total area of tension reinforcing bars	A_f	1,96	[in^2]
Nominal cover	cover	1,875	[in]
Distance from extreme compression fiber to centroid of tension reinforcement	d	13,68	[in]
FRP reinforcement ratio	ρ_f	0,003644	[-]
	A	95,06	[ksi]
	B	19330,19	[ksi]
	C	9,75	[ksi]
Stress in FRP reinforcement in tension	f_f	129,62	[ksi]
Nominal moment capacity	M_n	3286,51	[lb·in]
		273,77	[kip·ft]
Strenghtreductionfactor	ϕ	0,550	
Factorednominal moment capacity	ϕM_n	150,57	[kip·ft]

6.6.2 Serviceability

Check the crack width[ACI 440.1R-39]			
Moment at the section	M_u	5,6	[kip·ft]
Limit of crack width	w_{lim}	28	[mils]
Bond-dependingcoefficient	k_b	1,4	[-]
Modular ratio	n_f	1,61	[-]
Ratio of depth of neutral axis to reinforcement axis	k	0,103	[-]
Stress in FRP reinforcement in tension	f_f	2,6	[ksi]
Ratio of distance from neutral axis to extreme tension fiber to distance to from neutral axis to center of tensile reinforcement	β	1,173	[-]
Thickness of concrete cover measured to the center of bar	d_c	2,13	[in]
Stirrupspacing	s	35,15	[in]
Crack width	w	23,2	[mils]

Check the creep rupture stress limits[ACI 440.1R-39]			
Moment due to sustained loads	M_s	5,6	[kip·ft]
Limit of stress level in FRP	$0.20 \cdot f_f$	14,0	[ksi]
Stress level induced in FRP by sustained loads	$f_{f,s}$	2,6	[ksi]

6.6.3 Shear

The section in correspondence of the lifting holes has the following properties:

Height of the web	h	15,8	[in]	401	[mm]
Width of the web	b	15,8	[in]	401	[mm]
Diameter of reinforcing bar	d_b	0,5	[in]	13	[mm]

Total shear area provided by FRP stirrups: 4#5 + 2#4 (vertical reinforcement).

Shear *[ACI 318-05]*			
	V_u	105	[kips]
Design tensile strength of FRP	f_{fu}	70	[ksi]
Radius of the bend	r_b	1	[in]
Diameter of shear reinforcing bar	d_b	0,5	[in]
Spacing of the FRP stirrups	s	4	[in]
Total shear area provided by FRP stirrups	A_{fv}	2,16	[in^2]
Distance from extreme compression fiber to centroid of tension reinforcement	d	13,68	[in]
Ratio of depth of neutral axis to reinforcement axis	k	0,157	[-]
Cracked transformed section neutral axis depth	c	2,15	[in]
Concrete shearcapacity	V_c	12,01	[kips]
Minimum radius of the bend	r_b	1,50	[in]
Design tensile strength of the bend of FRP bar	f_{fb}	31,5	[ksi]
Stress level in the FRP shear reinforcement	f_{fv}	26,0	[ksi]
Shear resistance provided by FRP stirrups perpendicular to member's axis	V_f	192,00	[kips]
FRP shearcapacity	V_f	144,00	[kips]
Strenghtreductionfactor	ϕ	0,75	
Factorednominalshearcapacity	ϕV_n	117,00	[kips]

7 APPENDIX 3 – PRELIMINARY ELECTRODE DESIGN PLANS AND SECTIONS

See annexed drawing # CESI B2016025

8 APPENDIX 4 – PRELIMINARY ELECTRODE DESIGN REINFORCEMENT DETAILS

See annexed drawing # CESI B2016165

9 APPENDIX 5 – PRELIMINARY TECHNICAL SPECIFICATION

See annexed CESI Document # CESI B2016318

REPORT

B2016318

Client Burns and McDonnell - Brea Office – CA United States

Subject SUBMARINE ELECTRODE TECHNICAL SPECIFICATION – ANNEX TO TASK 1&11 FINAL REPORT

Order B&McD – Doc. No. EC-1 (09-03-2011) – Prot. CESI B1025003

Notes

N. of pages 9 **N. of pages annexed** --

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Table of contents

REVISIONS HISTORY

Revision number	Date	Protocol	List of modifications and/or modified paragraphs
00	05-25-2012	B2016318	First emission

1 ELECTRODE DESCRIPTION

The electrode is formed by using 88 (eighty eight) concrete cylindrical boxes (see Fig. 1-2 and 1-3, below), regularly spaced and laid on the seabed on a circle, which is 420 m in diameter. The distance among the centers of two adjacent boxes is 15 m. The electrode is electrically subdivided into 8 sections of 11 boxes each. Electrical connections, as well as box structure, are reported in detail in the Appendix 3 and 4 of Task 1 "New or Upgraded Electrode Design and Study" and task 11 " Feasibility Analysis for New Electrode Array Location" – FINAL REPORT (report # B201670). The electrode must be able to be operated according to the Duty Cycle reported in Fig. 1-1 when all 8 sections are dispersing ("normal operations") and also when just 6 sections are dispersing ("special operations").

2 ELECTRODE DUTY CYCLE

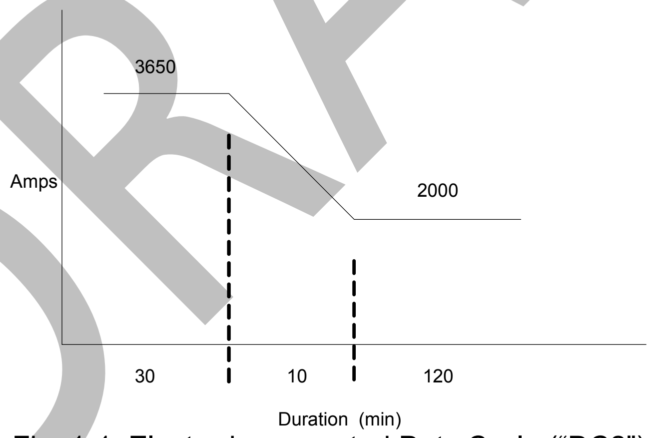


Fig. 1-1: Electrode requested Duty Cycle ("DC2")

3 BOX DESCRIPTION

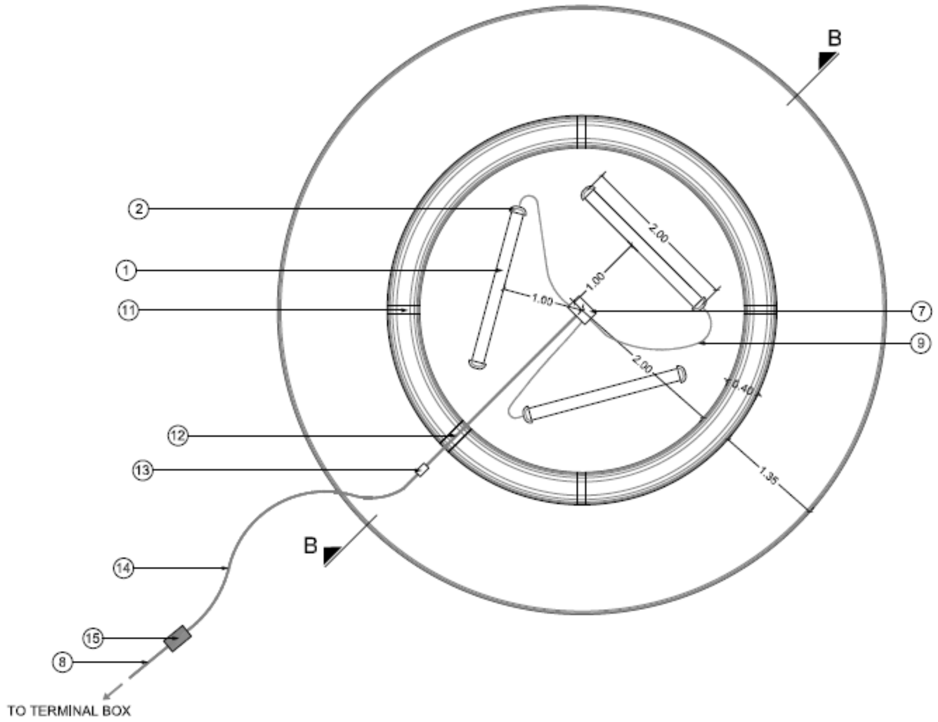
Each box has an internal cylindrical cavity with diameter 4.0 m; each cavity contains 3 (three) graphite bars (1), with diameter 0.15 m, length 2.0 m, first 5 cm on each side covered by an insulating and waterproof cap (2) (one protects the electrical connection, the other one just covers the opposite side of the bar). The dispersing surface of each bar is therefore 0.895 m^2, and the total graphite dispersing surface per box is 2.69 m^2. The real dispersing surface is the upper surface of the coke, which is 12.57 m^2 per box.

Bars are tangentially disposed to form an "unclosed triangle". The midpoint of each bar is located 1 m from the centre of the box. Therefore the minimum distance from the closest point on an adjacent bar is about 0.73 m. Bars' tips are 1.42 m distant from box center, see Fig. 1-2 below. Bars are laid on a layer of coke (3), previously disposed on the bottom of the internal HDPE lining (5) provided for the mechanical protection of box internal surface, in such a way that the minimum distance between the bar and the bottom lining is 5 cm, see Fig. 1-3. Electrical connections of the graphite bars' cables (9) and the sub-electrode pigtail (14) are then realized inside a junction box (7) (made using insulating material, located in the concrete box center, and laid on the bottom lining) that will eventually be resin-casted to make it waterproof. All cables will be mechanically protected by potential damage due to the action of coke/gravel, by inserting them into mechanically resistant flexible plastic conduits (not indicated in drawings).

The plastic conduit crossing the side wall of the box (12) should be placed before the concrete casting or, in alternative, after positioning the plastic conduit the free space between it and the inlet hole must be permanently sealed. In the same way, as the plastic conduit has to cross the HDPE liner (5) too, after its positioning also the space between it and the liner has to be permanently sealed. Furthermore, to prevent electrical current from oozing out through the conduit internal cavity, this must be filled with an insulating mastic both on the external end (out of the box) and on the internal end (when entering the resin-casted junction box). The sub-electrode pigtail (14) cable must be securely clamped (13) to the concrete structure to prevent damage to the internal connections in case of the pigtail is pulled from outside the box. The point where the pigtail (14) will exit the box must be located at 0.5 m from the bottom (interface coke/gravel), to prevent its damage or its coverage with debris. The pigtail terminates on a plug-in connector (15), that a scuba diver will manually plug in, after box laying, with the matching connector located at the end of the sub-electrode cable (8).

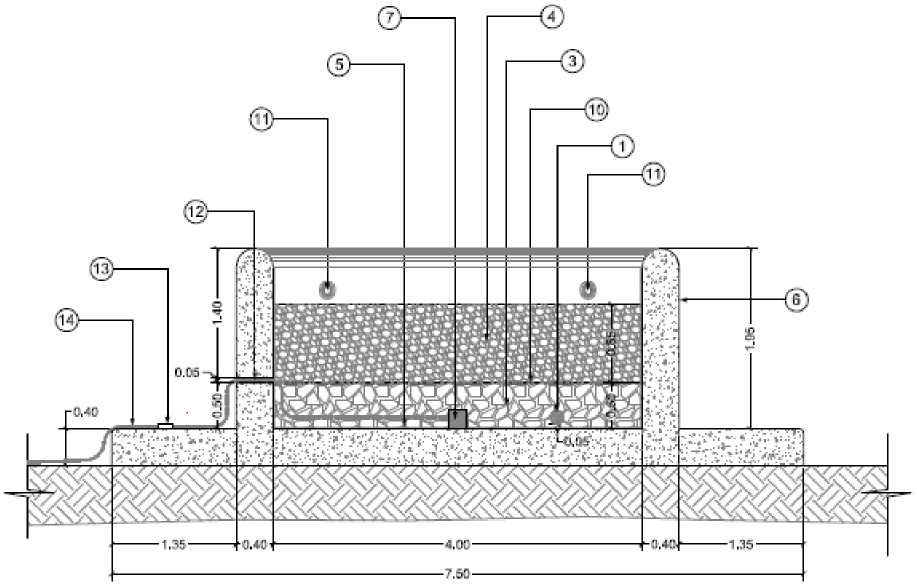
At this stage (i.e. after graphite bars' laying), coke is added until the final thickness of 0.5 m is reached for coke layer (3). Particular care must be taken to accurately fill the space around the bars, to prevent them from breaking when pressed. At the end a layer of gravel (4) of further 0.85 m is added (giving an estimated pressure on coke of 680 kg/m^2).

If, for any reason, it is necessary to prevent the diffusion of coke particles (3) inside gravel (4), or to prevent coke contamination coming through the gravel, a sheet of porous/woven polyester fabric or other suitable tissue (10) can be optionally inserted on the top of the coke, before the final covering with gravel. In any case the correct material must be chosen in such a way to be transparent to the electrical current flow, as the full current discharged by the electrode must flow through it.



1	Graphite bar
2	Waterproof cap
7	Resin-casted junction box
8	Sub-electrode cable
11	Lifting hole
12	Cable inlet HDPE pipe
13	Cable clamp
14	Sub-electrode pig tail
15	"Plug-In" connector

Fig. 1-2: Cylindrical concrete box – Plan view

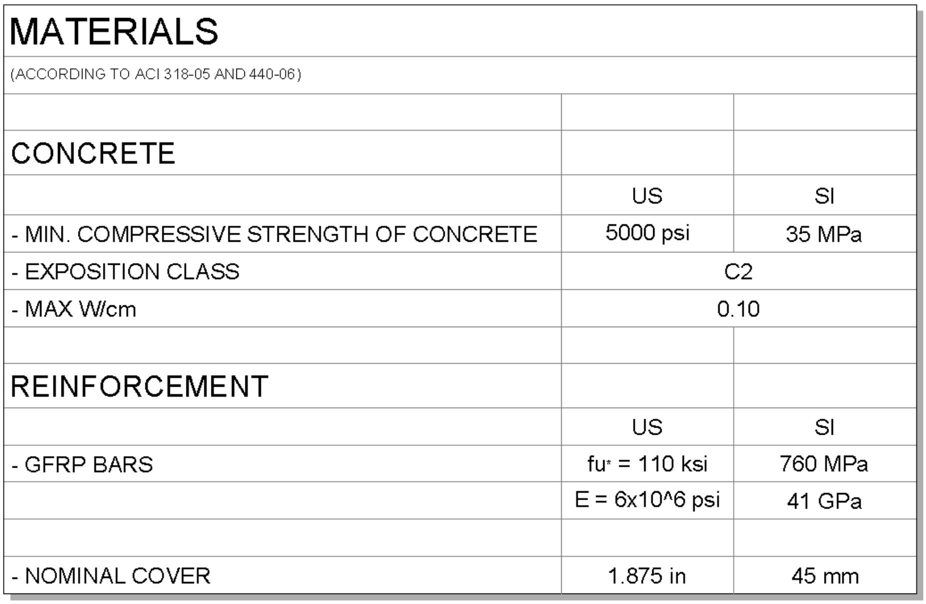


1	Graphite bar
2	Waterproof cap
3	Coke (20÷40 mm grain size)
4	Gravel (20÷40 mm grain size)
5	HDPE liner
6	Epoxy painting
7	Resin-casted junction box
8	Sub-electrode cable
9	Graphite bar cable
10	Porous woven polyester fabric sheet
11	Lifting hole
12	Cable Inlet HDPE pipe
13	Cable clamp
14	Sub-electrode pig tail
15	"Plug-in" connector

Fig. 1-3: Cylindrical concrete box – Section B-B

4 BOX CONSTRUCTION MATERIALS

Reinforced concrete:
Concrete is proportioned to provide an average compressive strength, f'_c, and to satisfy the durability criteria.
Required min. compressive strength of concrete is 35 MPa (5000 psi).
The exposition class is C2.
Reinforcement is realized by GFRP (Glass Fiber Reinforced Polymer) bars to avoid corrosion and interaction with electric fields.
The following table shows materials properties according to ACI 318-05 and ACI 440-06.



MATERIALS

(ACCORDING TO ACI 318-05 AND 440-06)

CONCRETE		
	US	SI
- MIN. COMPRESSIVE STRENGTH OF CONCRETE	5000 psi	35 MPa
- EXPOSITION CLASS	C2	
- MAX W/cm	0.10	
REINFORCEMENT		
	US	SI
- GFRP BARS	f_u^* = 110 ksi	760 MPa
	E = 6x10^6 psi	41 GPa
- NOMINAL COVER	1.875 in	45 mm

Tab. 1-1: Concrete box material specification

Protective painting:
The concrete box must be painted before the installation of the HDPE liner, on every surface, by using a suitable product to prevent water from penetrating the concrete. If possible, the selected treatment should be waterproof for the requested lifetime of boxes (40 yrs). An anti fouling external treatment shall also be applied, using a product compliant with the U.S. environmental regulations.

Protective elastomeric epoxy recommended for protection and waterproofing of concrete

Definition of the material
Epoxy resin (cyclo aliphatic), two component high solids content, elastic to be applied directly on the structure previously treated with a specific primer. Before applying the primer is essential to check that the concrete surfaces to be protected are not degraded and / or contaminated with oil, grease or other substances. The thickness of the layer must be at least 500 µm.
The product shall have the following characteristic:

- high chemical resistance to a multitude of aggressive;
- adheres monolithically to the support;
- presents the characteristics of crack bridging ability: this property allows the coating to remain intact through existing cracks in the concrete;
- resists hydraulic pressure positive, negative, and the osmotic;

- protects against the risks of entry: prevent water ingress (even under pressure) allows the material to counter any processes of deterioration;
- increases the electrical resistivity of the concrete;
- resists UV radiation.

Protection/electrical insulation of the internal cavity:
To protect the internal painting from the possible damage due to the gravel, the bottom and the lateral wall of the box must be lined using a sheet (5) of thick (5÷10 mm) hard electrically insulating rubber (for example HDPE), resistant both to seawater, to the action of chlorine and to the action of coke/gravel. The bottom sheet must be thermosealed to the lateral sheet, in such a way to form an "internal" sealed HDPE tank, of the same dimension of the cavity within the concrete box. The height of such internal tank must arrive at the point where the lateral wall starts to deviate from the vertical direction to form the top rounded corner with radius of 20 cm. In this way it will cover the four holes (11), opened on the side wall, necessary to hang the box to a crane during the laying, as soon as the rope is removed. In this way the amount of electrical current flowing out such holes during operations will be substantially limited.

Graphite bars:
High quality impregnated graphite bars (1); max. resistivity 5÷15 μΩ·m, if possible already equipped with an adequately sized connection cable (9) (the current per each single bar should be less than 25 A as worst case, and the section of cable coming from outside is 25 mm^2; for this reason, and also to ensure a suitable mechanical behavior, a cable with section of 10 mm^2 is recommended to feed each bar). To prevent corrosion of copper bar cable due to the action of salty water, the connection must be guaranteed by the manufacturer as absolutely waterproof for 40 years.

Graphite bars electrical connections:
In case the connection has to be realized before the installation, the electrical connection of the graphite bar cable (9) with the graphite bar (1) must be made to ensure very low contact resistance (less than 5 mΩ), highly stable and reliable connection, and it must made be totally waterproof for 40 years, through the use of epoxy caps, and/or heat-shrink caps and, if needed, suitable sealant (2). On the opposite tip of the bar, a similar cap (2) must be installed, to prevent electrical current to flow out from there; in this way just the lateral surface of bars will be used as dispersing surface. The insulation/waterproof requirements of such cap must be equal to the cap located on the current fed tip.

Coke:
metallurgical coke or coke breeze (***NOT RAW COAL, which is unfit***), grain size: 20÷40 mm, max. resistivity 0.025 Ω·m at 680 kg/m^2 (mono-granular, to easily allow water flow)

Gravel:
heavy granite gravel (the selected material must not be subject to any electrochemical reactions when exposed to DC electric field and must not be subject to any to chemical alteration when exposed to the chemical products discharged during electrode operations, such as hydrogen, oxygen and chlorine), without trace of iron ore, grain size: 20÷40 mm, specific weight (dry): 1,800 kg/m^3. Gravel grains characteristics must be selected in such a way to allow free water circulation and electrical current flow; in particular gravel must be mono-granular.

Connectors:
See Task 2 final report.

Junction box:
Hard plastic connection box, sized for the connection of one 25 mm^2 cable with 3 single core cables-10 mm^2 copper; it must be able to permanently resist to the mechanical pressure of the gravel and the coke (about 1,000 kg/m^2); it must be filled with waterproof and insulating resin.

Cables:

- Sub-electrode pigtail (14):
  - single phase, low voltage, 25 mm^2 copper, extruded insulation, outer sheath with improved mechanical characteristics
- Graphite Bar Cable (9)
  - single phase, low voltage, 10 mm^2 copper, extruded insulation, outer sheath with improved mechanical characteristics

5 METHOD OF CONSTRUCTION AND INSTALLATION

Box Prefabrication:
The main steps of the prefabrication of the boxes are described below:

- Implementation of the bottom slab;
- Implementation of the walls of the boxes;
- Transport of the boxes in an area of temporary storage.

Box installation:
The prefabricated boxes are transported by a barge to the place where they must be positioned.
After that initial phase, the boxes will be placed with a crane on the seabed in the final position.
A team of divers assists for all the duration of the phase of installation of the boxes, assuring that the boxes are placed according to the design layout and monitoring the perimeter to detect any possible problem of contact between the boxes and the bottom.

Client	Burns and McDonnell - Brea Office – CA United States
Subject	Task 3 "Electric Field and Voltage Gradient Studies" – FINAL REPORT
Order	B&McD – Doc. No. EC-1 (09-03-2011) – Prot. CESI B1025003
Notes	

N. of pages	20	**N. of pages annexed**	--

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REVISIONS HISTORY

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00	05-30-2012	B2016112	First emission

1 BACKGROUND AND SCOPE OF WORK

Background of the activity: aim of the project is the consultancy about the review of the present sea electrode of the Pacific Direct Current Intertie, located about 1,570 m offshore S. Monica, CA, and the analysis and proposal of a new location and the design of a new electrode.

Scope of the work: this report describes the expected electric field strength in the water, surface, vicinity of electrode considering the new operations (see task 1 report and its annexes).

Such activities are also mentioned as "Task 3 - Electric Field and Voltage Gradient Studies"

2 TASK 3 "ELECTRIC FIELD AND VOLTAGE GRADIENT STUDIES" - DESCRIPTION OF THE SUBTASKS

	Subtasks
a	Study and report the expected electric field strength in the water, surface, vicinity of electrode, adjacent shore from new operations
b	Investigate voltage gradient
c	Prepare report for electric field and voltage gradient study -harmful consequences from fields on marine life -Min recommended distance from the electrode -Voltage gradient with new operations -Map of equipotential lines -Current density and max voltage gradient -Voltage gradient causing large currents on nearby metal -Mitigating measures

2.1 Subtask 3a:

The electric field in the water has been studied using two different approaches: for the "distant" field (more related with the risk of corrosion), analytical computations were performed. This activity has been reported in detail in Task 5.

For the "close" field, i.e. in the immediate proximity of the electrode (which is more related with safety issues), two approaches were adopted:

- Adequate design, to limit the maximum value of electric field, and thus to achieve the compliance with the ICNIRP pre-standard IEC 62344. Basically it led to choose a sufficiently ample dispersing surface for the electrode;
- Verification of the design through the use of a numerical method (the Finite Element

Method, or FEM), applied to the electrode and to its “close” proximity. This approach was needed to limit the size of the resulting model, as the geometry needs to be “discretized” in a number of small volumes (the so-called “elements”). If the precision close to the electrode must be high, a high number of elements is locally needed; but also the global number of elements will increase, so we cannot discretize very tiny details within an area thousands of km wide. In our computations, the resulting FEM meshes already had several millions elements, and a number of unknowns in the order of 15-20 million, depending on the model. Computational times were of 9-13 hours on a very fast last generation PC (HP Z400, equipped with an Intel® Xeon® W3670 six-cores CPU, clock 3.3 GHz, and 24 GB RAM), representing an operational limit to this kind of study. For these reasons it is not possible to analyze at the same time what happens over the electrode and far from it, and this led to our aforementioned approach. For the analysis of the whole electrode, a full 3 dimensional approach was used, while, to study with better detail the shape of a single concrete box, a 2 dimensional approach was used. The adopted programs were Opera2d and Opera3d by Cobham CTS ltd (formerly Vector Fields ltd), 24 Bankside, Kidlington, Oxfordshire, OX5 1JE - UK.

2.2 Subtask 3b

See subtask 3a.

2.3 Subtask 3c

In our numerical computations the assumed parameters were:

- Seawater electrical conductivity: 5.0 S/m;
- Gravel electrical conductivity: 2.5 S/m;
- Seabed and shore electrical conductivity: 0.001 and 0.01 S/m.

The shoreline was modeled as straight, to allow to exploit problem symmetries (in other terms, just half of the geometry has been discretized, otherwise a further doubling in the number of elements would have made the problem intractable). The discretized geometry is therefore just one of the two parts of the original geometry when we imagine it is divided by a straight vertical plan, perpendicular to the shoreline and passing through the center of the electrode. Suitable boundary conditions were imposed on such cut (zero normal component of current density). The distance of the electrode center from the shoreline was assumed 4,800 m (in the real case the closest point on the shore are located at 4,600 (from Topanga Beach) and 5,000 m (from Sunset Boulevard intersection with the Pacific Coast Highway), and 4,800 is the average value). In other term, Fig. 1-3 is represented the by mirroring of the real FEM mesh across the plane XZ; the real FEM mesh is characterized by Y>0.

The concrete boxes, due to the surface treatment with insulating paint, and to the lining of the internal cavity with insulating rubber, have been modeled as perfectly insulating; therefore the current is dispersed from their upper face only.

The computations were initially 3 dimensional, to determine the distribution of current over the different boxes. This derives from an intrinsically three dimensional distribution of the current flow inside the water in the various cases, which can be largely different in the various analyzed cases.

The following cases were analyzed for seabed electrical conductivity of 0.001 and 0.01 S/m:

a) Complete electrode (88 boxes in operations);
b) Electrode in special operations, 66 boxes in operations, missing sections N&S;
c) Electrode in special operations, 66 boxes in operations, missing sections E&W;
d) Electrode under test (resistance measured between groups N&S of 11 boxes each);
e) Electrode under test (resistance measured between groups E&W of 11 boxes each).

The differences between cases b) and c) were minimal; cases d) and e) gave very similar result. This means that the distance between the electrode and the shoreline is sufficient to have the results almost insensitive to asymmetric changes to the configuration of the electrode.

Computations using the higher value of seabed electrical conductivity (0.01 S/m) resulted in similar values as the ones based on 0.001 S/m. This means that the results are locally driven by the conductivity of seawater (i.e. most part of the electrical current flows inside seawater, which is from 500 to 5,000 times higher than that of seabed/ground).

Based on the results, we will report the results for cases a), b) and d) only. All distances are expressed in meters.

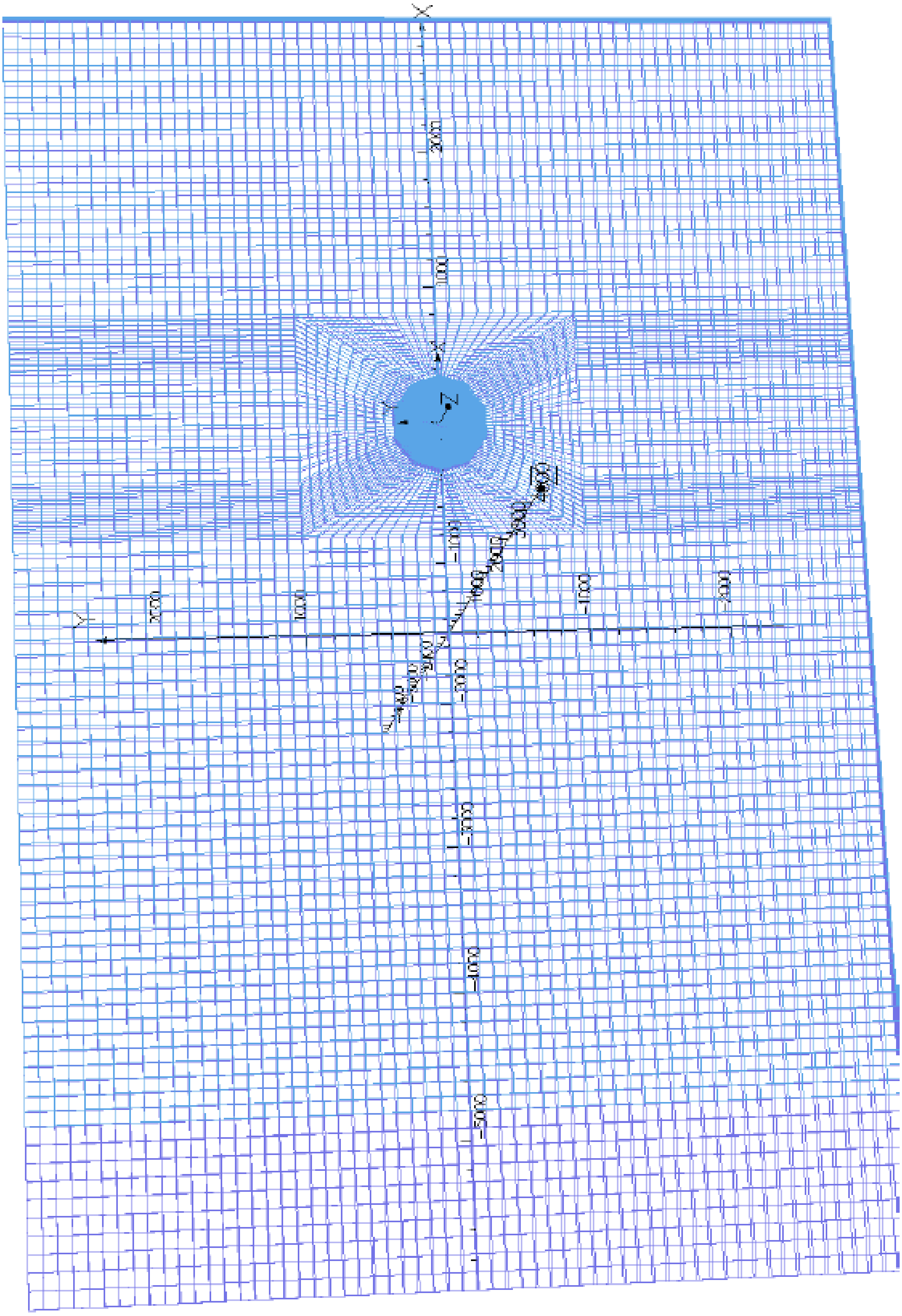

Fig. 3-1: The complete FEM mesh

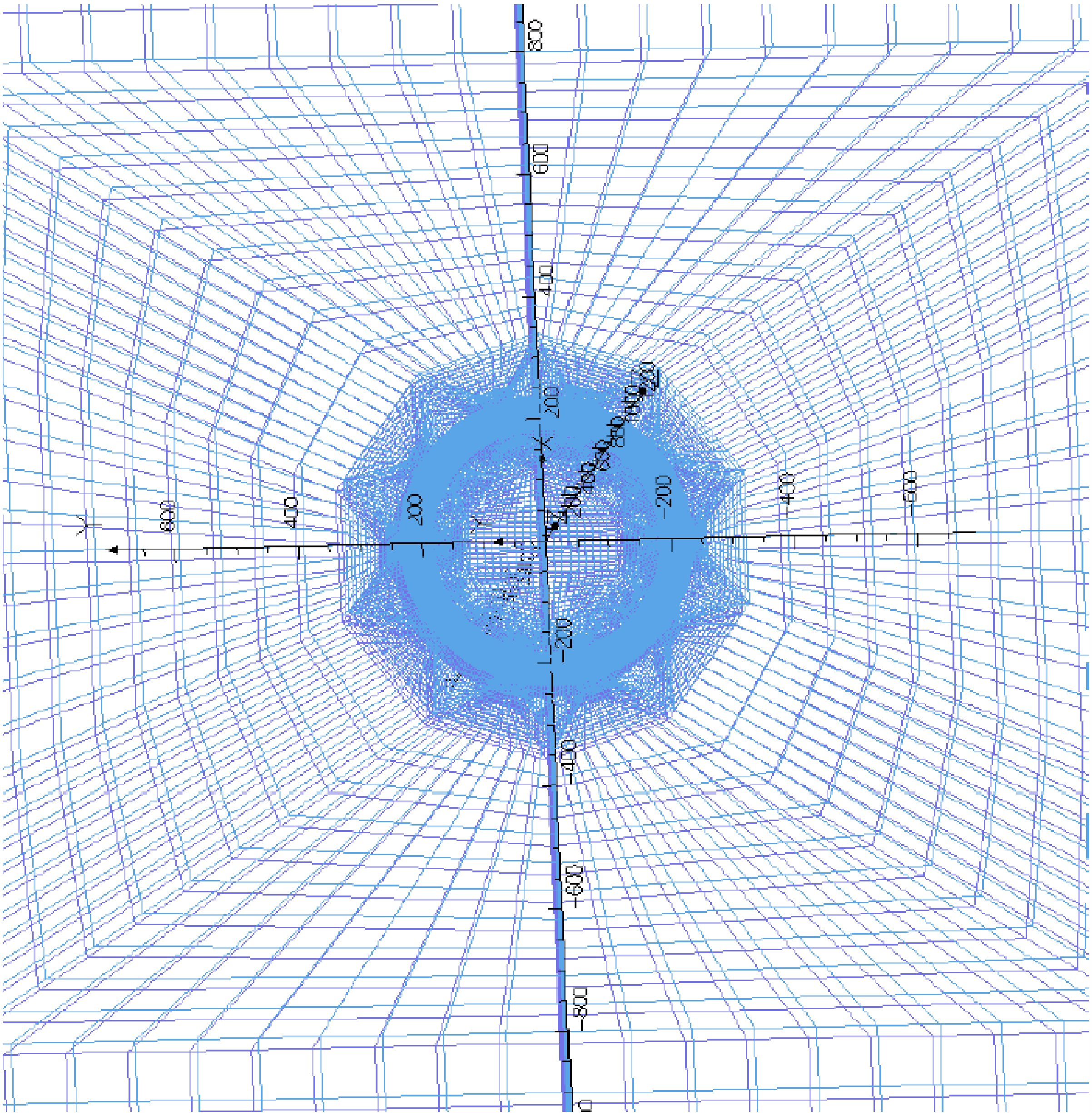

Fig. 3-2: The FEM mesh: detail

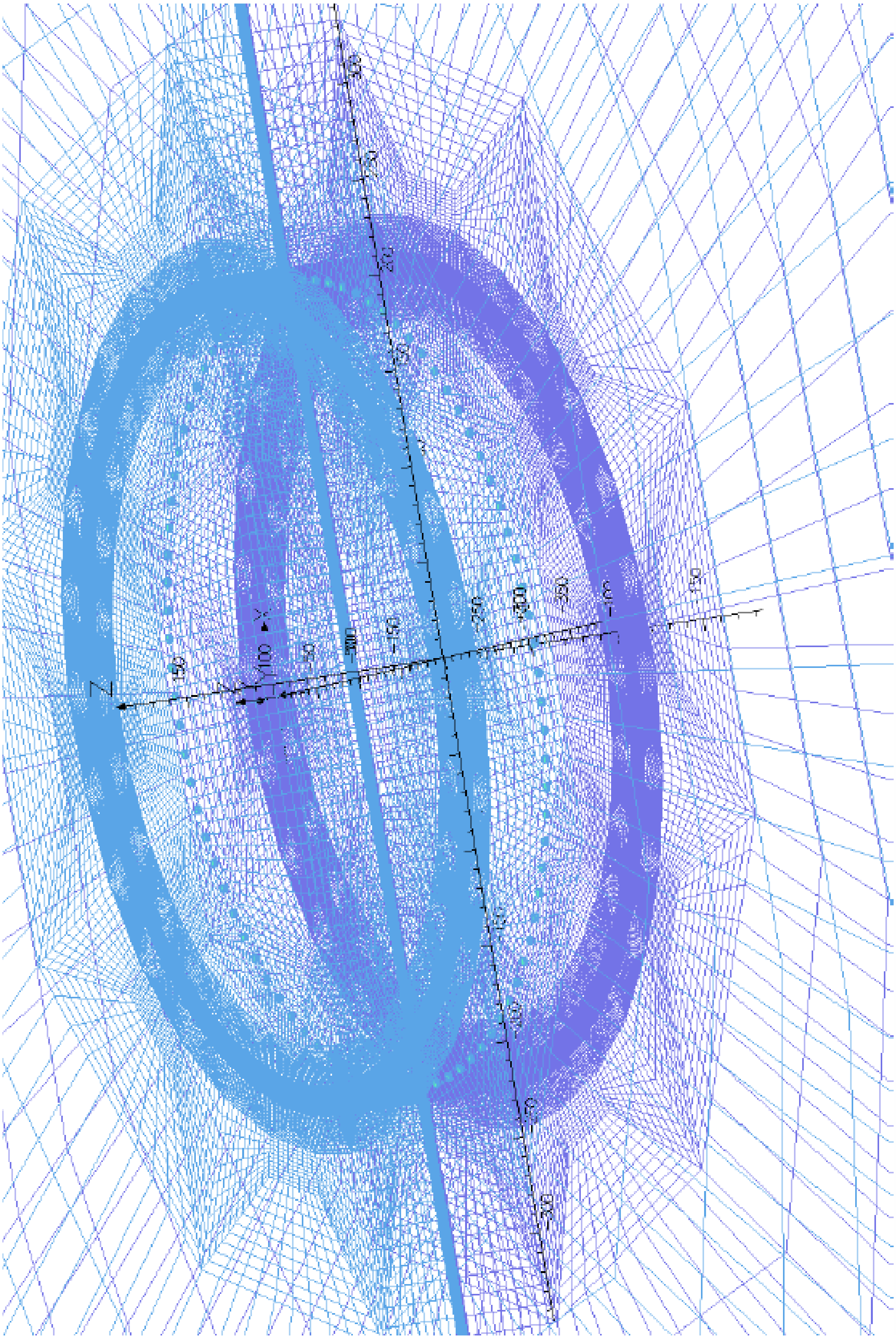

Fig. 3-3: The FEM mesh: position of concrete boxes (small blue cylinders)

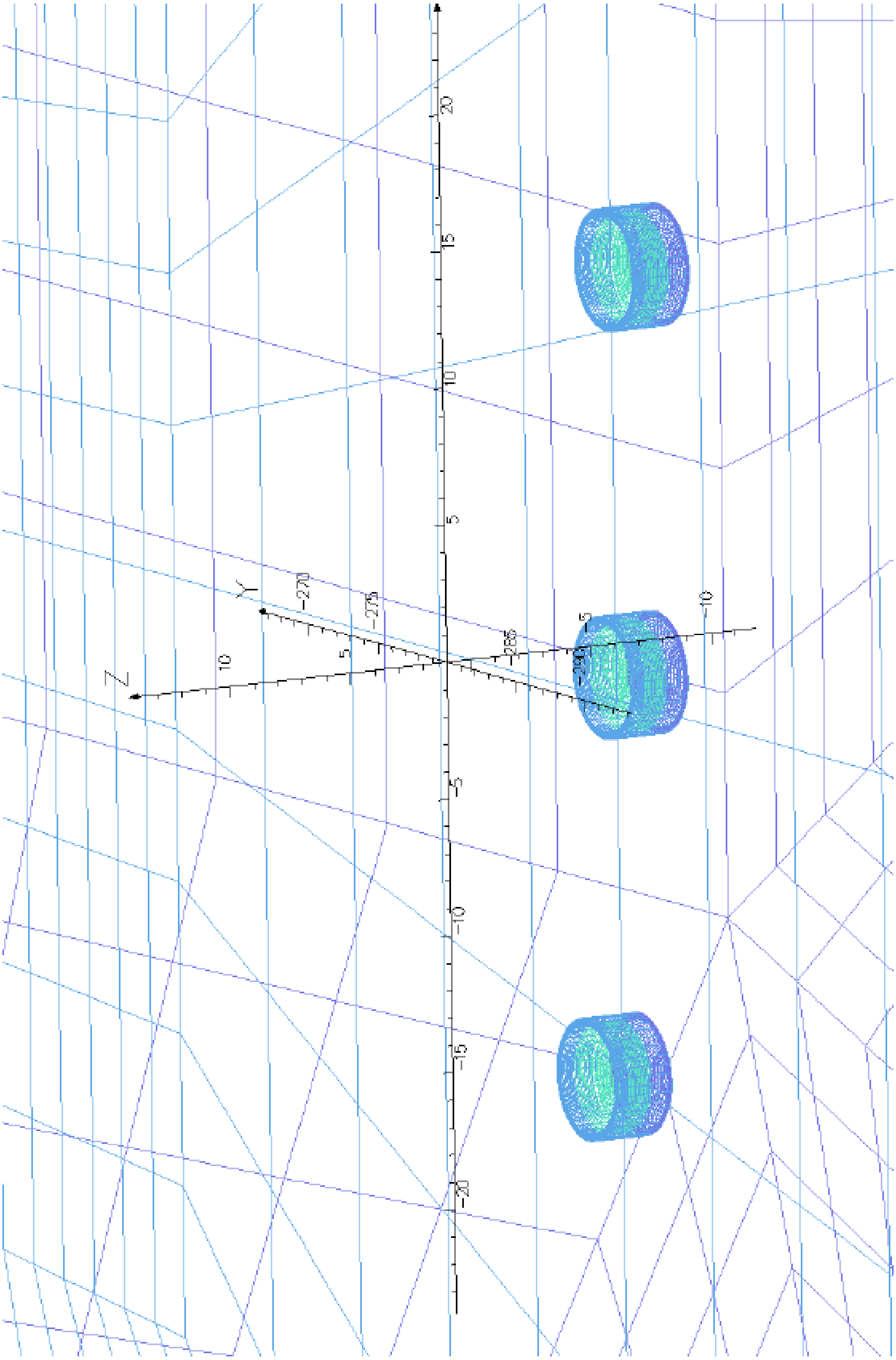

Fig. 3-4: The FEM mesh: detail of concrete boxes

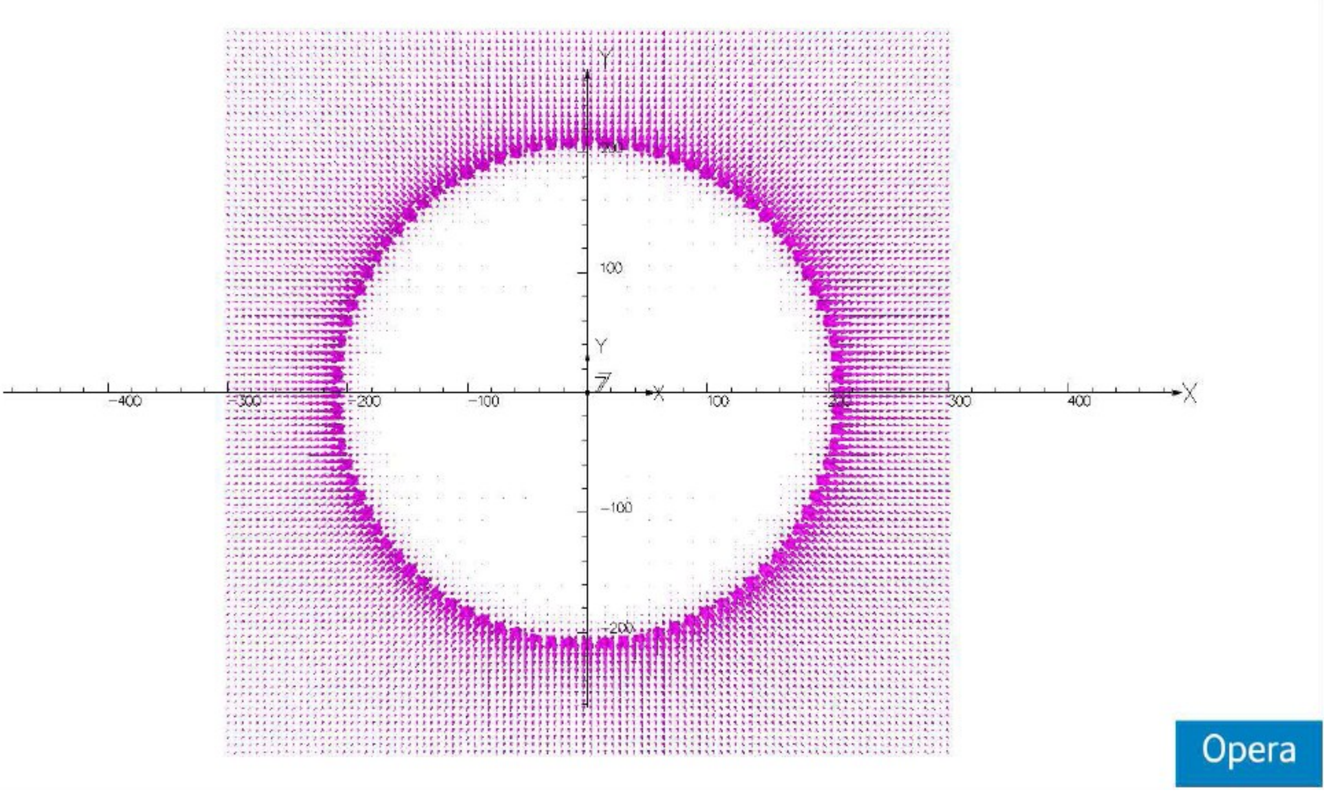

Fig. 3-5: Qualitative current density field at -40 m, over the electrode (case a)

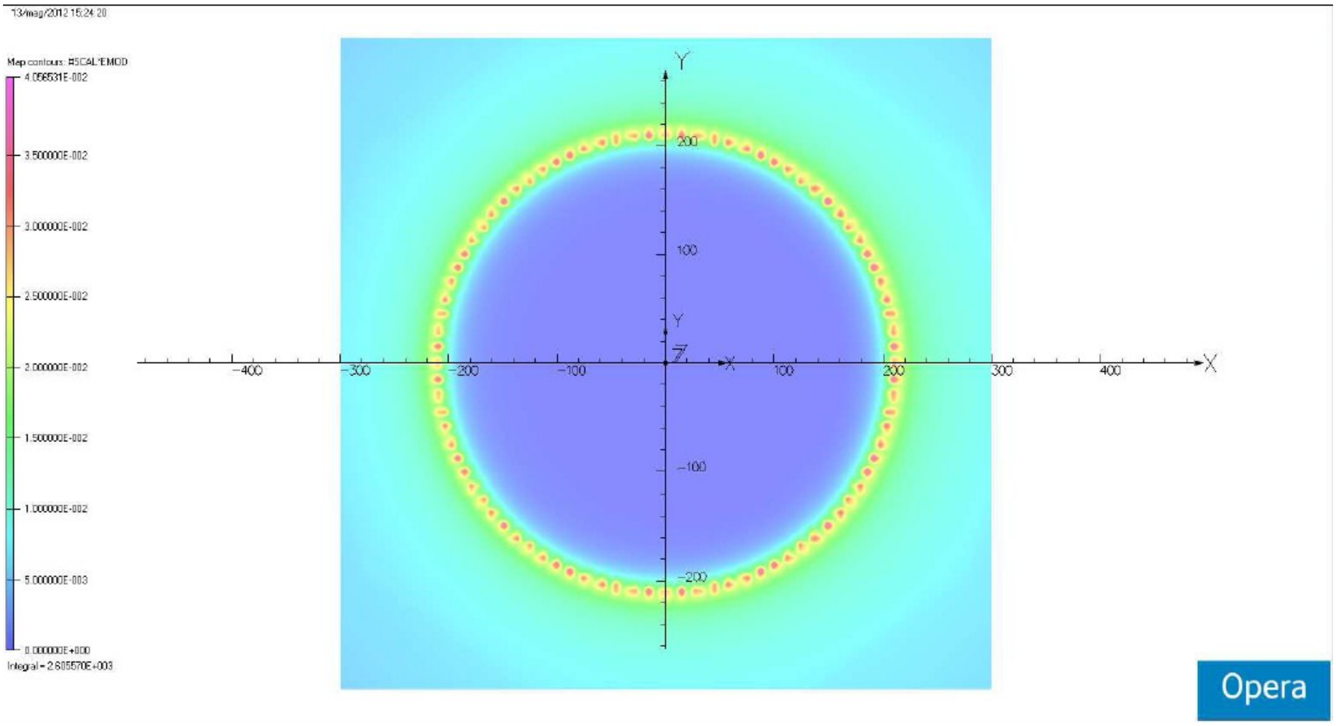

Fig. 3-6: Electric field modulus at -40 m, over the electrode (case a). Max is 4.06e-2 V/m.

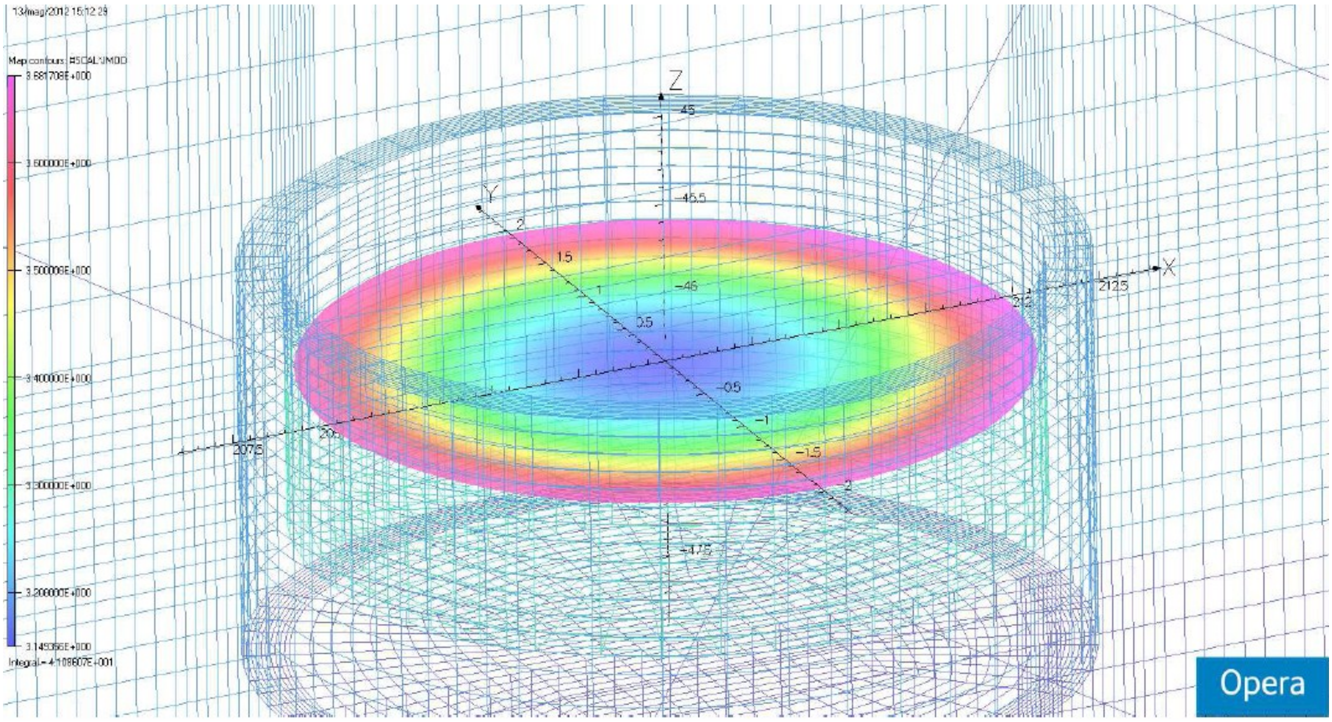

Fig. 3-7: Current density field mod. at -46.39 m, 1 cm over the gravel (case a). Max 3.68 A/m^2.

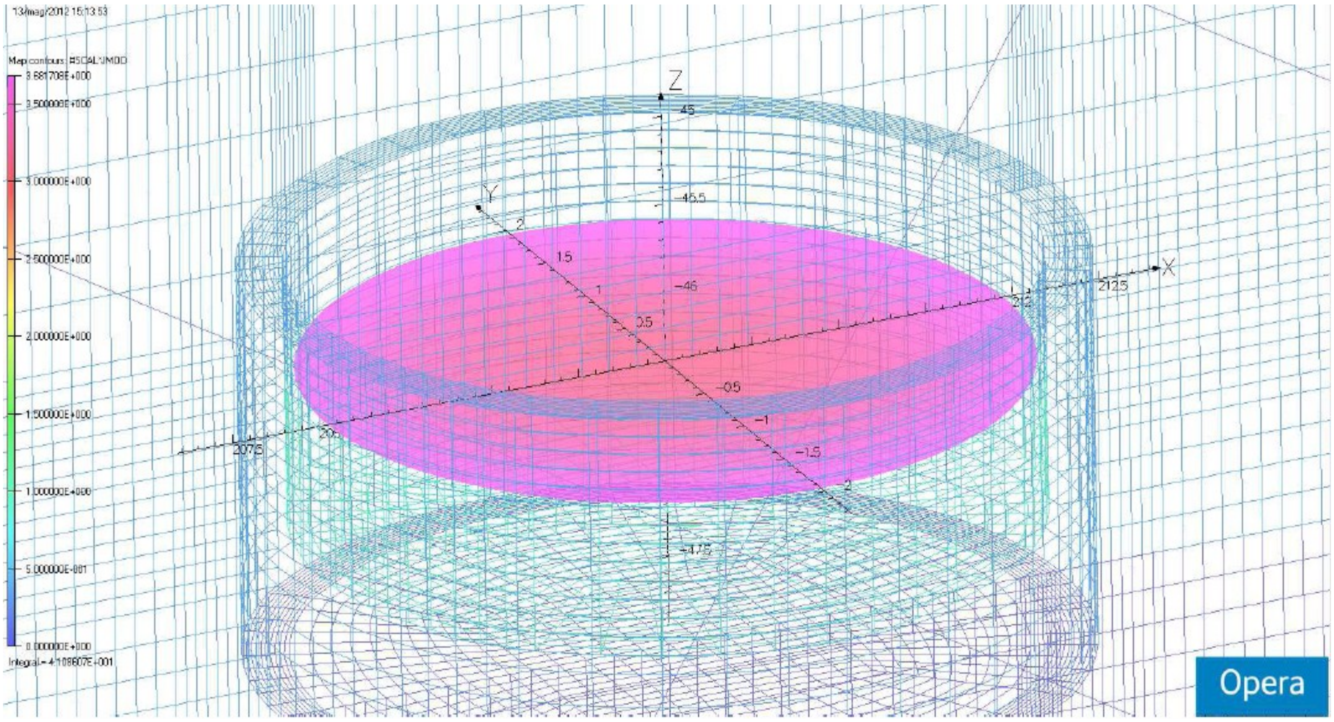

Fig. 3-8: As previous Fig., lower limit set to zero, max 3.68 A/m^2.

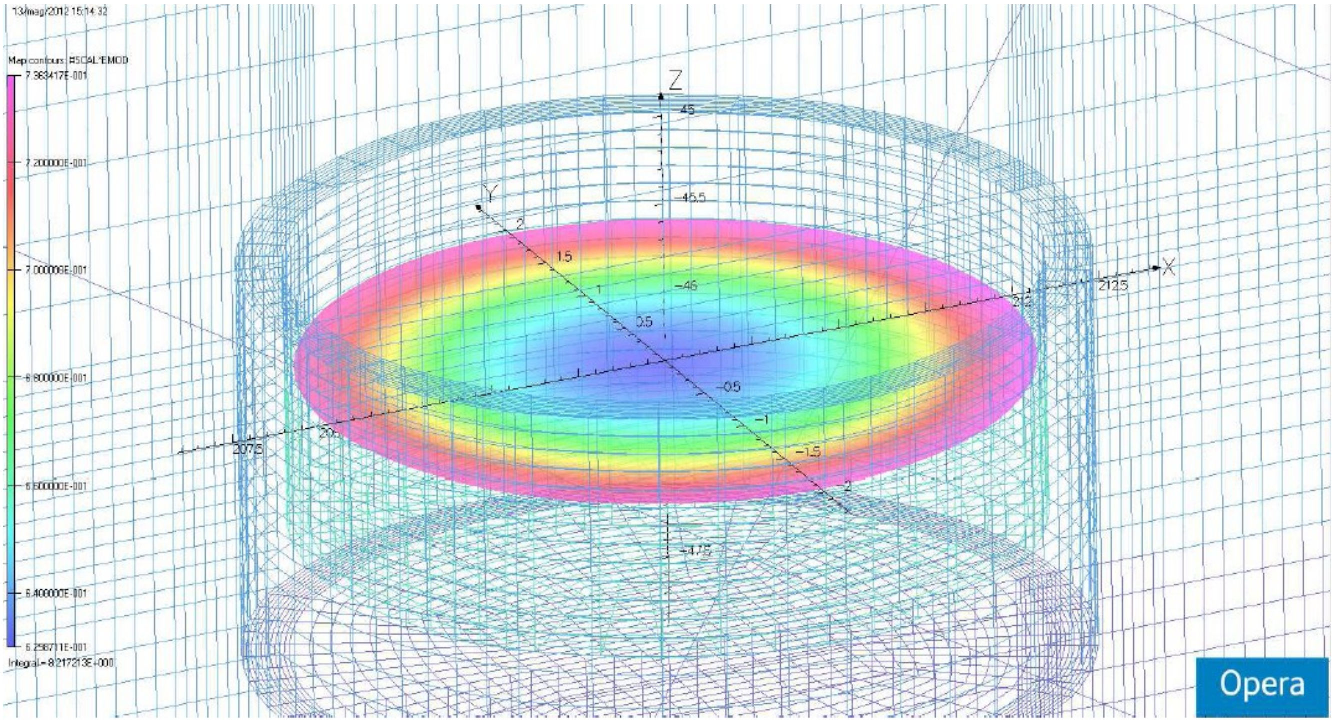

Fig. 3-9: Electric field mod. at -46.39 m, 1 cm over the gravel (case a). Max. 0.736 V/m.

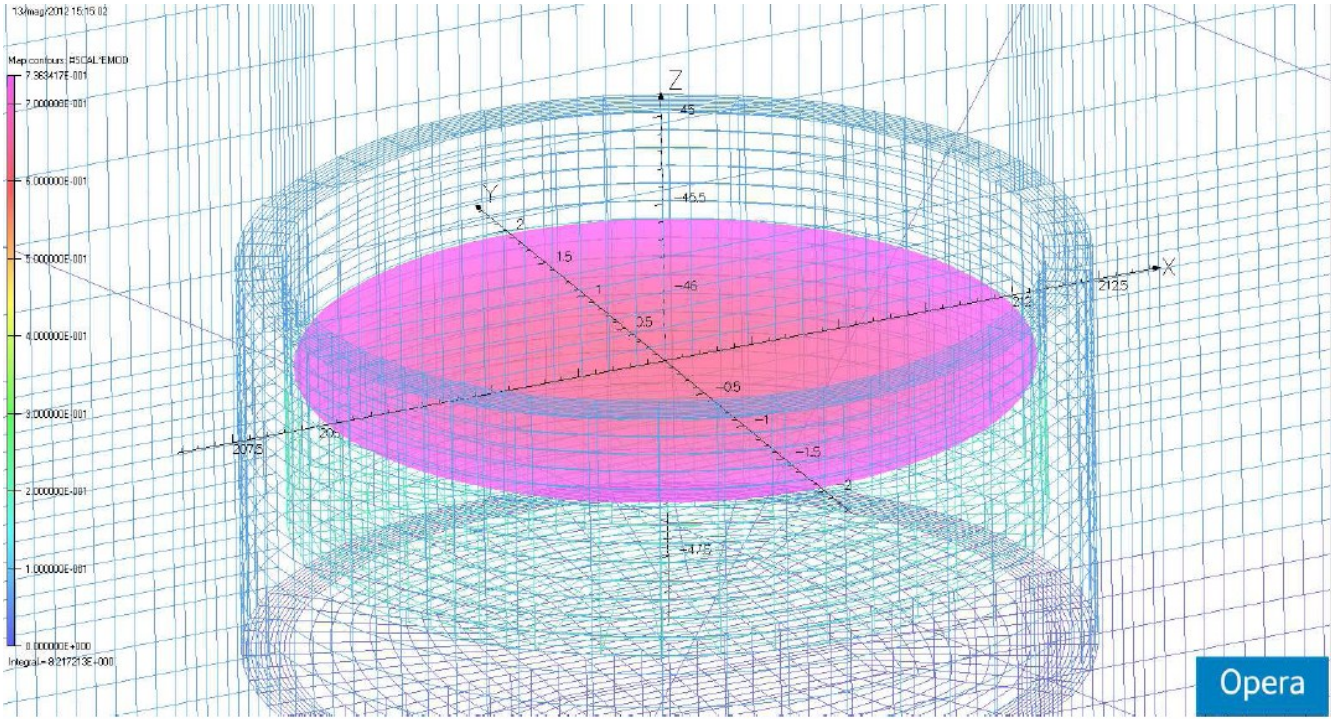

Fig. 3-10: As previous Fig., lower limit set to zero, max. 0.736 V/m.

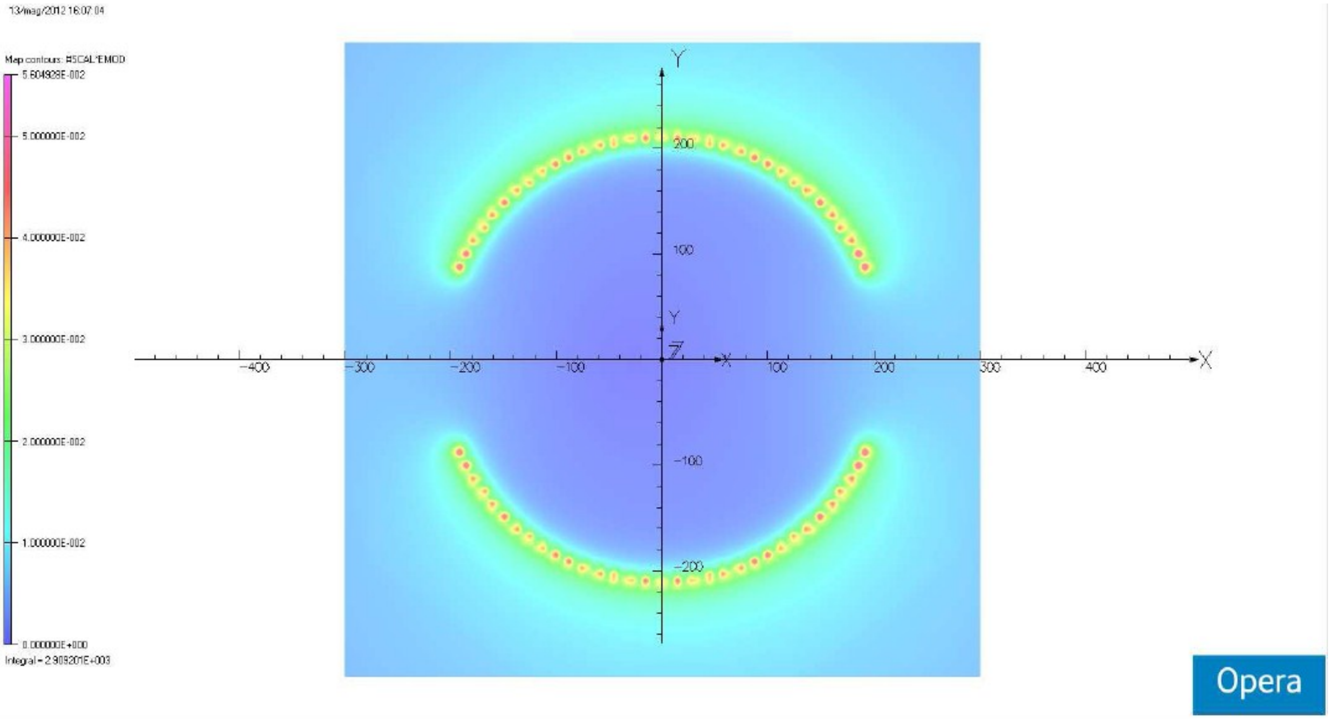

Fig. 3-11: The electric field mod. at -40 m, over the electrode (case b). Max. 5.6e-2 V/m.

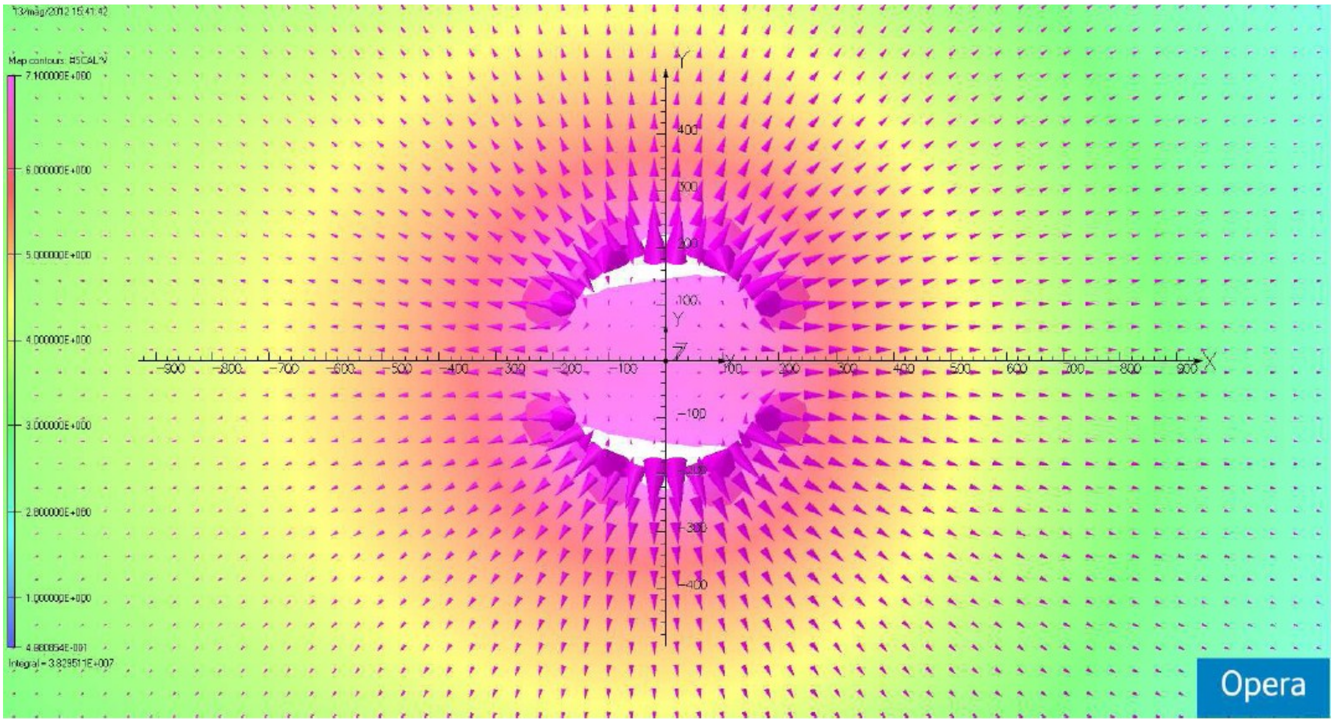

Fig. 3-12: Qualitative current density field at -40 m, over the electrode (case b)

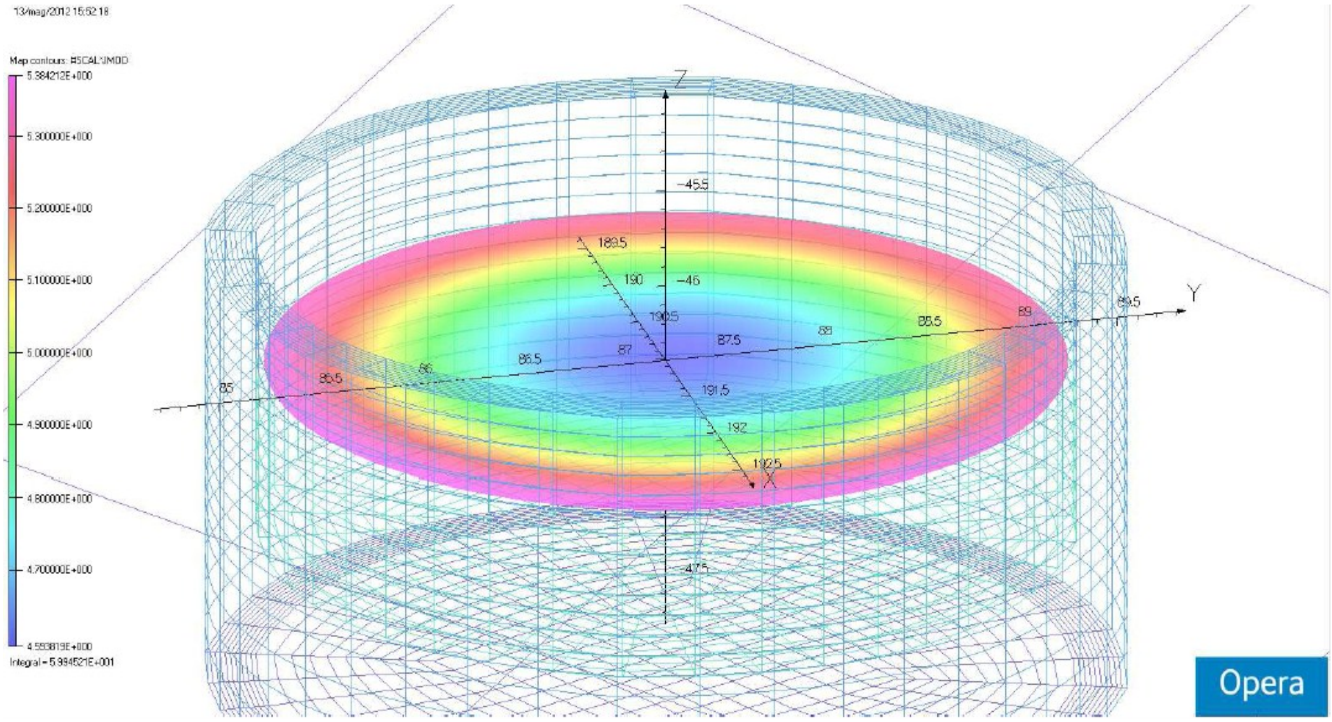

Fig. 3-13: Current density field mod. at -46.39 m, 1 cm over the gravel (case b, worst box). Max 5.38 A/m^2.

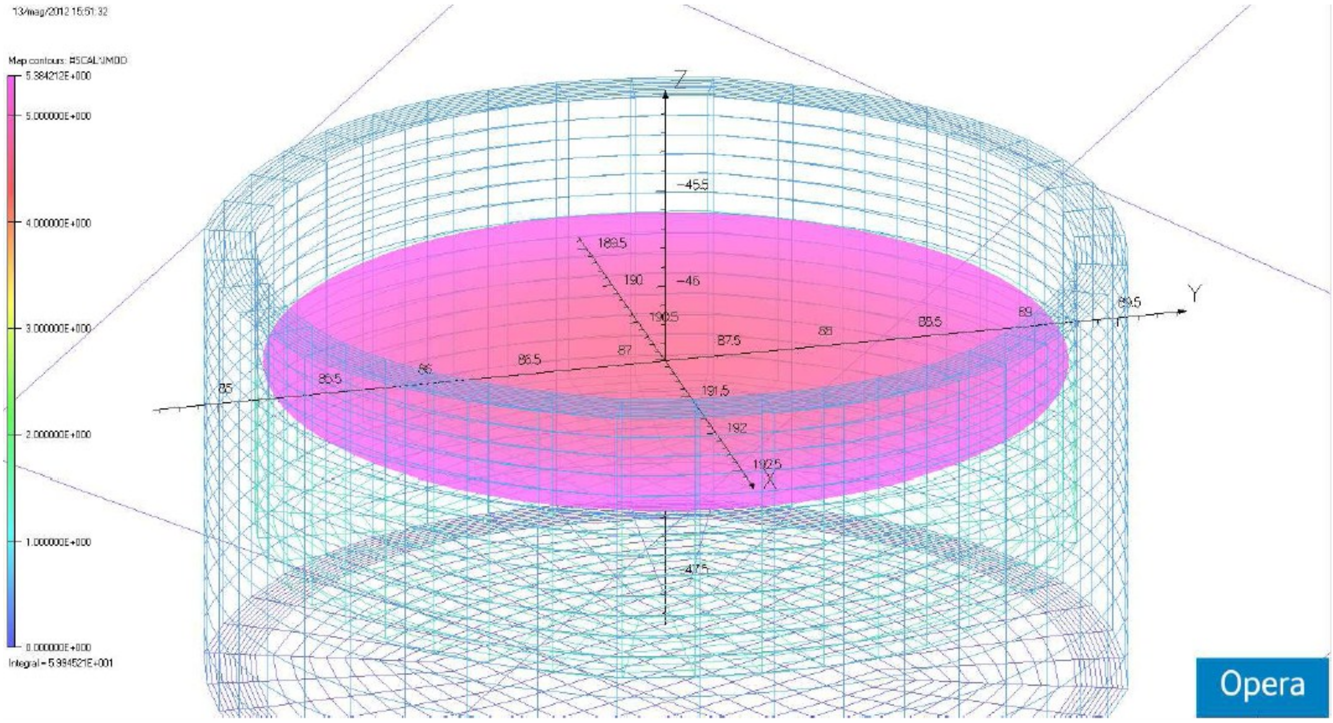

Fig. 3-14: As previous Fig., lower limit set to zero, max 5.38 A/m^2.

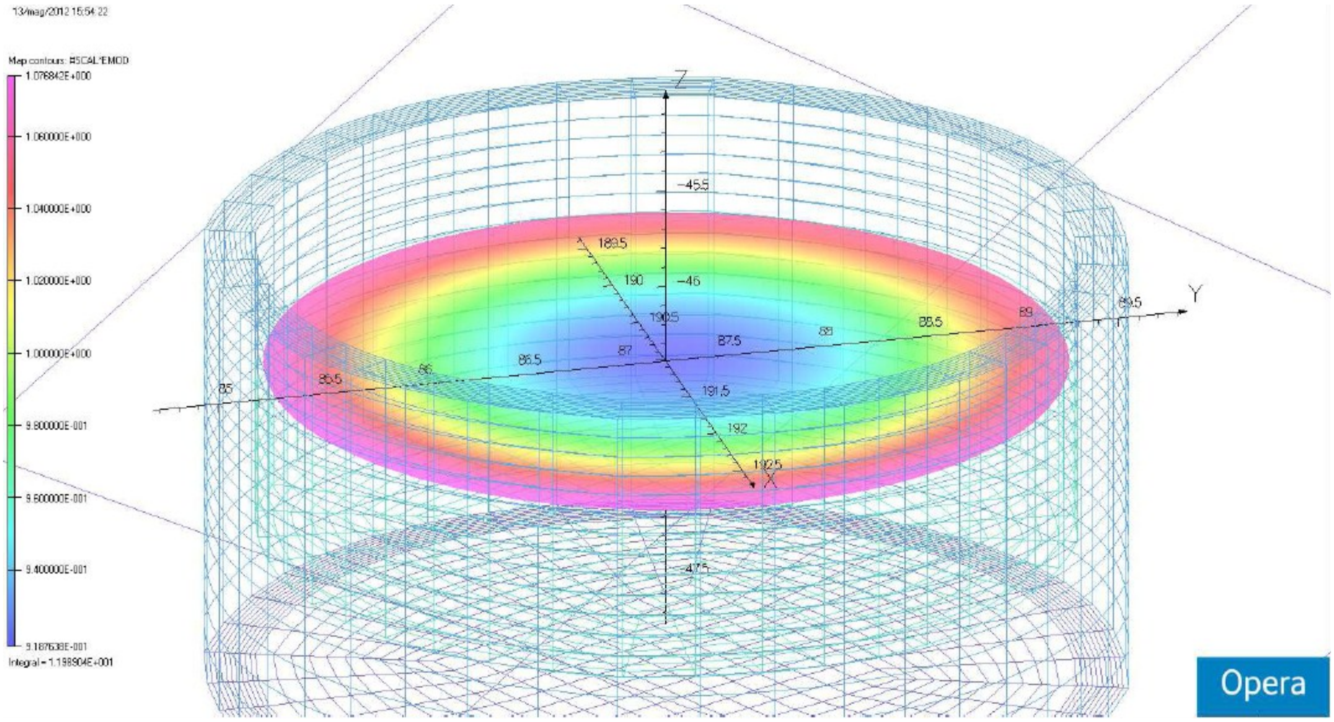

Fig. 3-15: Electric field mod. at -46.39 m, 1 cm over the gravel (case b, worst box). Max. 1.077 V/m.

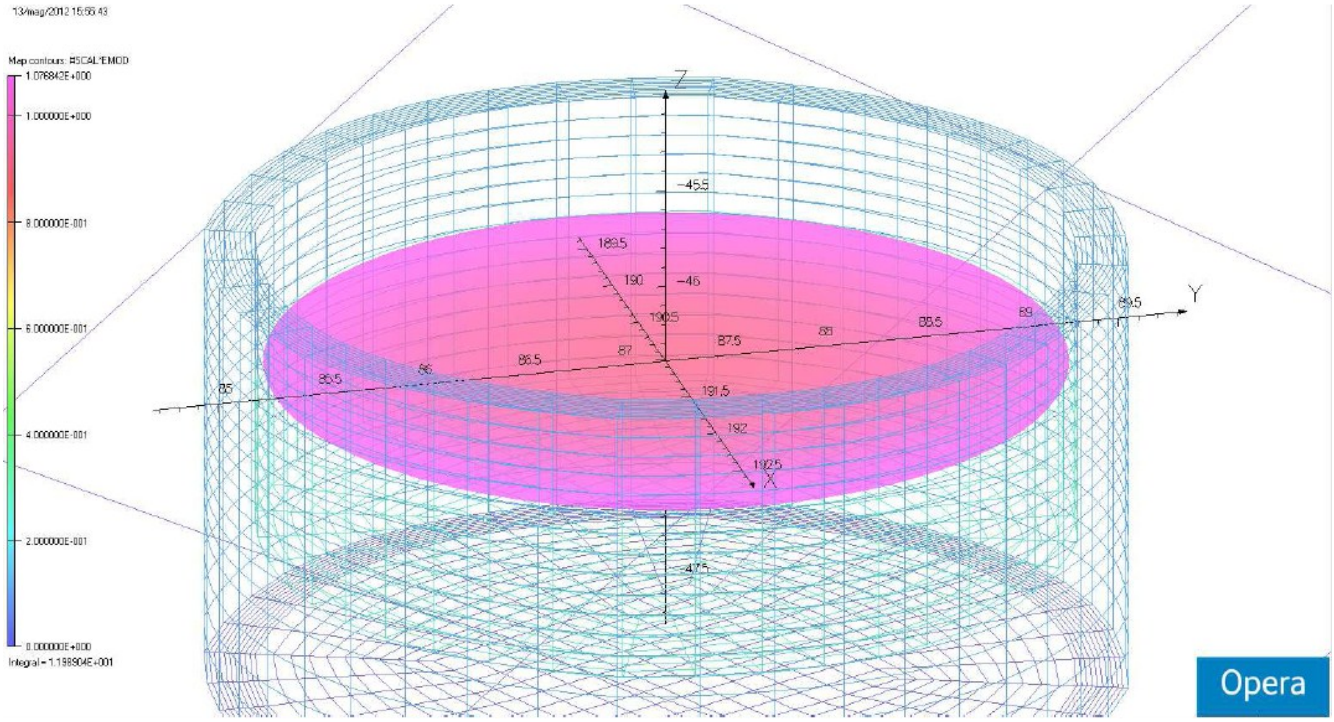

Fig. 3-16: As previous Fig., lower limit set to zero, max. 1.077 V/m.

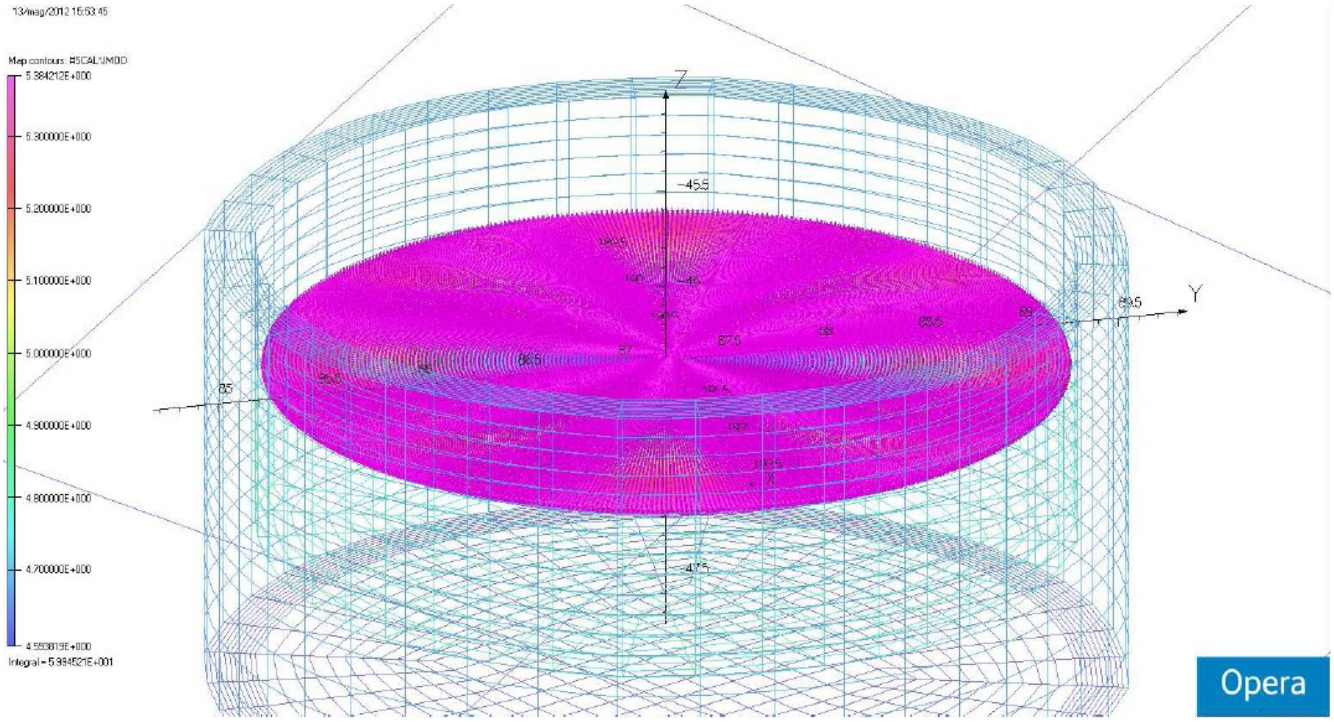

Fig. 3-17: Current density vectors at -46.39 m, 1 cm over the gravel (case b, worst box). Max 5.38 A/m^2.

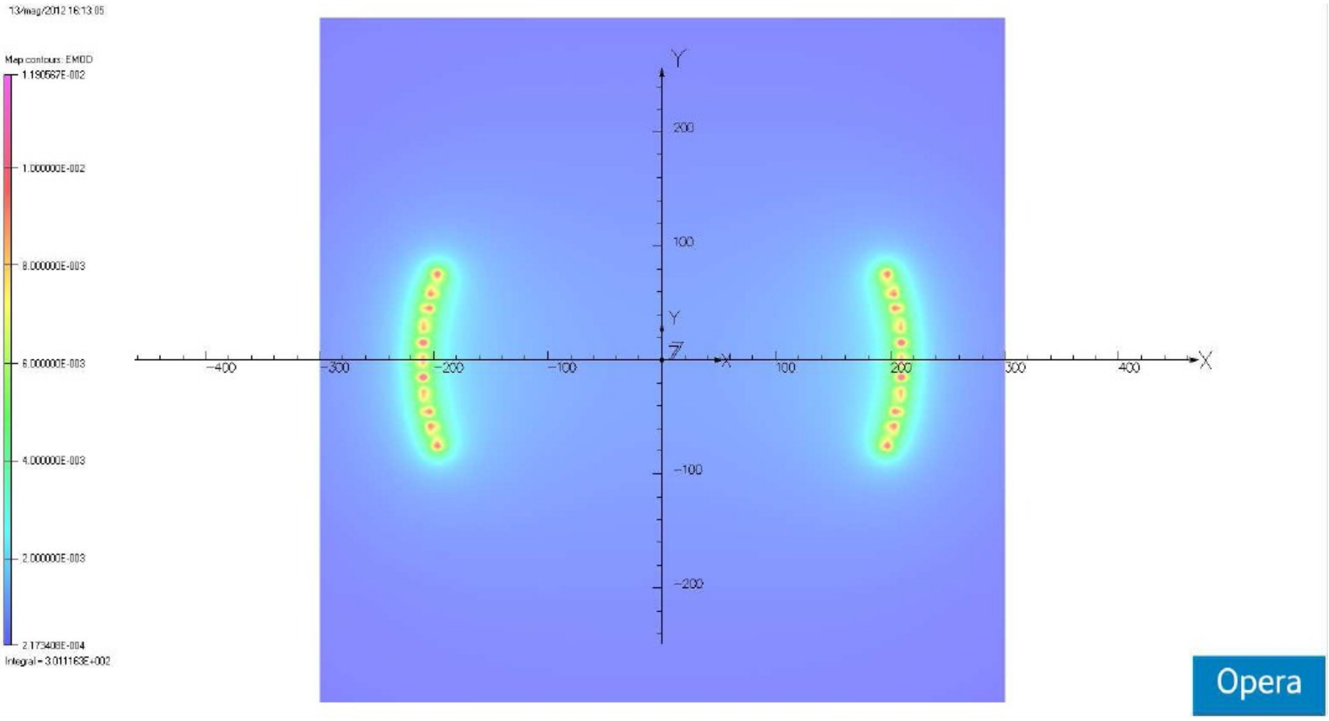

Fig. 3-18: Electric field modulus at -40 m, over the electrode (case c, fed at ±1V). Max 1.2e-2 V/m.

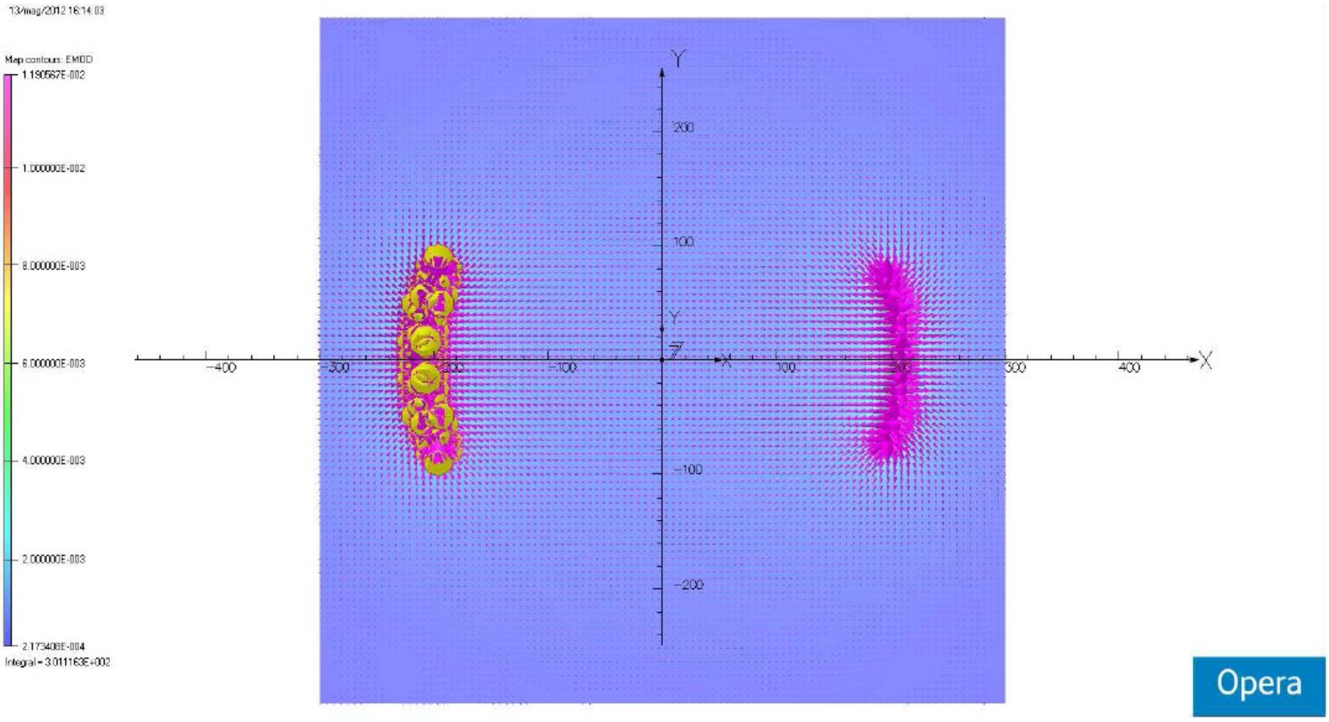

Fig. 3-19: Qualitative current density field at -40 m, over the electrode (case c, fed at ±1V)

This case (d/e), qualitatively much different from case a (normal operations) and b/c (special operations) is the testing: current is circulated between two opposite sections of the electrode, to verify the electrical continuity of feeding cables. Therefore current exits upwards from the right section (red cones means that they are directed “towards the reader”), moves towards the left electrode, and enter it (this is confirmed by the yellow cones: in the used software yellow is the color adopted to represent the internal surface of the cones, and this means that, on the left section, the current is directed downwards).

Computations for cases a, b and c were performed by assigning suitable boundary conditions over the electrical potential; at the end, during post processing, the total current dispersed by the electrode was computed through an integration over a cylindrical Gaussian surface. Dividing 3,650 A by the result of the integration allowed us to compute a scaling coefficient to use during the subsequent part of post processing (the problem linearly depends on the current). So all the reported results for cases a, b and c must be understood as real values when the electrode is operated at full current of 3,650 A.

For case d and e the computations were performed assigning +1.0 V to one of the two groups of electrode under testing, and -1.0 V to the other. The current flowing between the two groups was evaluated through integration over a plane passing through the center of the electrode. Such value was used to estimate the maximum value for the current to use during testing (which should not exceed 400 A, corresponding to a max. current on the box of 40 A).

Please be aware that the fields over gravel surface at first glance may seem quite different on the different points of the surface, but this is due to the limits automatically chosen by the software for the scaling: to solve this problem of representation, a second image, with the lower bound set to zero has always been reported. In this case it is easier to verify that the fields are highly uniform.

To be mentioned that, as it is apparent from the images about 3D computations, the top side of concrete box lateral walls has been modeled as flat. This was due to modeling simplification (in the sense that to set up a sophisticated three-dimensional model would have further increased the dimension and the complexity of the problem).

At this point, on the basis of the current dispersed by a single box, determined through the 3 dimensional analysis, to examine in better detail what happens, a 2D approach has been used over a single box. All computations were made scaling the results given by the 2D axi-symmetrical approach according with the currents computed before through the 3D computations, both for the “normal operations” case (i.e. 88 boxes working, where max. current per box is 42.5 A) and for the “special operations” case (i.e. worst case when 66 boxes are working, and where max. current per box is 64 A).

The result is that the electric field over gravel surface is very uniform (0.6-0.7 V/m in normal operations, Fig. 3-20, and 0.9-1.1 V/m in special operations, Fig. 3-21).

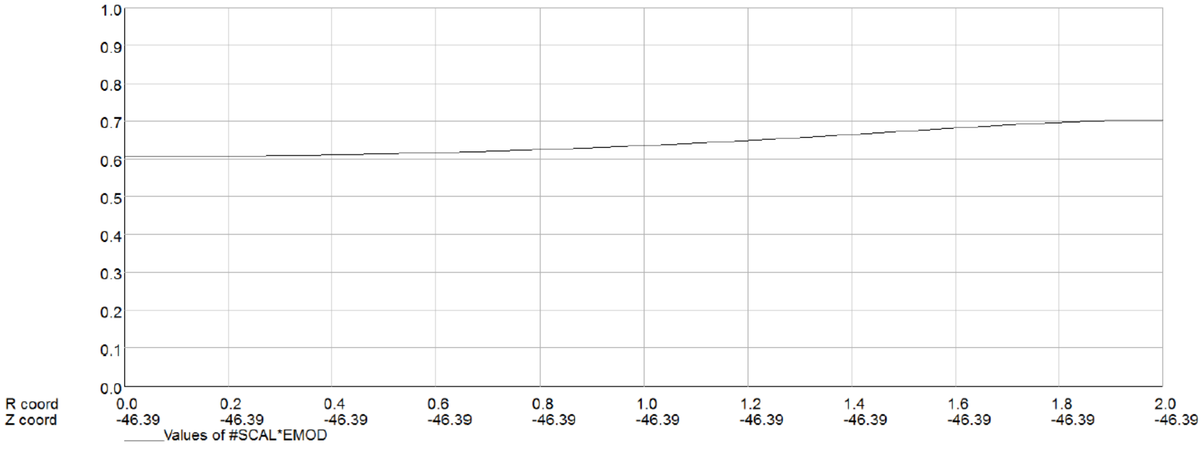

Fig. 3-20: Electrical field in normal operations, radial direction, 1 cm over gravel surf.

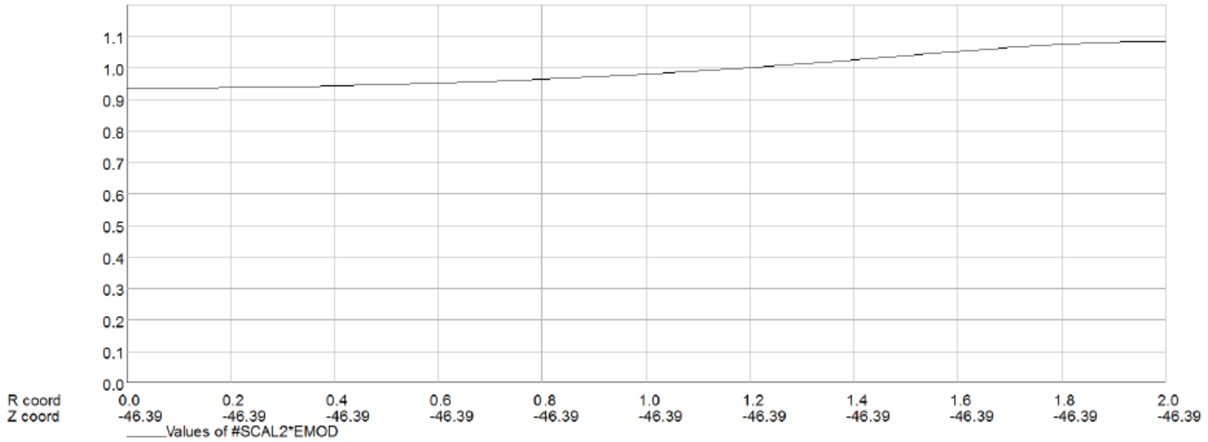

Fig. 3-21: Electrical field in special operations, radial direction, 1 cm over gravel surf.

A qualitative picture of the current flow field is reported in Fig. 3-22.

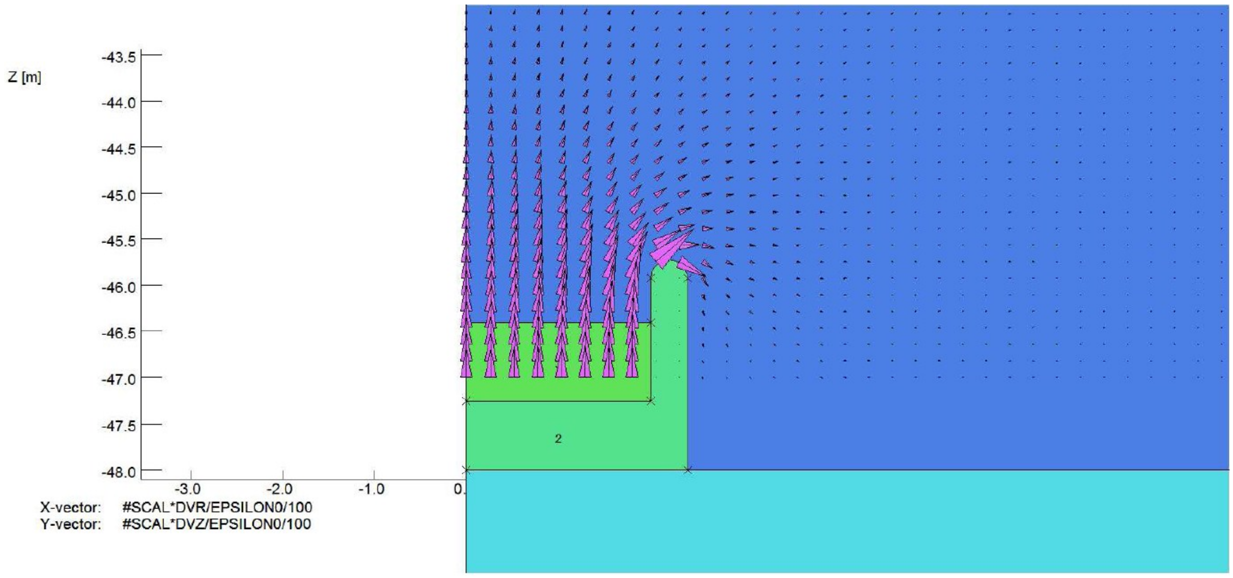

Fig. 3-22: Graphical representation of local current flow around the box

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REPORT

APPROVED B2016113

Client Burns and McDonnell - Brea Office – CA United States

Subject Task 4 “Magnetic Field Study“ – FINAL REPORT

Order B&McD – Doc. No. EC-1 (09-03-2011) – Prot. CESI B1025003

Notes

N. of pages 29 **N. of pages annexed** --

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Table of contents

REVISIONS HISTORY

Revision number	Date	Protocol	List of modifications and/or modified paragraphs
00	05-30-2012	B2016113	First emission

1 BACKGROUND AND SCOPE OF WORK

Background: aim of the project is the consultancy about the review of the present sea electrode of the Pacific Direct Current Intertie, located about 1,570 m offshore S. Monica, CA, and the analysis and proposal of a new location and the design of a new electrode.

Scope of the work: this report describes the results of magnetic field calculation in OH lines, UG cables and submarine electrode and compass deflection.

Such activities are also mentioned as “Task 4 - Magnetic Field Study”.

2 TASK 4 “MAGNETIC FIELD STUDY” - DESCRIPTION OF THE SUBTASKS

	Subtasks
a	Determine the magnetic field OH lines, UG cables, submarine electrode
b	Investigate and evaluate the increased current
c	Calculate and determine the worst case for the magnetic fields from OH line, UG cables and electrode array and submarine cables
d	Perform a compass deflection study
e	Investigate changes in magnetic deviation and related impacts on ships compass
f	Prepare a report
g	Propose measures to mitigate the magnet fields

2.1 Subtask 4a

The determination of the magnetic field was accomplished through the use of analytical integration of Biot-Savart’s law. In particular, for the OH and UG cases, a 2D approach was used (i.e. assuming that the lines are straight, and the relative position of conductors are the same over any plane perpendicular to the axis of the line). For the UG line this approach is coincident with the reality; for OH lines the height of conductors has been assumed as coincident with the height in the point of minimum clearance: This, of course, leads to a worst case condition for the evaluation of magnetic field values on the ground (the conductor is modeled as closer to the ground). For the magnetic field emitted by submarine cables, due to the more complex shape of cables, a 3D approach was adopted, considering the conductors being subdivided into a number of straight segments. For the magnetic field due to the current flowing into the water, a numerical integration based on the current density field determined during Task 3 was performed.

Results are:

- magnetic fields emitted by OH lines are largely compliant with ICNIRP recommendation (0.4 T, see below);
- magnetic fields emitted by UG lines are fully compliant with ICNIRP recommendation,

but their value may exceed the values recommended to prevent physical damages due, for example, to collision with moving ferromagnetic objects (500 μT, see below). For this reason it is recommended that UG cables are buried deeper that 1.5m;

- magnetic fields emitted by submarine cables are fully compliant with ICNIRP recommendation; main cables coming from the shore are buried in trenches at least one meter below the seabed, and total current electrode is subdivided over 6/8 cable, so not even the limit of 500 μT should be exceeded.
- There is an induced error that may affect magnetic compass indications; it will be analyzed in better detail in subtask 4d.

2.2 Subtask 4b

The only considered current value was 3,650 A, which is the maximum value assumed by the current over one Duty Cycle, as agreed with the Customer. In any case, magnetic field linearly depends on the current, so it can easily be scaled according the current value.

The adopted exposure limits throughout this report are ICNIRP ones:

- 0.4 T for DC field; however it is suggested to apply a more restrictive limit to avoid potential indirect adverse effects on health, such as physical damages due to the collision with moving ferromagnetic objects, et cetera. Within the guideline, ICNIRP cites as an example to be adopted in practical policies a IEC limit (2002) of 0.5 mT, i.e. 500 μT, i.e. 5 G.
- 200 μT for sinusoidal fields having frequency in the range 25-400 Hz.

Detailed results are reported within subtasks 4d and 4f.

2.3 Subtask 4c

See subtask 4a.

2.4 Subtask 4d

The compass deflection study, of course limited to the sea, was performed by computing the natural deflection (i.e. deviation angle of the north indicated from the compass with the geographical north in absence of current), and then computing the deflections when electrode current is present (two cases must be considered, as the current can have either directions, and the deflection can thus be different in anodic and in cathodic operations). The area where the deflection can be stronger is the area where the distance from the compass and the cables is minimal, i.e. the area over the cables, very close to the shoreline, where:

1) it is unlikely that large commercial ships may cross such area;
2) commercial ships have a number of other navigation systems, immune to magnetic field effects; now also private yachts and also small boats are equipped with GPS if not GNSS navigation apparatuses.

Normally the magnetic field produced by the cables is more localized, and more intense than the magnetic field due to the currents flowing through the water.

The configuration of the cables potentially giving the most problems is when the dc cables are positioned in the N-S direction. In this case the generated magnetic field is directed along the E-W direction, giving a large impact over the deflection angle. The angle between the electrode cable and the North is about 25°, close to the most problematic direction.

The effect on the magnetic compass of ship in navigation over a dc cable are reported in detail fashion in the paper [13], where it describes the effect of the error on deflection on the track of one ship (when the autopilot is controlled by a magnetic compass): in particular, if the ship crosses the cable with an angle which is lower than the maximum deviation induced by the dc cable on compass indication, the ship is “captured”, i.e. the track becomes parallel to the cable, and positioned at a certain lateral distance. The ship, when captured, may steadily follow cable alignment, even though sometimes limited size oscillation around cable alignment are observed. Otherwise, if the cable is crossed with a larger angle, after the crossing the new track will be parallel to the previous one, and simply laterally shifted of a quantity depending on compass deflection and on the dynamic of the ship. According to the simulations and experiments on Kontiskan cable reported in [13] such lateral shift is 50-150 m.

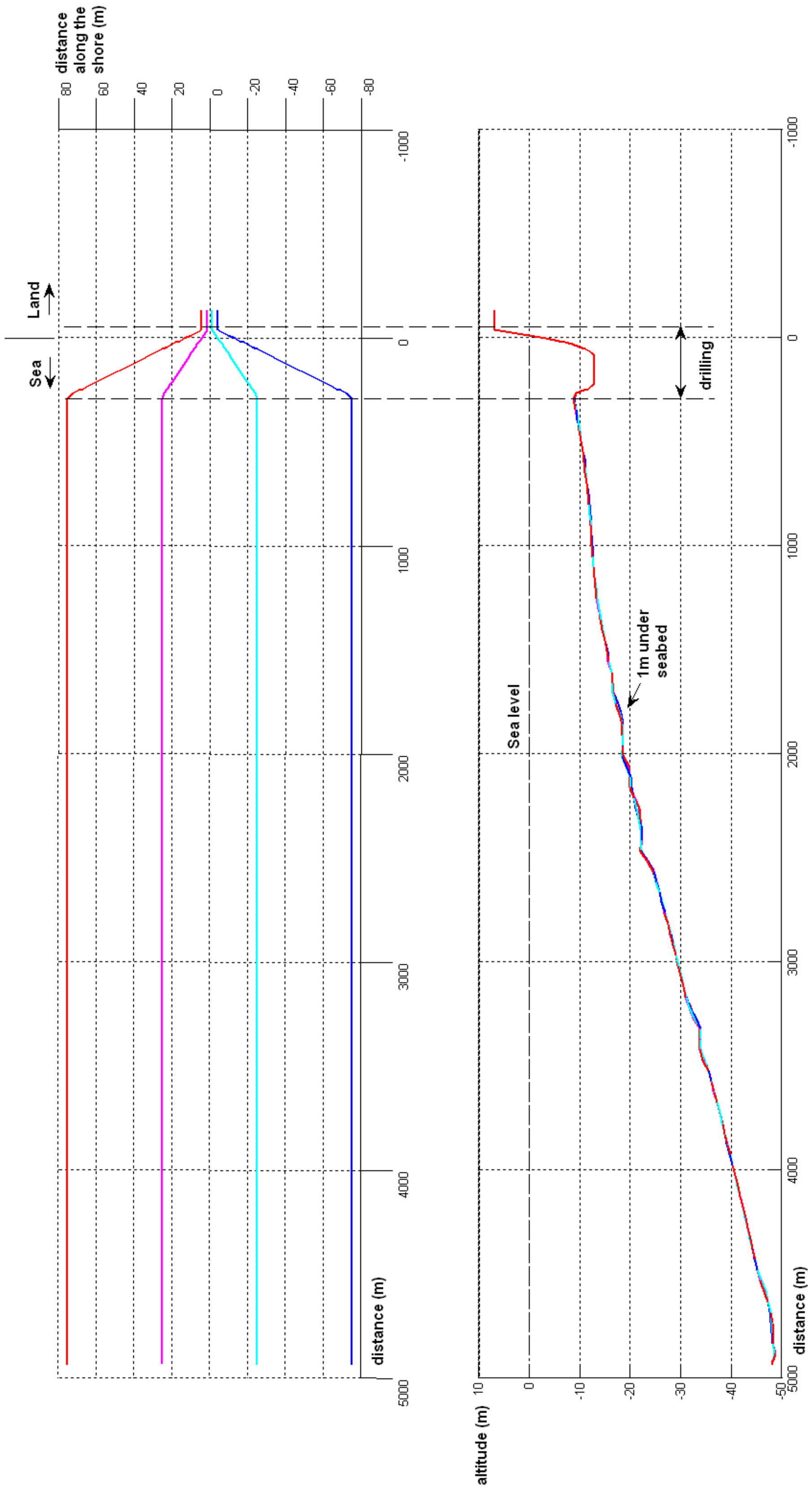


Fig 4-1: Top and side view of submarine cables' position

The object of this study is not a long main submarine cable forming the dc power link as the one studied in [13], which crosses a crowded strait (the Kattegat) between Denmark and Sweden; it is just an electrode cable, located within 5 km from the shoreline in an area reasonably distant from the commercial harbor, which is located on the other side of Palos Verdes Peninsula.

For this reason, it is very unlikely that a commercial ship could follow a track crossing the cable, as simply there is no reason for a commercial ship to be so close to the coast inside S. Monica bay.

Within S. Monica bay is located Marina del Rey, but, as a yacht following a straight E-SE track coming from Malibu would pass a couple of km more offshore than the electrode (and, in any case, even passing over the cable, it would be crossed almost perpendicularly, minimizing possible track errors).

Natural earth magnetic field has been obtained from the website of National Geophysical Data Center (NGDC), which is a section of the National Oceanic and Atmospheric Administration (NOAA). Site address is: http://www.ngdc.noaa.gov/geomag-web/#igrfwmm

The provided values for the area of interest are:

- B-east: 5.348 μT (horizontal component, eastwards directed)
- B-north: 23.951 μT (horizontal component, northwards directed)
- B-vert: 40.476 μT (vertical component).

The total horizontal field is 24.540 μT.
The total field is 47.335 μT.

The natural magnetic declination for the area (in unperturbed conditions) is 12.586 decimal degrees.

The results of the computations are here reported; the first images (4-2 to 4-9) are in normal operations conditions (i.e. all 88 boxes working, as well as the 8 submarine conductors, and all the pigtails). “Positive” means that current is flowing from the shore towards the electrode, and vice versa for “negative”.

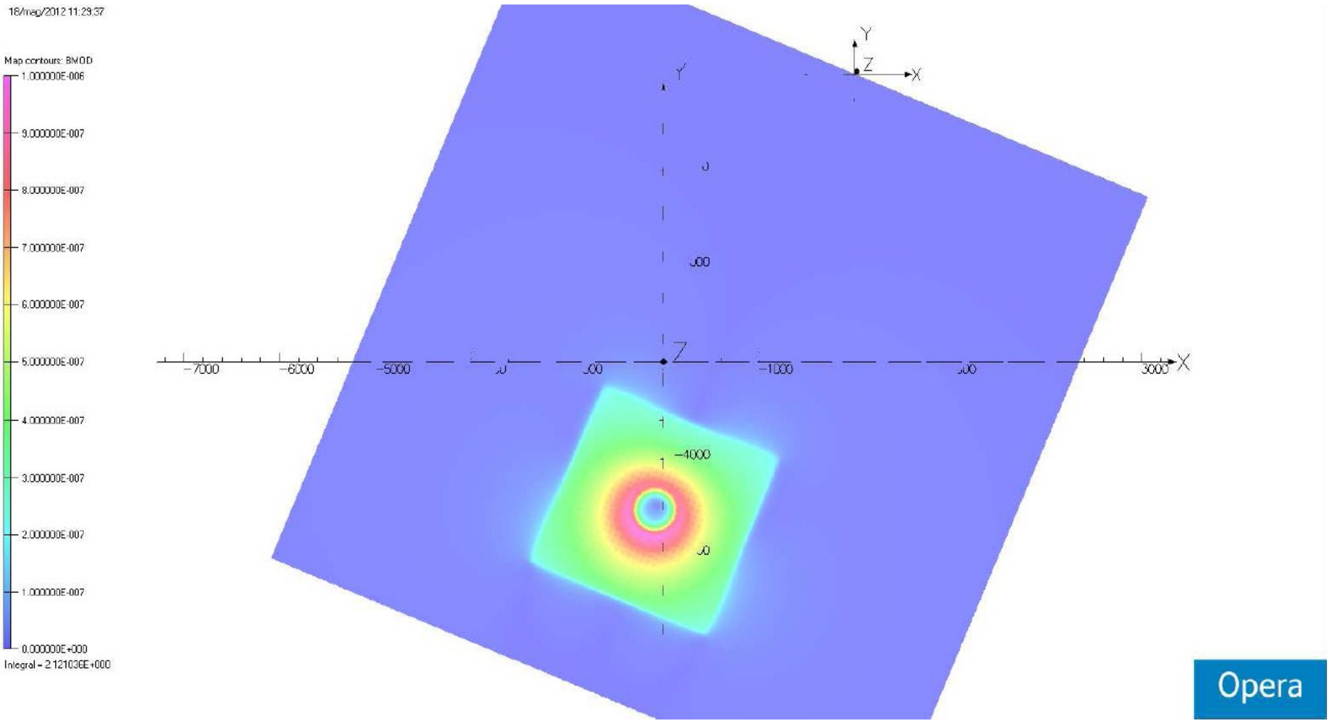


Fig 4-2: Magnetic field due to the current flowing into seawater alone, normal operations Max. 1 μT

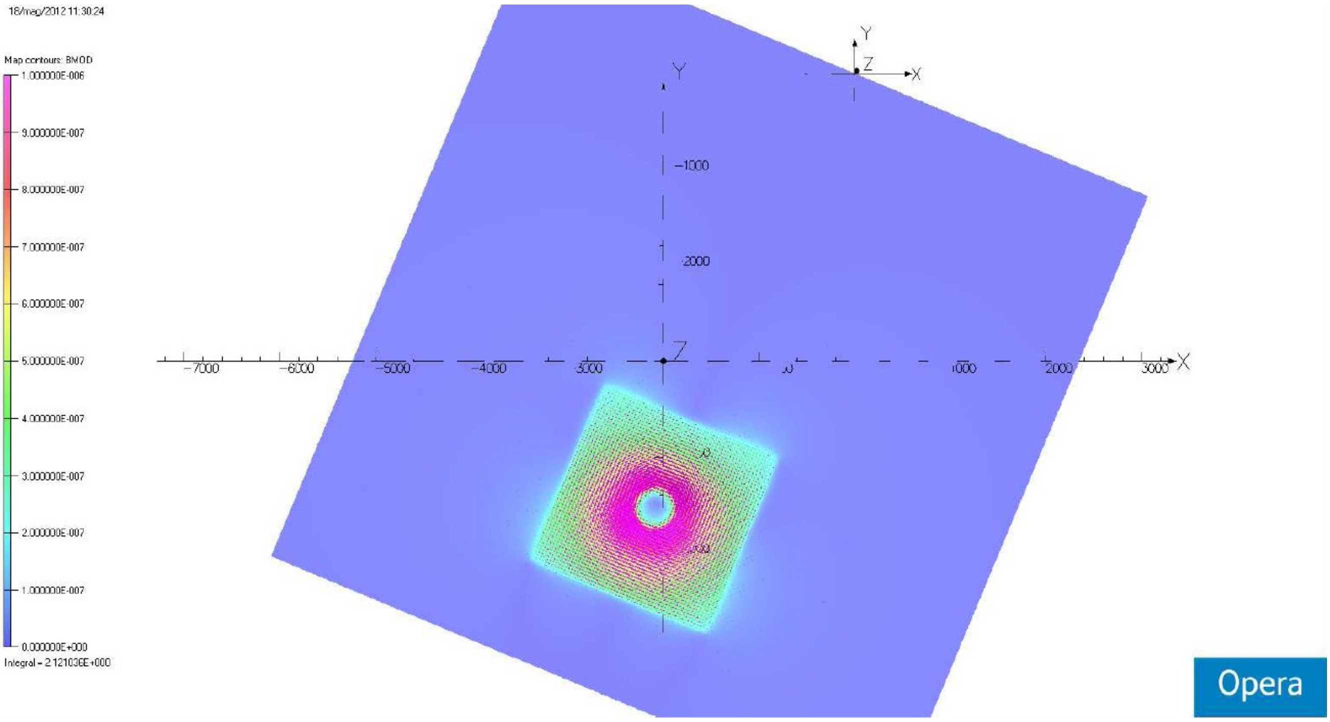


Fig 4-3: As above, plus vectors

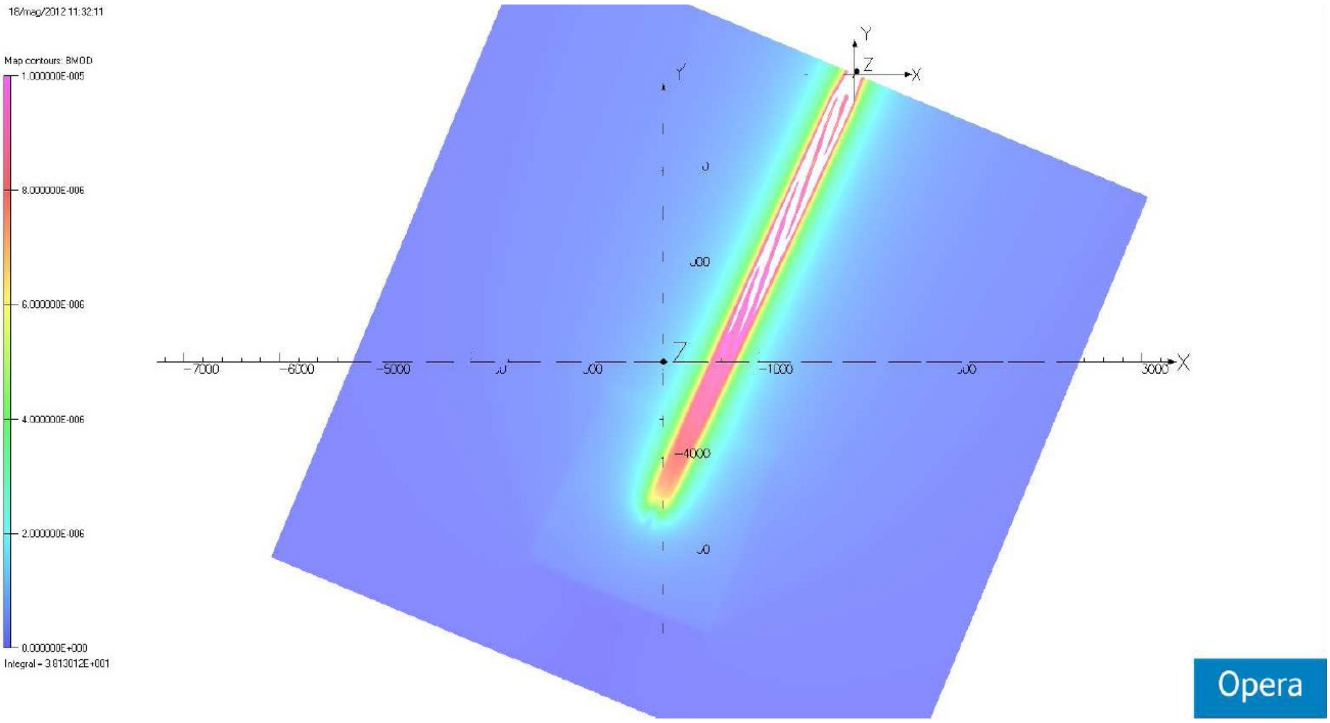


Fig 4-4: Magnetic field due to positive cables and current flow, normal operations
Max. 10 μT

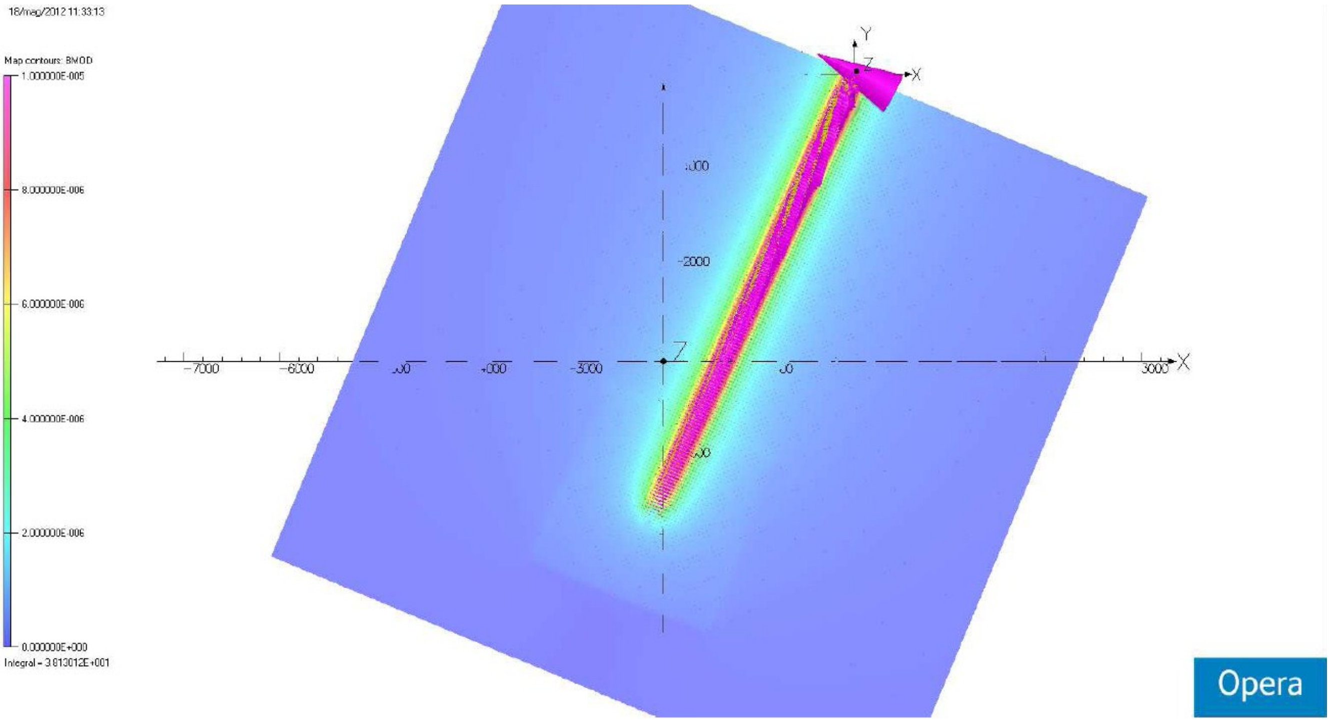


Fig 4-5 : As above, plus vectors

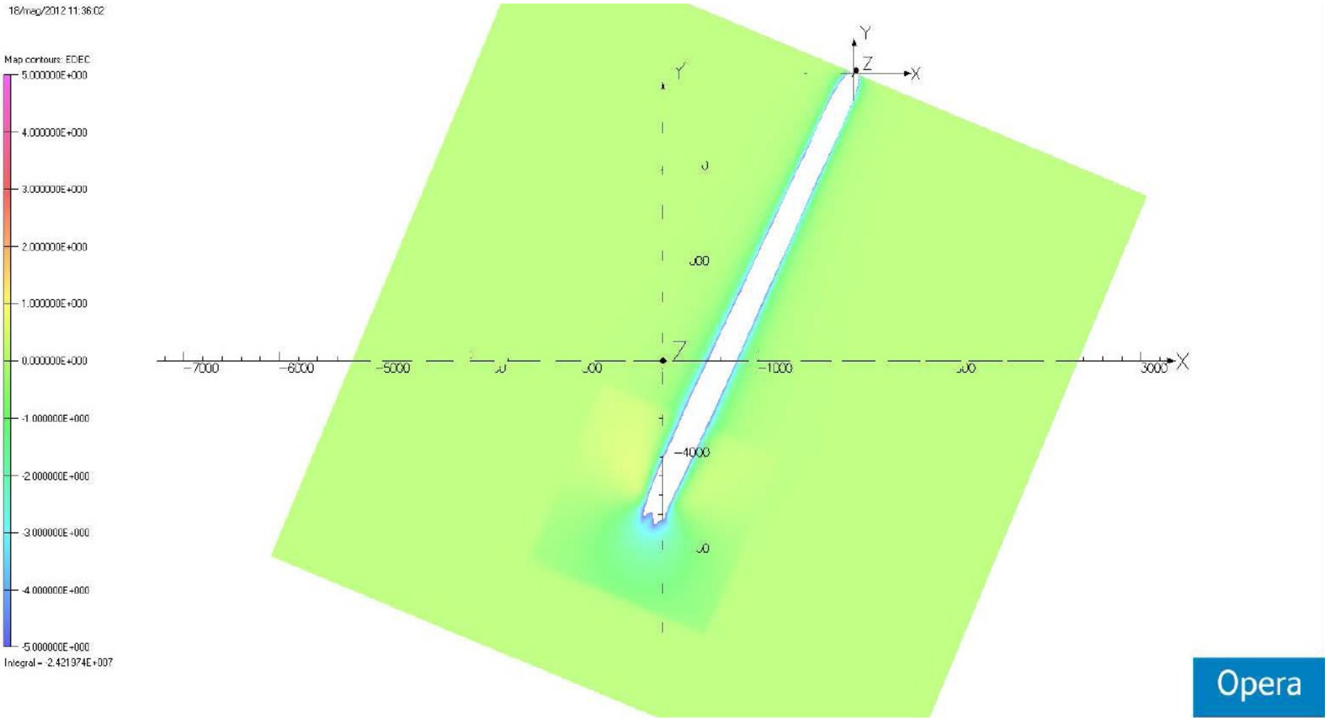


Fig 4-6: Error on declination (max. ±5°), positive cables and current flow, normal operations

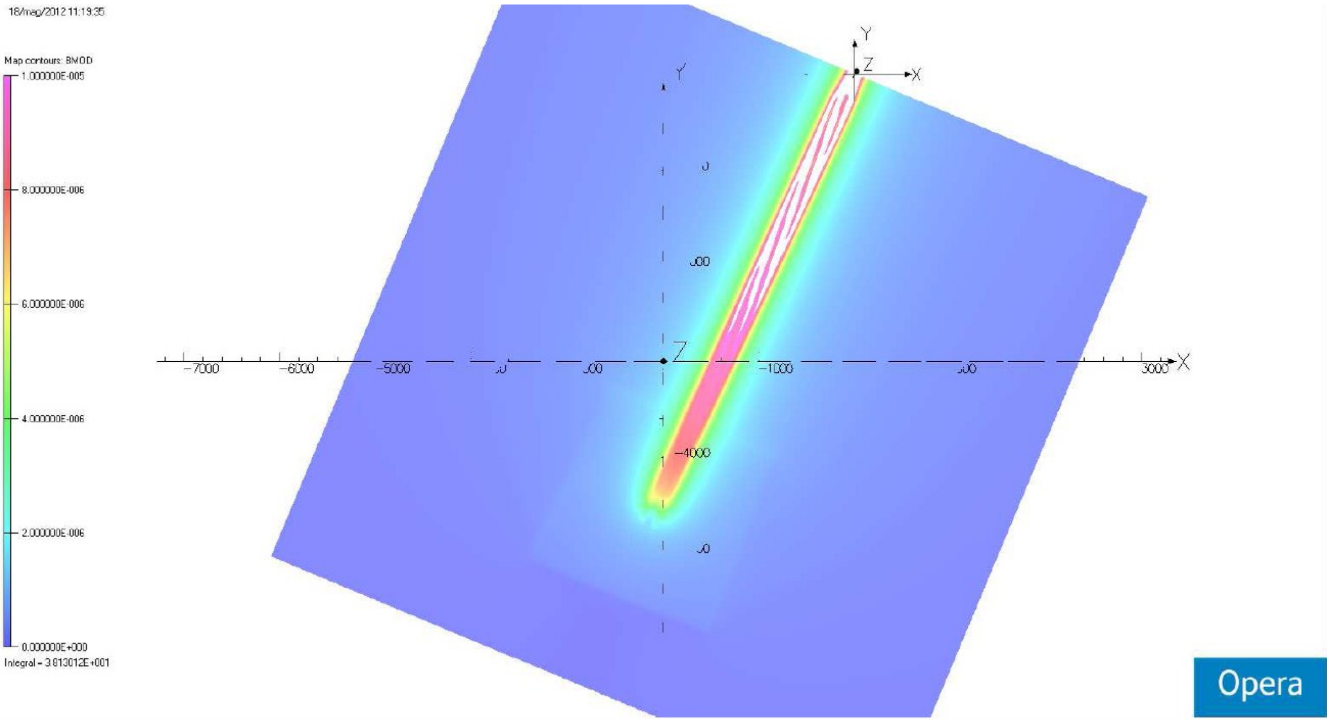


Fig 4-7: Magnetic field due to negative cables and current flow, normal operations
Max. 10 μT

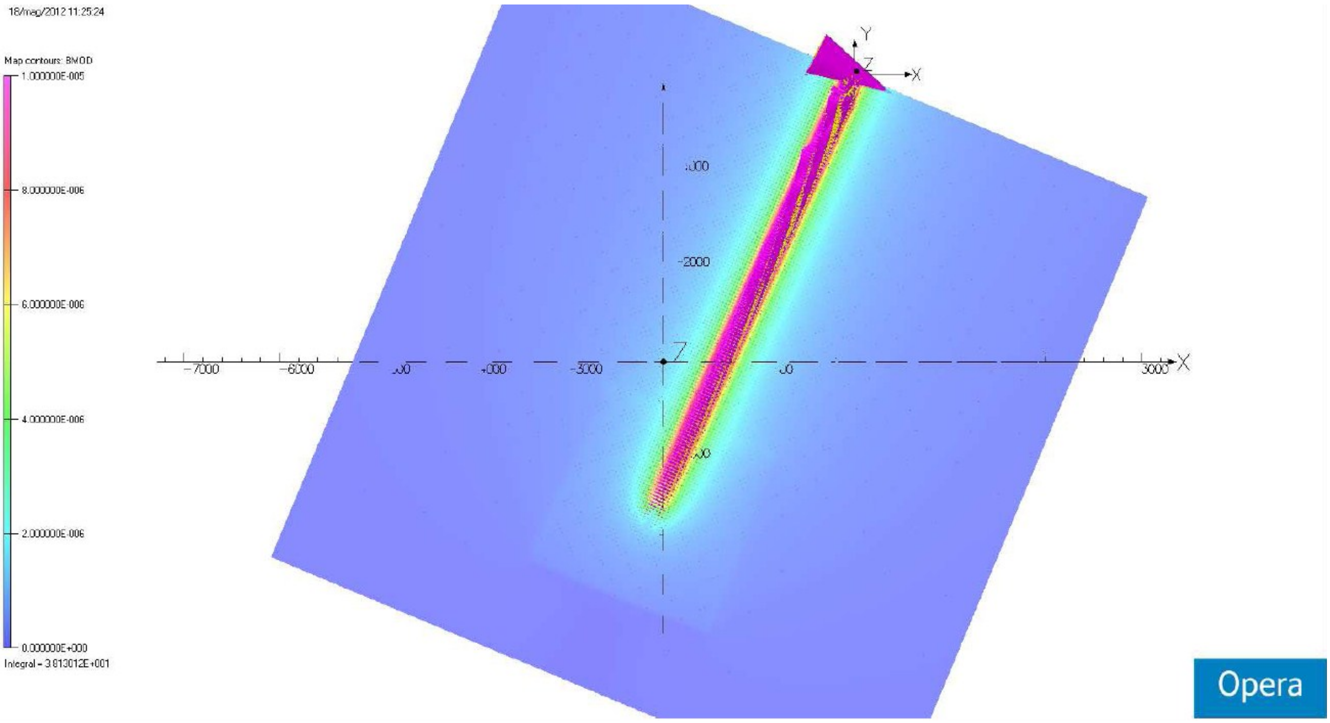


Fig 4-8: As above, plus vectors

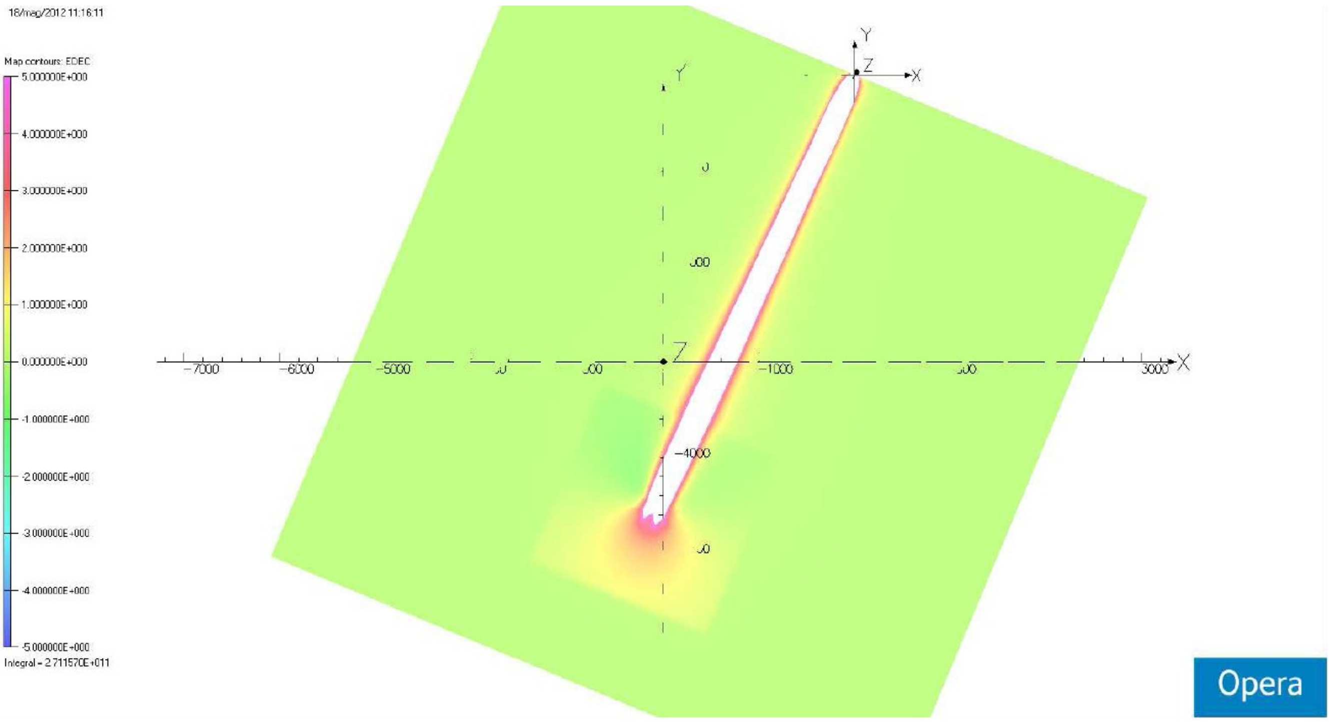


Fig. 4-9: Error on declination (max. ±5°), negative cables and current flow, normal operations

The following images (4-11 to 4-18) are in special operations conditions (i.e. just 66 boxes working, as well as just 6 submarine conductors, and the relevant pigtails). “Positive” and “negative” must are as above. The switched-off conductors are in red in Fig. 4-10 below:

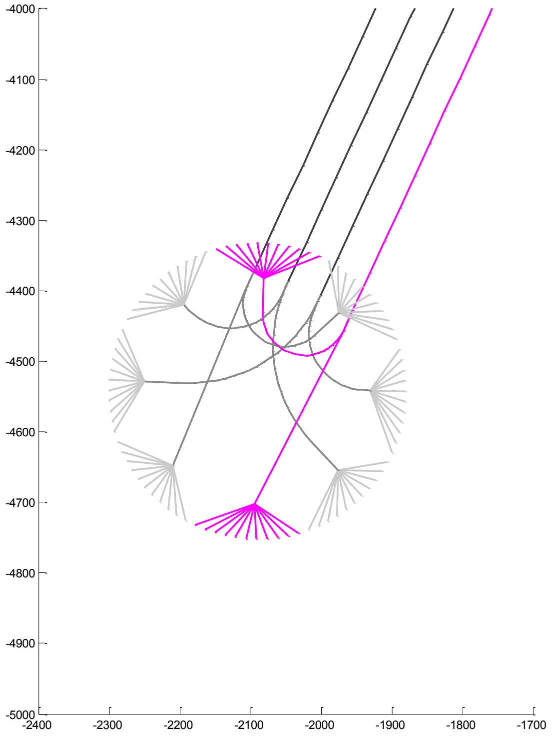


Fig 4-10: Switched-off conductors considered for the special operation case (in red)

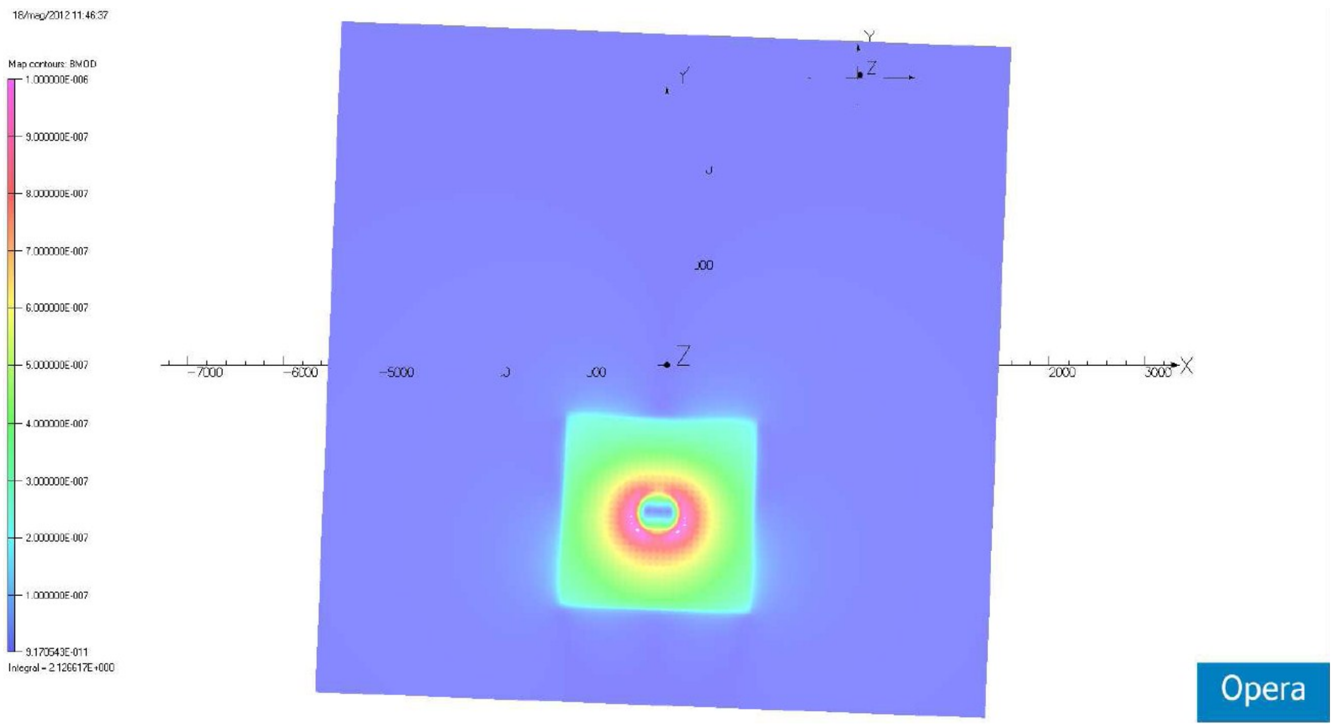


Fig 4-11: Magnetic field due to the current flowing into seawater alone, special operations Max. 1 μT

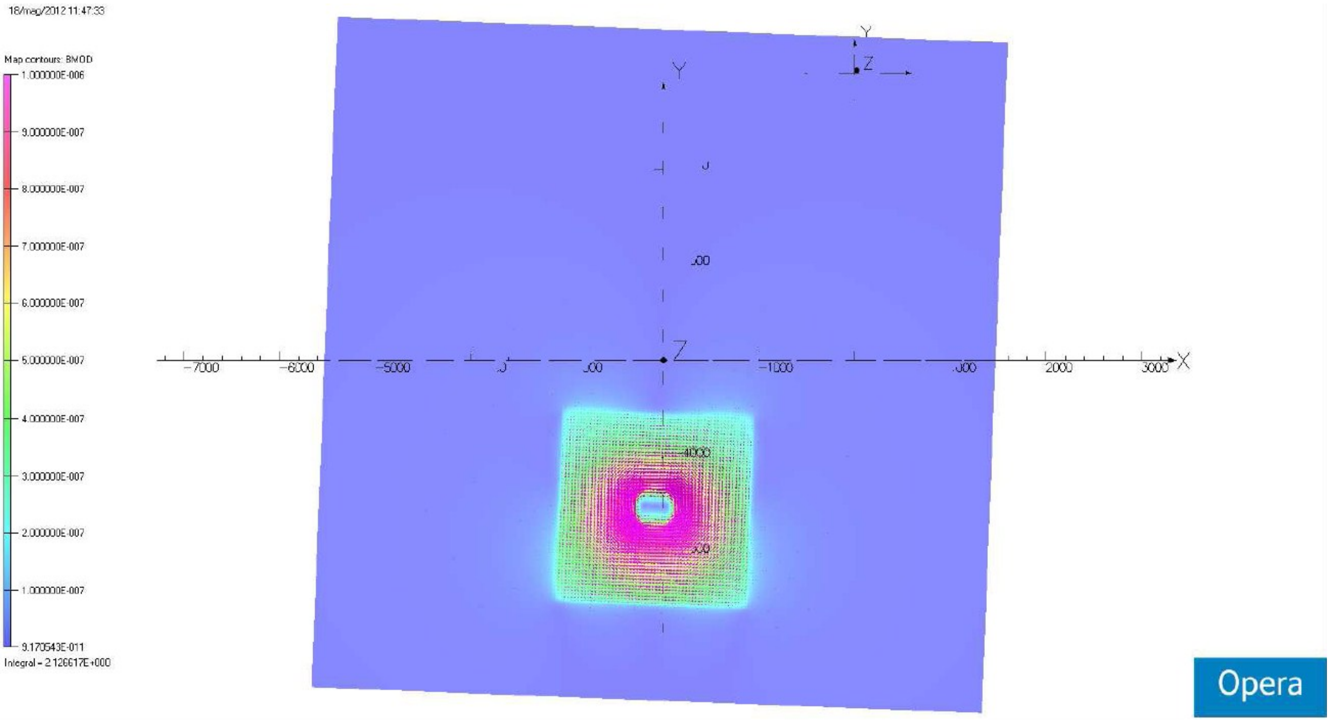


Fig 4-12: As above, plus vectors

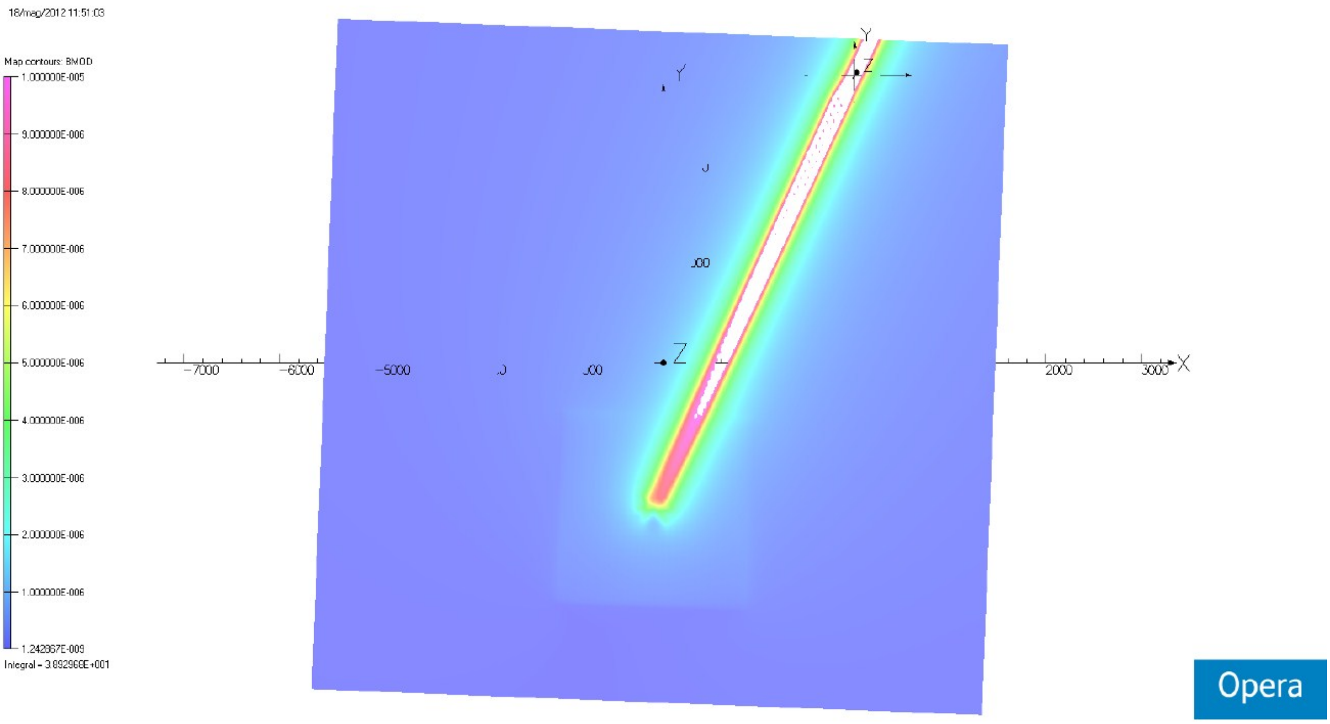


Fig 4-13: Magnetic field due to positive cables and current flow, special operations Max. 10 μT

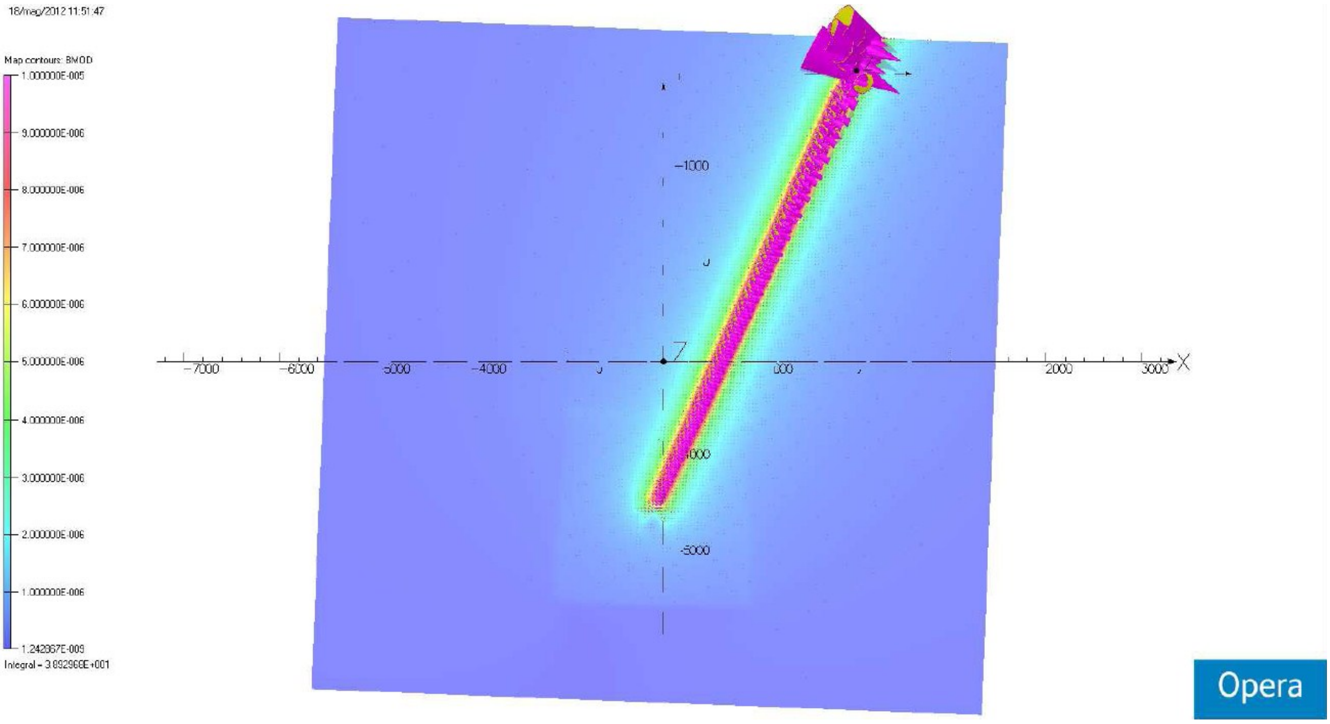


Fig 4-14: As above, plus vectors

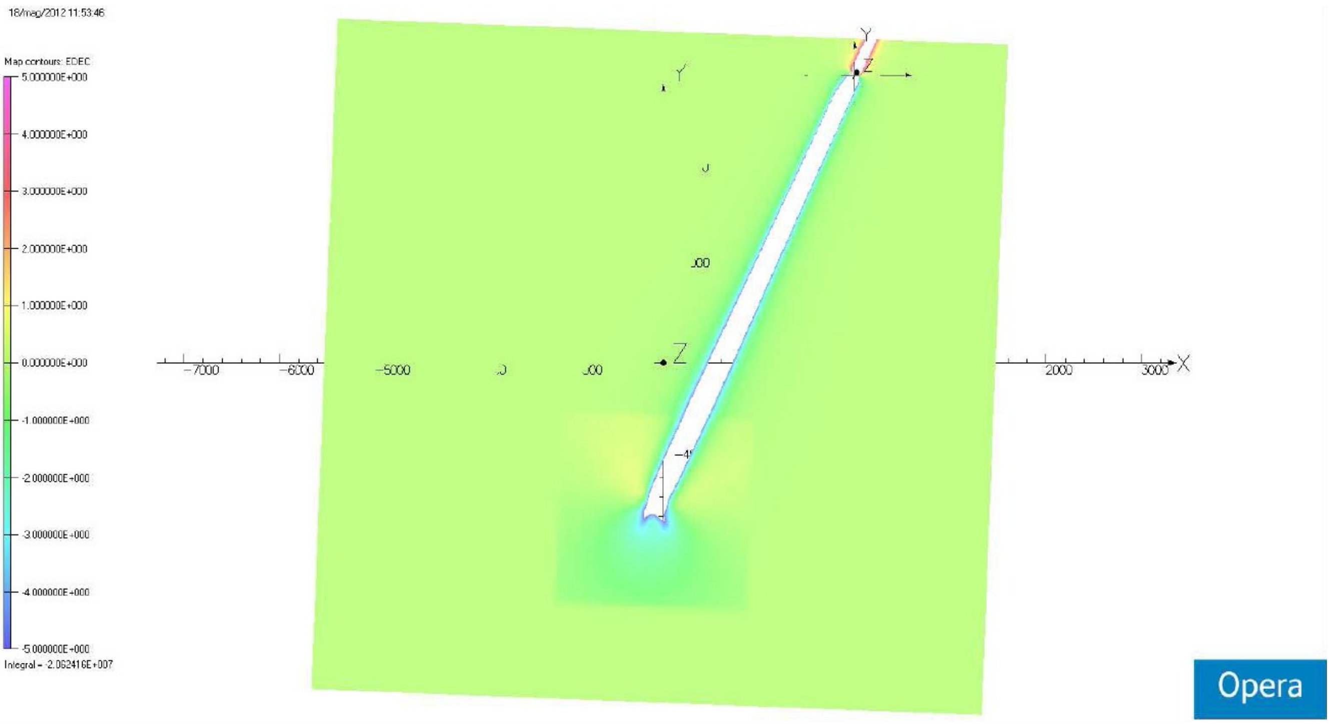


Fig 4-15: Error on declination (max. ±5°), positive cables and current flow, special operations

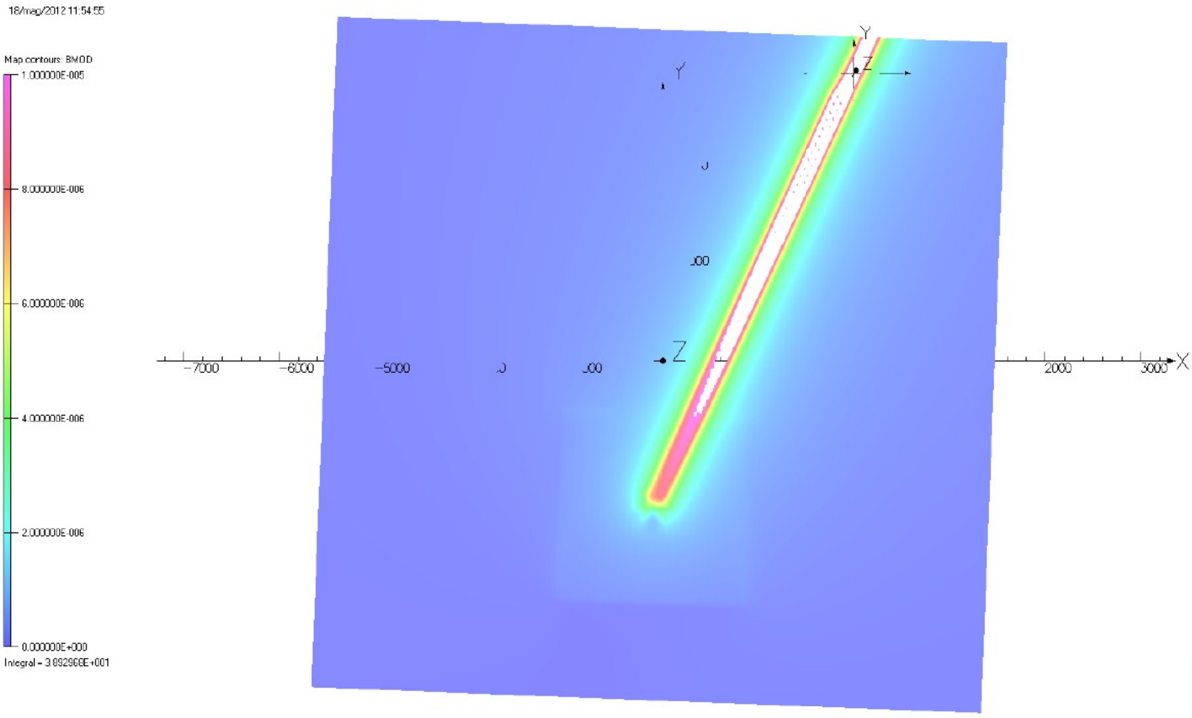


Fig 4-16: Magnetic field due to negative cables and current flow, special operations Max. 10 μT

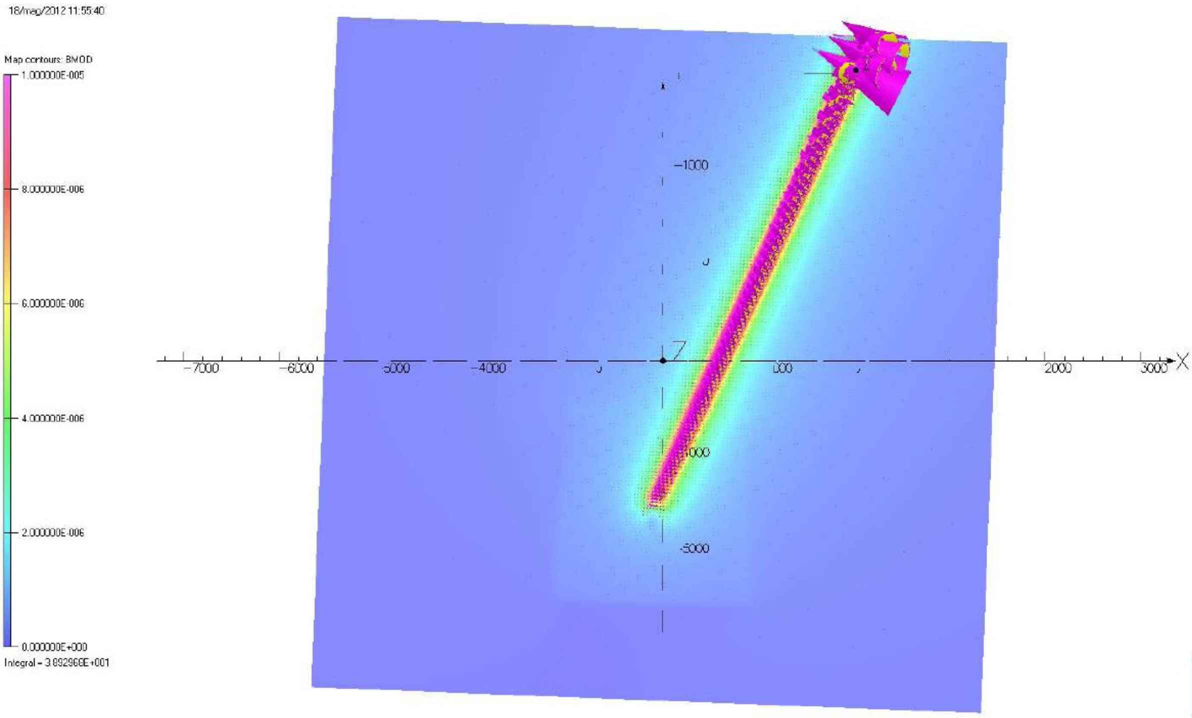
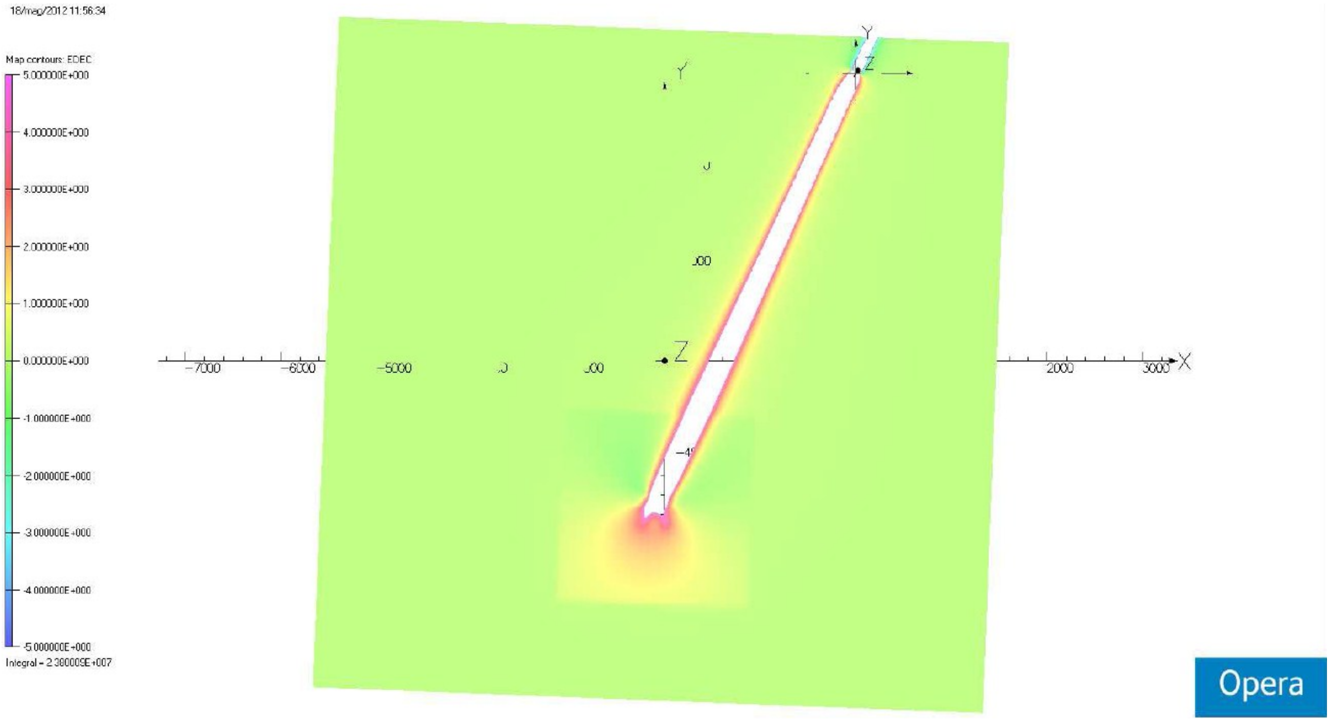


Fig 4-17: As above, plus vectors



4-18: Error on declination (max. ±5°), negative cables and current flow, special operations

For all cases it is apparent that:

a) the effect of the magnetic field produced by the current flowing into the water is minimal with respect to the field produced by the main cables. Please notice that the maps are limited to 1 μT for the first, and to 10 μT for the second; this consideration is obvious examining the images reporting both contributions;
b) the “negative” case tends to increase the eastward component of natural Earth magnetic field, and therefore gives positive errors (i.e. the declination is further increased wrt the natural one);
c) the “positive” case has an opposite behavior;
d) the effect can be appreciated on a narrow strip centered over the feeding cables.

The conclusion is that:

- magnetic field levels within the sea are largely compliant with ICNIRP recommendation about human health;
- the deflection of magnetic compass outside the white areas in Figg. 4-6, 4-9, 4-15, 4-18 is limited to ±5 degrees; this means that the impact over ship’s tracks is practically irrelevant (in other terms, if a ship in the area is subject to an error on compass reading of 5 degrees and it crashes on the coast, it means that the true track was already directed towards the coast even without the error induced by the current flowing into the electrode line.
- Higher compass deflection values can be expected within the white areas in Figg. 4-6, 4-9, 4-15, 4-18, which is very limited in size (around 280 m), and this fact shall be clearly reported in nautical maps and aids to navigation.

2.5 Subtask 4e

See subtask 4d.

2.6 Subtask 4f

The reported computations results are as follows; please be aware that, in order to increase the readability, the maximum plotted value has been limited to 100 μT, while the exposure limit is 200 μT; therefore the areas where the limits are exceeded are contained inside the white areas, and smaller than the plotted ones, which represent values exceeding 100 μT. Spatial coordinates, in all images, are in the range -50 - +50 m (left/right) and 0- 50 m (ground/top).

2.6.1 Overhead lines

The most representative point for each section of the overhead lines was analyzed. The total number of lines is five (the original four, plus the new Topanga line):

1) Sylmar-Rinaldi (span close to Tower 105)
2) Rinaldi-Northridge (span close to Tower 248)
3) Northridge-Tarzana (span close to Tower 306)
4) Tarzana-Olympic (span close to Tower 911)
5) Topanga State Park

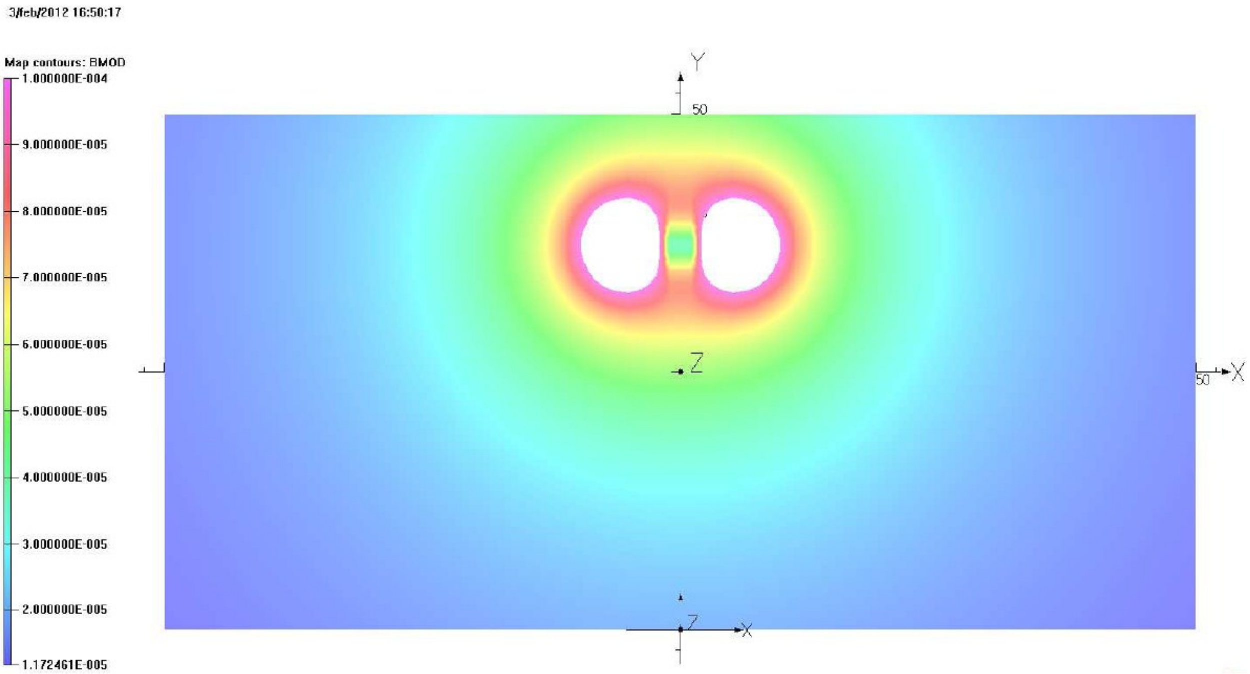


Fig. 4-19: DC Magnetic Induction for Sylmar-Rinaldi, twr 105

Fig. 4-20: Location for Sylmar-Rinaldi, twr 105

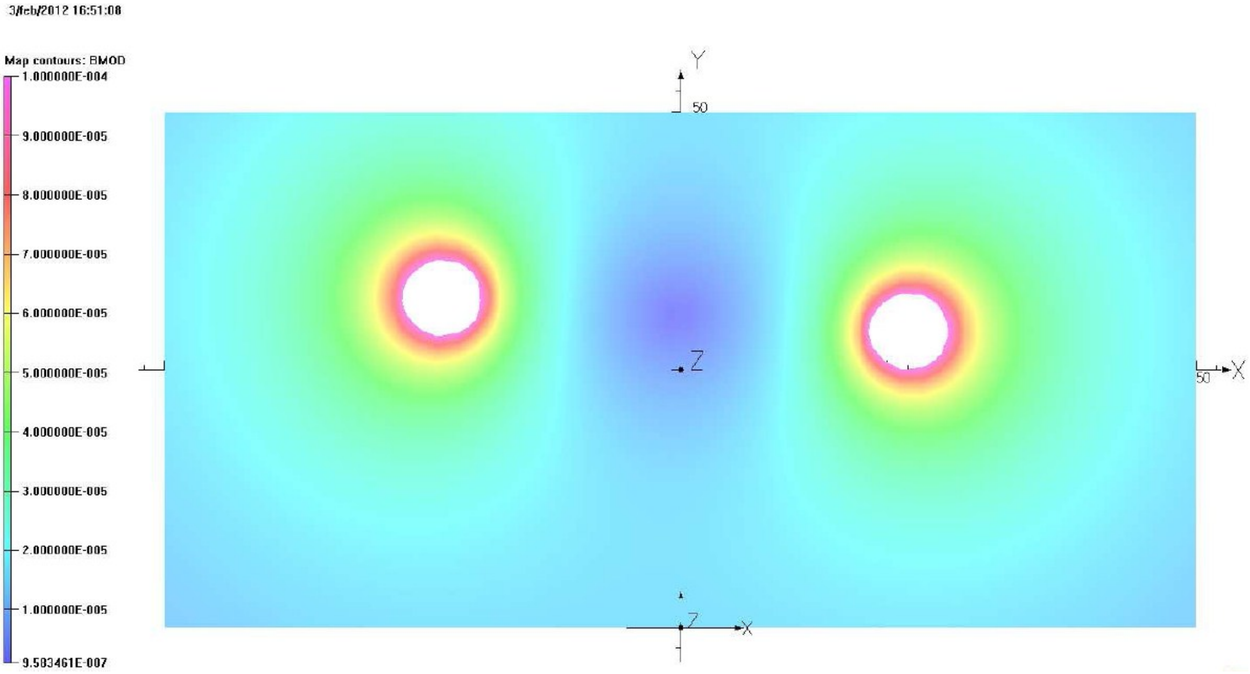


Fig. 4-21: DC Magnetic Induction for Rinaldi-Northridge, twr 248

Fig. 4-22: Location for Rinaldi-Northridge, twr 248

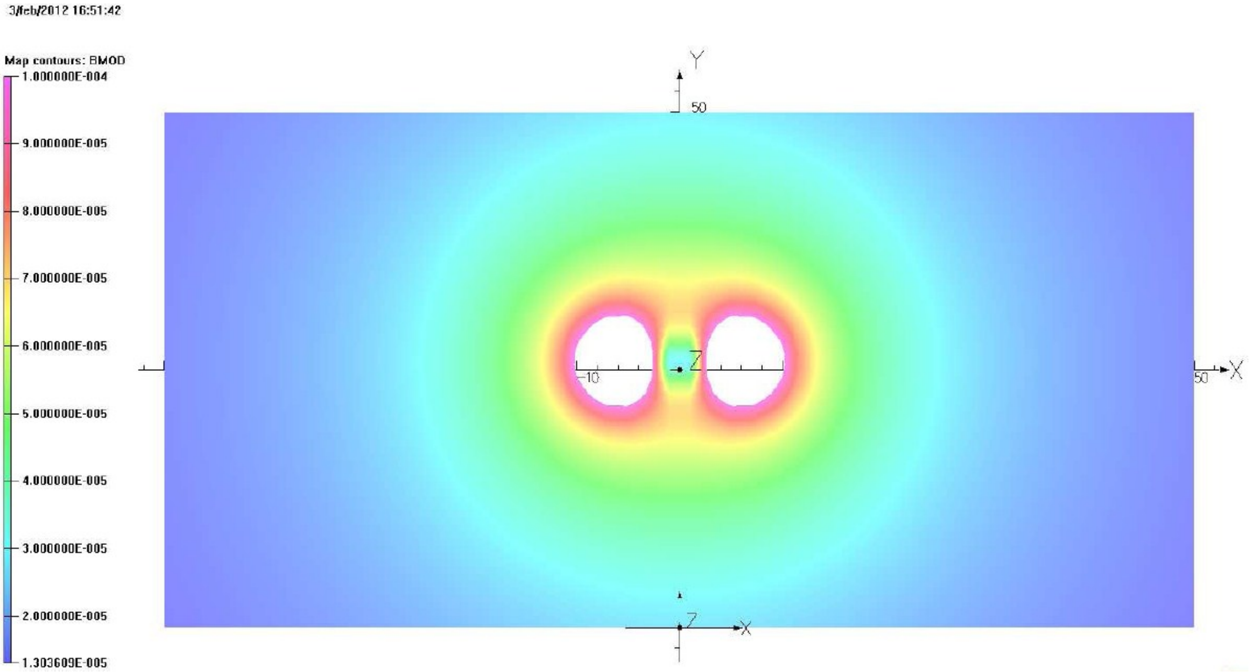


Fig. 4-23: DC Magnetic Induction for Northridge-Tarzana, twr 306

Fig. 4-24: Location for Northridge-Tarzana, twr 306

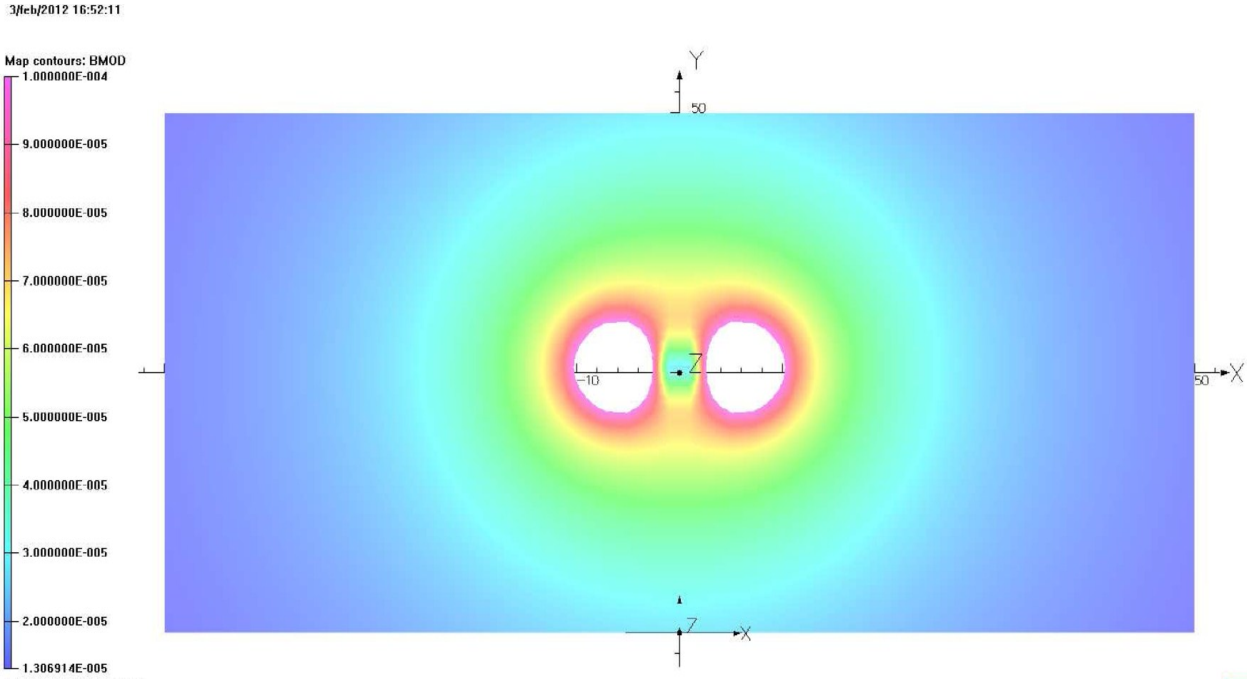


Fig. 4-25: DC Magnetic Induction for Tarzana-Olympic, twr 911

Fig. 4-26: Location for Tarzana-Olympic, twr 911

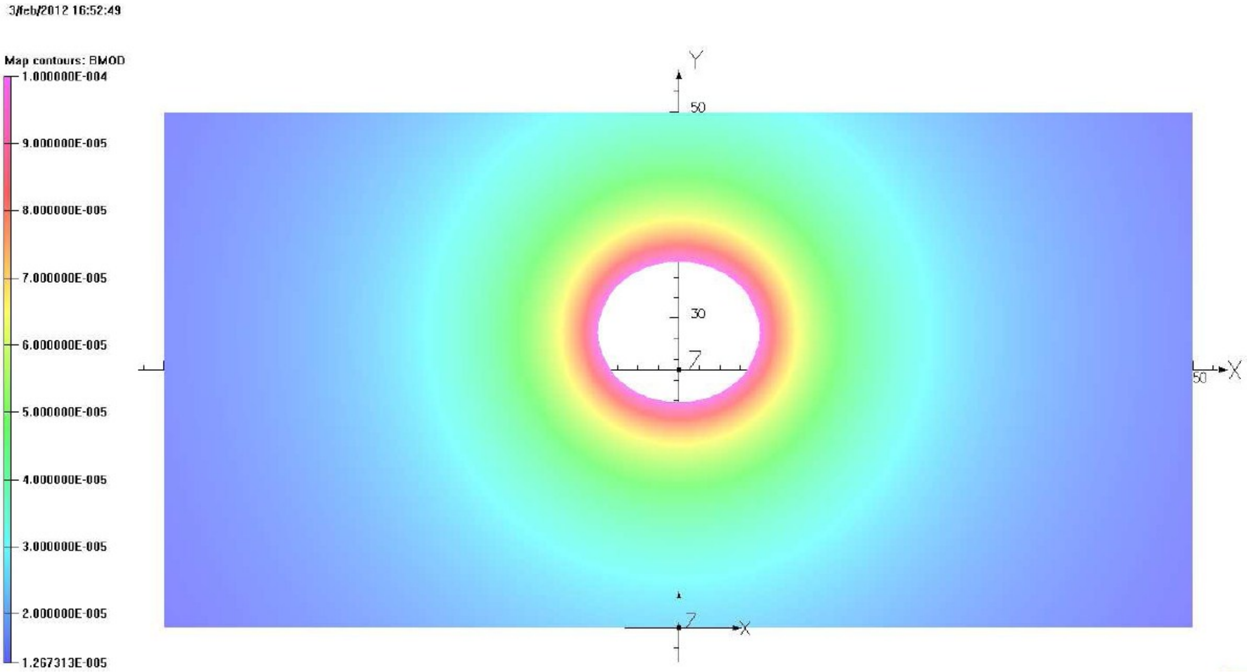
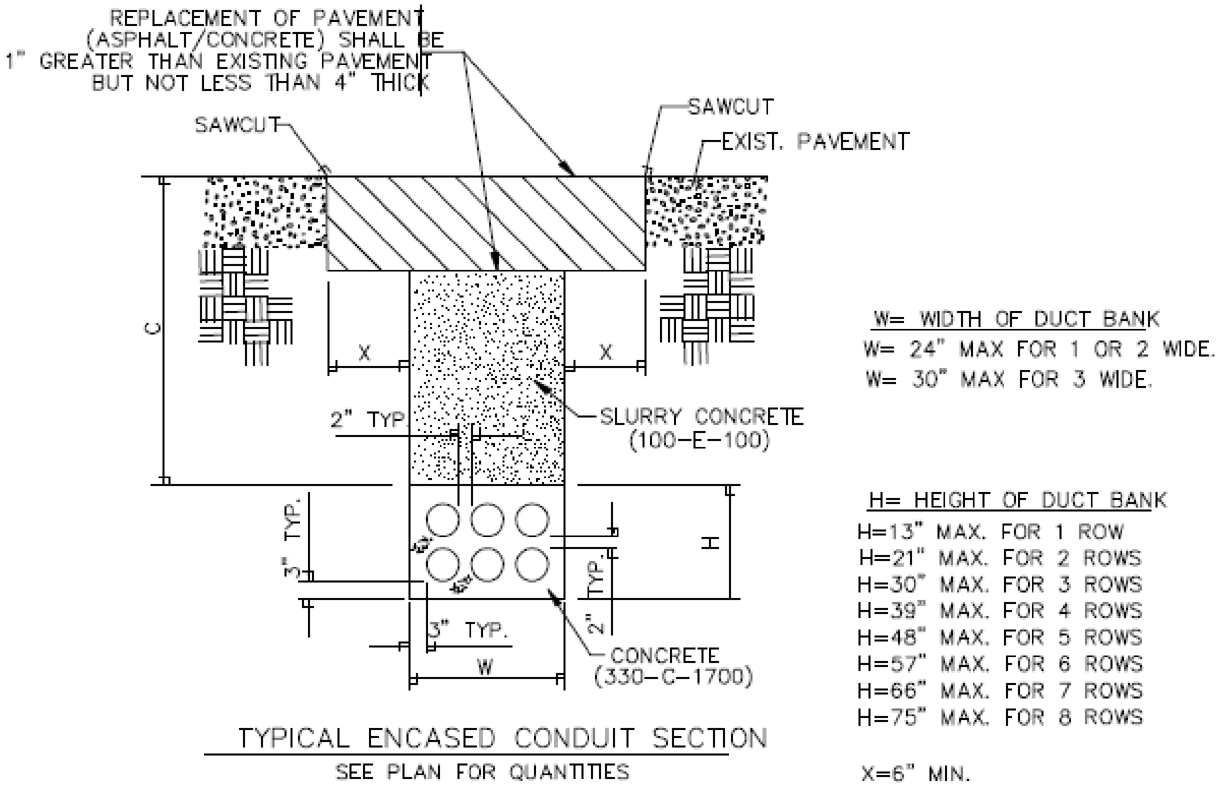


Fig. 4-27: DC Magnetic Induction for Topanga State Park section

The conclusion is that, within the reachable areas, the value of DC magnetic induction due to the OH lines is well within the adopted ICNIRP limits.

2.6.2 Underground lines

The duct sections drawings, describing the layout of the line running from Kenter Canyon to Sunset Vault, were taken from LADWP document 09h5019.pdf:



NOTES:

IN PUBLIC PROPERTY (UNLESS NOTED ON PLANS)
C= DUCT BANK COVER
C= 30" MIN. BELOW GUTTER GRADE FOR PAVED STREETS OR PARKWAYS.
C= 42" MIN. BELOW FINISHED SURFACE GRADE FOR STATE HIGHWAY.
C= 42" MIN. BELOW THE BASE OF LOWEST RAIL FOR RAILROAD CROSSINGS.

IN PRIVATE PROPERTY (UNLESS NOTED ON PLANS)
C= DUCT BANK COVER
C= 24" MIN. FOR PRIMARY CONDUIT AND ALL SECONDARY CONDUITS IN PAVED AREAS.
C= 36" MIN. FOR PRIMARY CONDUIT IN LANDSCAPED OR UNIMPROVED AREAS.

Fig 4-28: Typical underground conduit section

Two geometrical configurations were studied: 2x2, i.e. two conductor in upper position and two conductors just below them, and 4x1, i.e. four conductors at the same height. For the first configuration, the burial depth of 24, 30, 36, 42” were considered; for the second one just 30”; such values must be understood as the value indicated with “C” in the above drawing. In the case 2x2 we considered as operated just the conductors of the upper layer. For each case, two subcases were considered: two operating conductors (“2c” case), each one carrying 1,825 A, and just one operating conductor (“1c” case), carrying the full rated current of 3,650 A. Please be aware that in the following picture the maximum plotted value is exactly the limit suggested by ICNIRP (500 μT); therefore the white part of the map represents points where the recommended magnetic induction value is exceeded. Spatial coordinates, in all images, are in the range -3 - +3 m (left/right) and 0-3 m (ground/top).

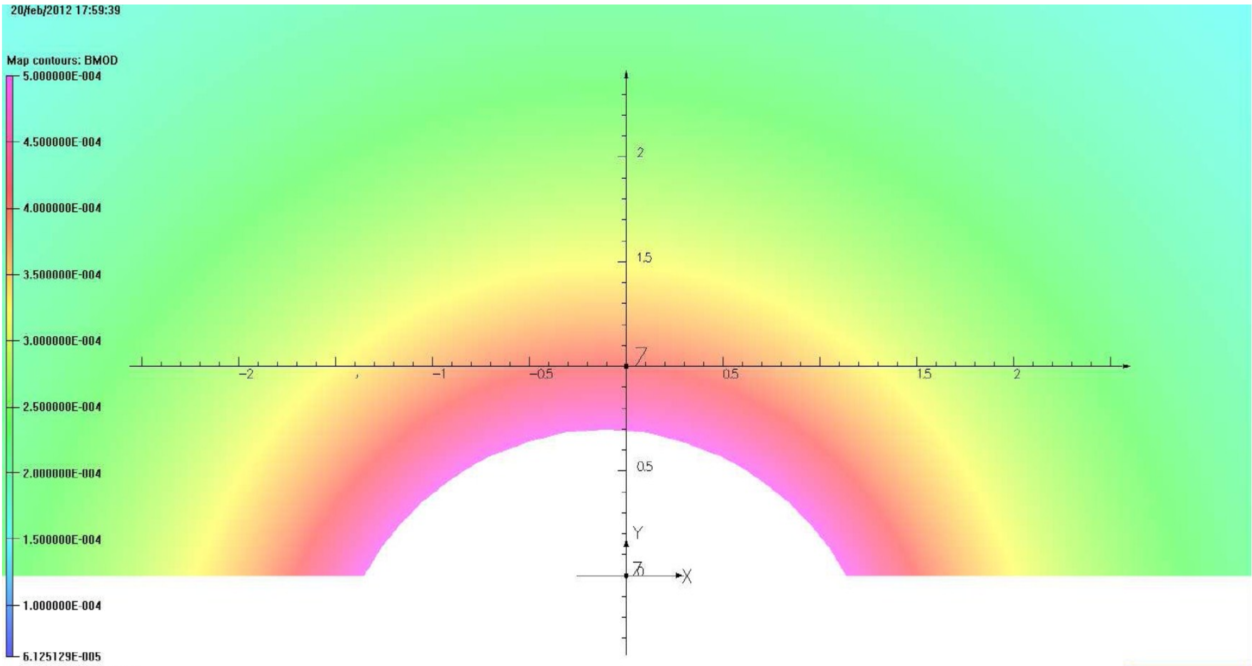


Fig. 4-29: DC Magnetic Induction for Kenter Cyn-Sunset Vault, 24”, 2x2, 1c

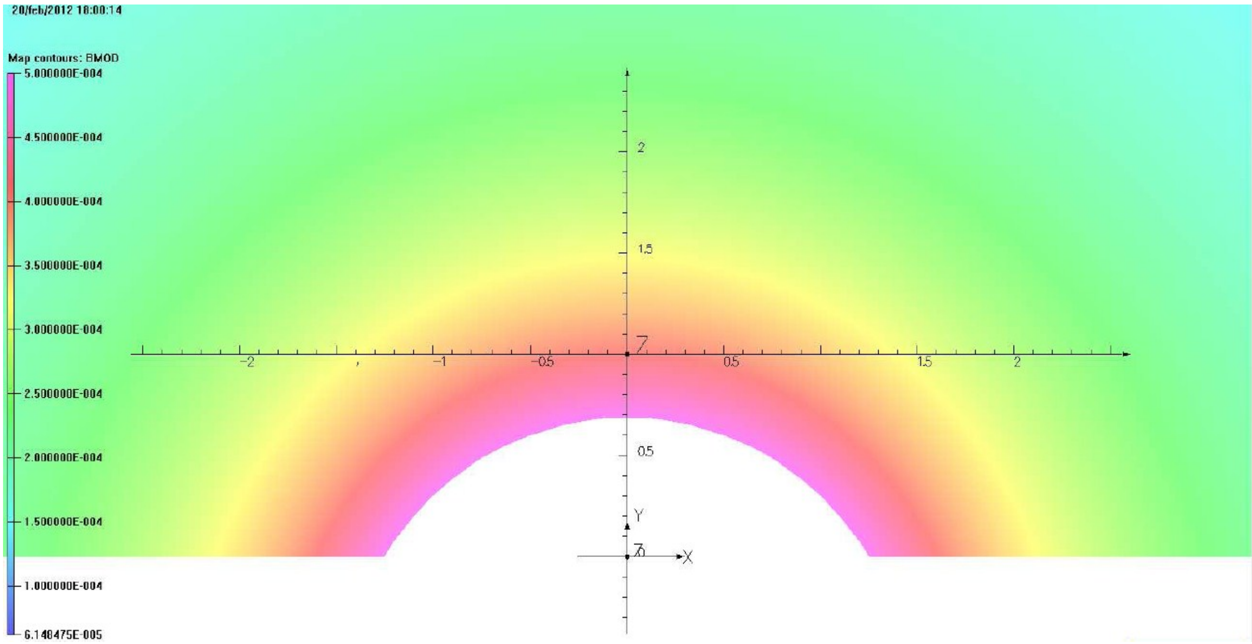


Fig. 4-30: DC Magnetic Induction for Kenter Cyn-Sunset Vault, 24”, 2x2, 2c

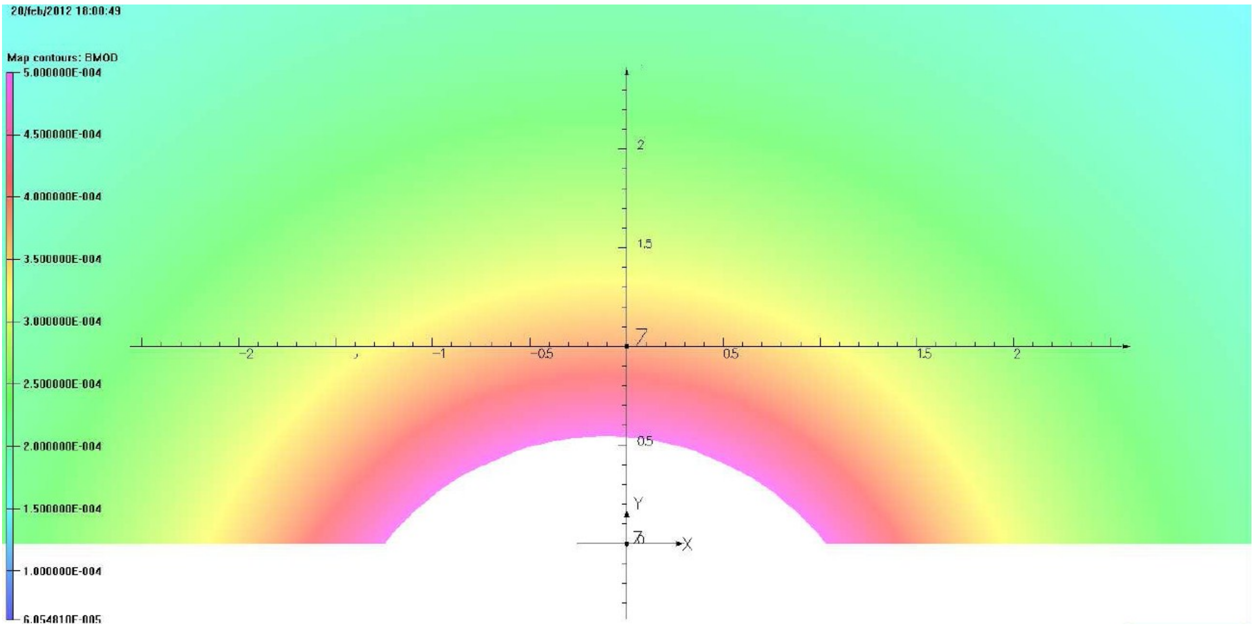


Fig. 4-31: DC Magnetic Induction for Kenter Cyn-Sunset Vault, 30”, 2x2, 1c

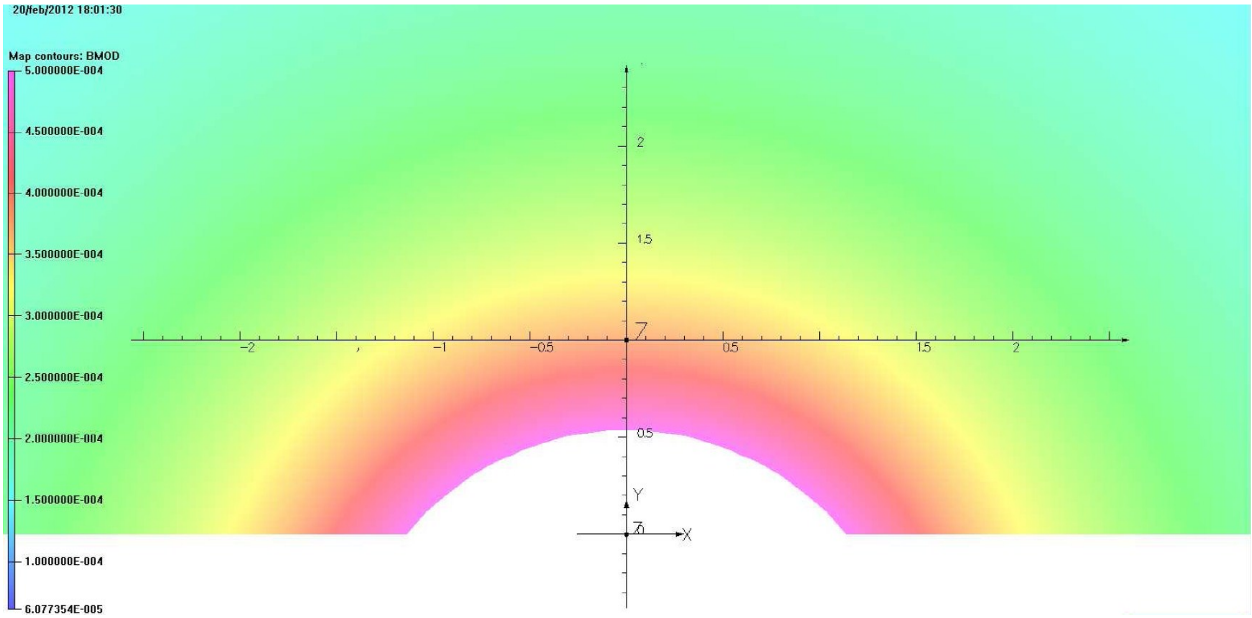


Fig. 4-32: DC Magnetic Induction for Kenter Cyn-Sunset Vault, 30”, 2x2, 2c

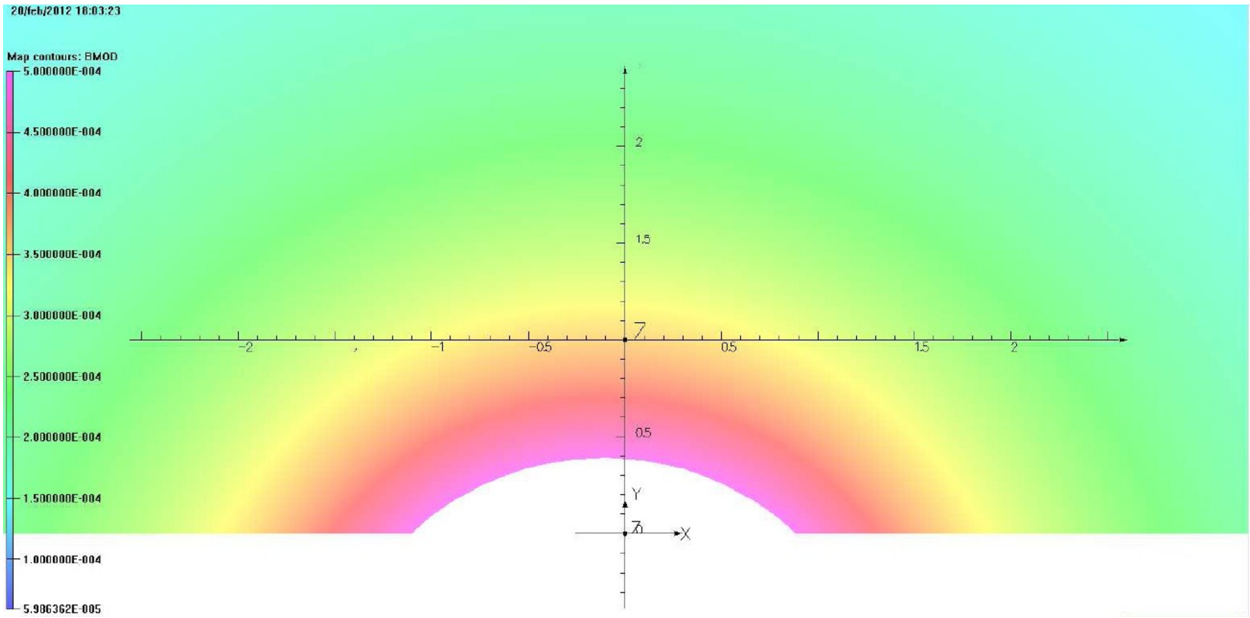


Fig. 4-33: DC Magnetic Induction for Kenter Cyn-Sunset Vault, 36”, 2x2, 1c

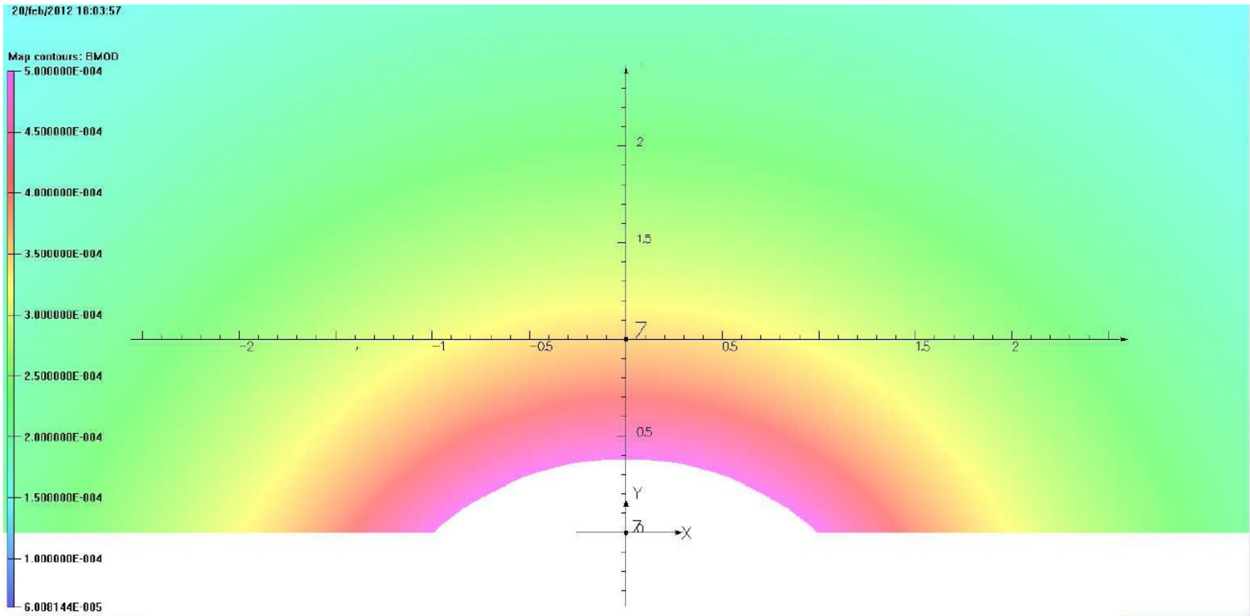


Fig. 4-34: DC Magnetic Induction for Kenter Cyn-Sunset Vault, 36”, 2x2, 2c

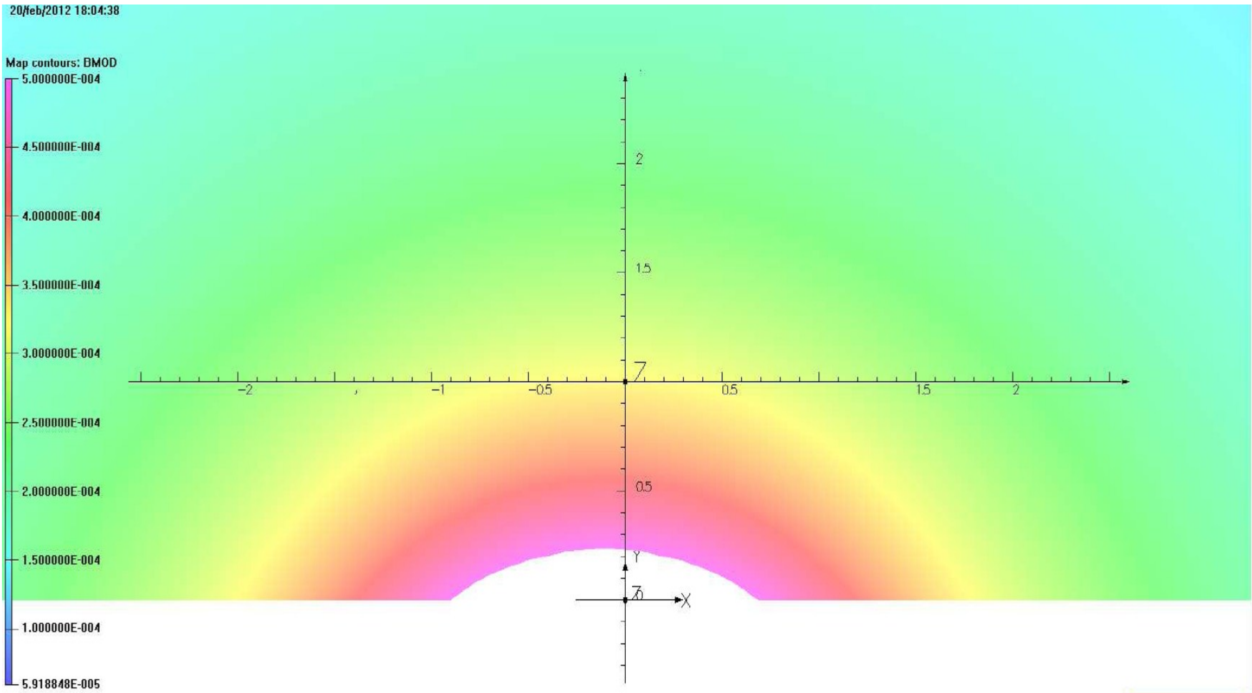


Fig. 4-35: DC Magnetic Induction for Kenter Cyn-Sunset Vault, 42”, 2x2, 1c

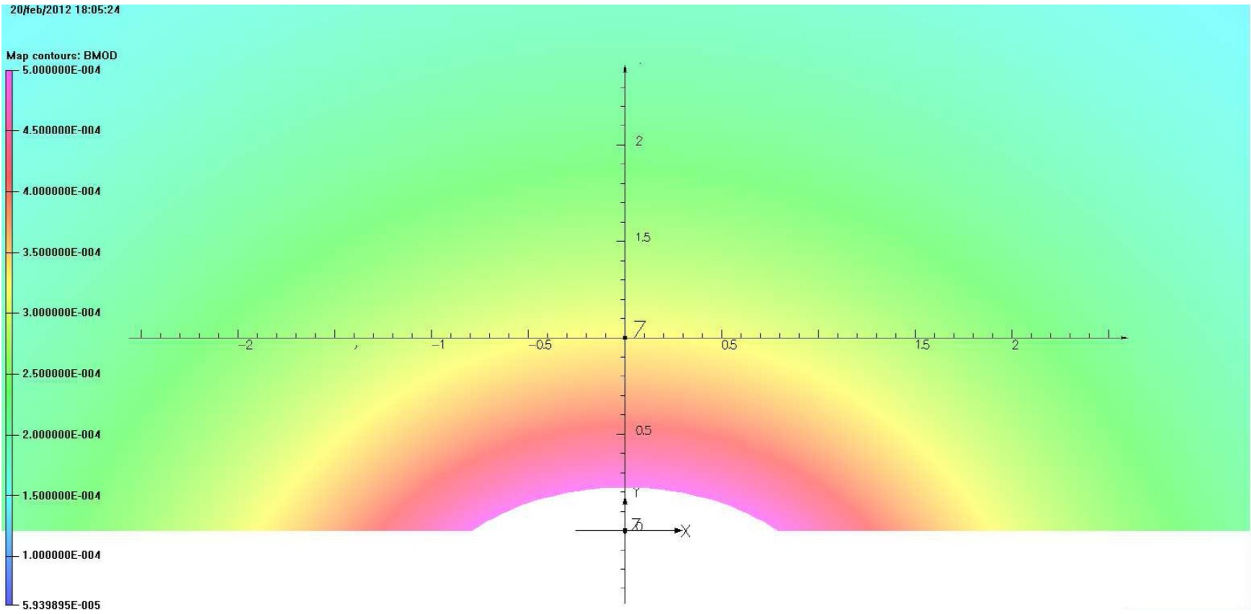


Fig. 4-36: DC Magnetic Induction for Kenter Cyn-Sunset Vault, 42”, 2x2, 2c

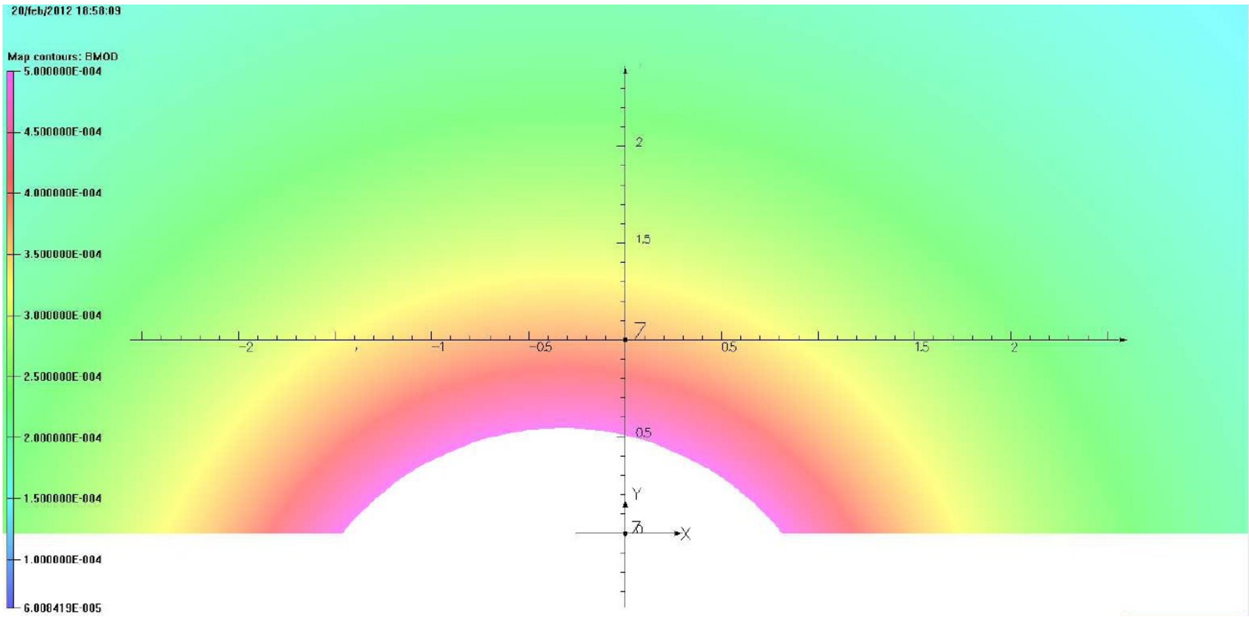


Fig. 4-37: DC Magnetic Induction for Kenter Cyn-Sunset Vault, 30”, 4x1, 1c

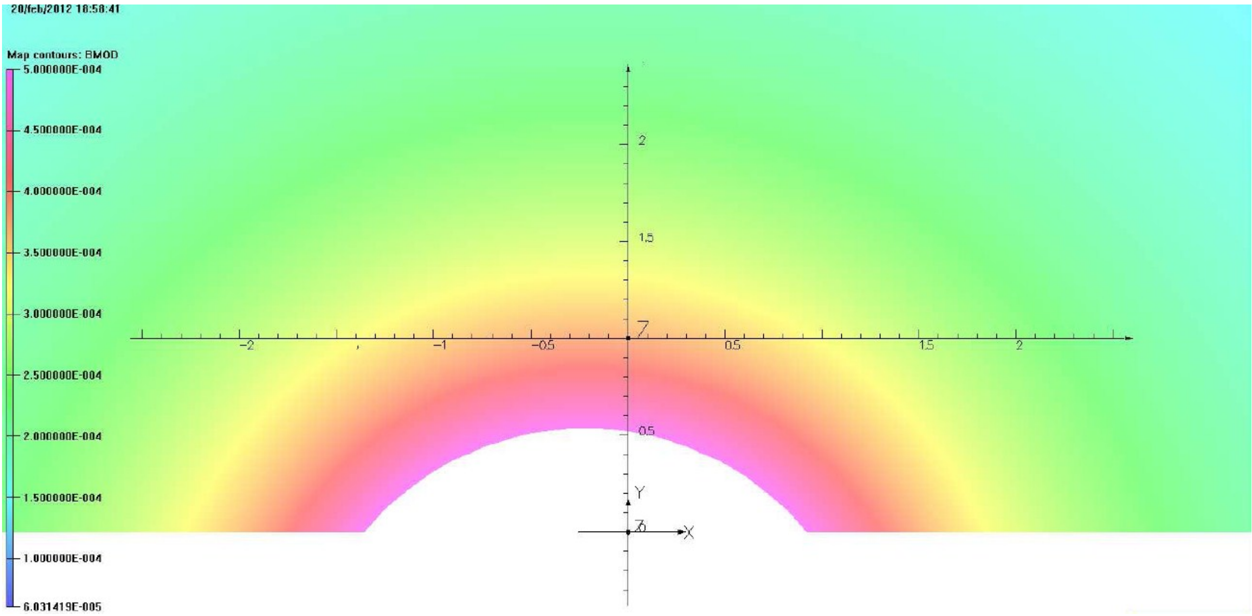


Fig. 4-38: DC Magnetic Induction for Kenter Cyn-Sunset Vault, 30”, 4x1, 2c

The conclusion is that:
to comply with the 500 μT, underground conductors should be buried deeper, at very least least 1.46 m, i.e. 58"). Please be aware that, differently from the depths reported before, this value must be understood as the distance of the center of the topmost conductor from the surface of the ground.

Other mitigations techniques would imply thick iron shield, impractical on a large scale line like this one (i.e. to cover kilometers of line with thick iron plates).

2.7 Subtask 4g

The mitigation of DC magnetic field is an extremely difficult, expensive and cumbersome task. On the basis of the previously exposed analysis, the only potentially problematic (=where the limit of 5G, i.e. 500 μT SUGGESTED within ICNIRP guidelines is exceeded) area is represented by the space immediately over the UG cables duct.

The simplest, least expensive and effective approach to comply with such limit, is to slightly increase the depth of cable duct, in such a way that the topmost conductor is buried deeper than 1.5 m.

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