INTERIM RECORD OF DECISION

PALOS VERDES SHELF
OPERABLE UNIT 5 OF
MONTROSE CHEMICAL CORPORATION
SUPERFUND SITE

LOS ANGELES COUNTY, CALIFORNIA

SEPTEMBER 2009

Region IX
United States Environmental Protection Agency
San Francisco, California

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FIGURES AND TABLES

Acronyms and Abbreviations

μg/cm^2	micrograms per square centimeter
μg/cm^2/year	micrograms per square centimeter per year
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
μm	micrometer
^{14}C	carbon-14
^{210}Pb	lead-210
ADCP	acoustic Doppler current profiler
ARARs	applicable or relevant and appropriate requirements
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	ambient water quality criteria
Bight '03	2003 Southern California Bight Regional Monitoring Program
BSAF	biota-sediment accumulation factors
Cal EPA	California Environmental Protection Agency
CDFG	California Department of Fish and Game
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
cm	centimeter(s)
COCs	chemicals of concern
cm/sec	centimeter(s) per second
CSM	conceptual site model
CTE	central tendency exposure
D*b*	biodiffusivity
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDMU	1-chloro-2,2-bis (p-chlorodiphenyl) ethylene
DDNU	unsym-bis (p-chlorodiphenyl) ethylene
DDT	dichlorodiphenyltricholoethane
DDTs	sum of dichlorodiphenyltricholoethane, dichlorodiphenyldichloroethane and dichlorodiphenyldichloroethene
DTSC	California Department of Toxic Substances Control
EE/CA	engineering evaluation/cost analysis
ELCR	excess lifetime cancer risk

EPA	United States Environmental Protection Agency
ERA	ecological risk assessment
FCEC	fish contamination education collaborative
FS	feasibility study
g	gram(s)
g/cm^2	gram(s) per square centimeter
$g/m^2/year$	gram(s) per square meter per year
HHRE	human health risk evaluation
HI	hazard index
HQ	hazard quotient
JWPCP	joint water pollution control plant
kg	kilogram(s)
km	kilometer(s)
km/day	kilometer(s) per day
km^2	square kilometer(s)
LACSD	Sanitation Districts of Los Angeles County
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
mg/kg	milligram(s) per kilogram
mg/L	milligrams per liter
mgd	million gallons per day
mm	millimeter(s)
Montrose	Montrose Chemical Corporation of California
MSRP	Montrose Settlement Restoration Program
ng/L	nanogram(s) per liter
NOAA	National Oceanic and Atmospheric Administration, U.S. Department of Commerce
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRDA	Natural Resources Damage Assessment
OC	organic carbon
OEHHA	Office of Environmental Health Hazard Assessment, California EPA
PCBs	polychlorinated biphenyls
ppb	parts per billion
ppm	parts per million

ppt	parts per trillion
PV Shelf	Palos Verdes Shelf
PVSTIEG	Palos Verdes Shelf Technical Information Exchange Group
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
SCB	Southern California Bight
SCCWRP	Southern California Coastal Water Research Project
SEC	sediment effect concentration
TOC	total organic carbon
Trustees	federal and state agencies that manage natural resources
TSS	total suspended solids
UCL	upper confidence level
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

GLOSSARY

baroclinic
: Descriptive of an ocean in which surfaces of pressure and density intersect at some level or levels. In a baroclinically stratified fluid, total potential energy can be converted to kinetic energy.

baroclinic flow
: In oceanography, the vertically varying circulation associated with horizontal inhomogeneities in the stratification of the oceans.

barotropic
: Descriptive of an ocean in which surfaces of pressure (isobaric surfaces) and density (isentropic surfaces) coincide at all levels, as compared to *baroclinic*. In a state of barotropic stratification, no potential energy is available for conversion to kinetic energy.

barotropic flow
: In oceanography, depth-independent circulation due to changes in surface elevation.

bathymetry
: The measurement and charting of the spatial variation of the ocean depths.

BBL
: In oceanography, abbreviation for bottom boundary layer.

benthic
: Descriptive of organisms that are attached to or resting on bottom sediments, as opposed to *pelagic*.

benthos
: One of three major ecological groups into which marine organisms are divided. The benthos are organisms and communities found on or near the seabed. This includes those animals and plants living on or in marine substrata as well as those that swim in close proximity to the bottom without ever really leaving it.

bioturbation
: The stirring and mixing of sediment by animal life.

carbon normalized, organic-carbon normalized
: Concentrations of organic contaminants (e.g., DDT and PCBs) and the toxicity of these contaminants in sediments have been observed to correlate well with the organic carbon content of sediments. Chemical concentration sediment data can be organic-carbon (OC) normalized by dividing the chemical dry weight concentration by the percent of total organic carbon in the sediment.

crustaceans
: Any of various predominantly aquatic arthropods of the class Crustacea, including lobsters, crabs, shrimps, ad barnacles, characteristically having a segmented body, a chitinous exoskeleton, and paired, jointed limbs.

bivalve
: A mollusk, such as an oyster or clam, having a shell consisting of two hinged parts.

echinoderm
: Any of numerous radially symmetrical marine invertebrates of the phylum Echinodermata, which includes the starfishes, sea urchins, and sea cucumbers, having a body often covered with spines.

epibenthic
Upon or above the bottom sediment

halocline
Vertical zone in the oceanic water column in which salinity changes rapidly with depth, located below the well-mixed, uniformly saline surface water layer.

lipid
Any of numerous fats and fatlike materials in animals that are related to the fatty acid esters and that together with carbohydrates and proteins constitute the principal structural material of living cells

macrofauna
Large animals.

mollusks
Any member of the phylum Mollusca, of largely marine invertebrates, including the edible shellfish and some 100,000 other species.

pelagic
Of, pertaining to, or living in open oceans rather than waters adjacent to land or inland waters.

pinnipeds
Aquatic mammals of the order Pinnipedia, that include the seals, walruses, and similar animals having finlike flippers as organs of locomotion.

phyla
Taxonomic divisions of the animal or plant kingdom.

polychaete worms
Any of various marine worms having paired, flattned, bristle-tipped organs of locomotion.

pycnocline
In physical oceanography, a layer where density changes most rapidly with depth. It can be associated with either a *thermocline* or a *halocline*.

soliton
Internal solitary wave.

thermocline
The depth at which the temperature gradient is a maximum. Generally, a layer of water with a more intensive vertical gradient in temperature than in the layers either above or below it. The depth and thickness of these layers vary with season, latitude and longitude, and local environmental conditions.

PART 1: DECLARATION

1.0 SITE NAME AND LOCATION

Palos Verdes Shelf (Montrose Chemical Corp. Superfund Site, Operable Unit 5)

Los Angeles County, California

CERCLIS ID# CAD008242711

2.0 STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedy for the Palos Verdes Shelf, Operable Unit 5 of the Montrose Chemical Corp. Superfund Site, in Los Angeles County, California.

The selected remedy was chosen in accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), as amended by the *Superfund Amendments and Reauthorization Act of 1986* (SARA), and, to the extent practicable, the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 *Code of Federal Regulations* [CFR] Part 300) (National Contingency Plan [NCP]). Specifically, this decision document has been prepared in compliance with CERCLA Section 117 and NCP Section 300.435(c)(2)(11). This decision document explains the legal and factual basis for selecting an interim remedy for this site. The information supporting this remedial action decision is contained in the Administrative Record for the Palos Verdes Shelf. The Administrative Record for this Interim Record of Decision is available for review at the U.S. EPA Region 9 Record Center, 75 Hawthorne Street, San Francisco, California, and at the following repositories:

Redondo Beach Public Library
303 N. Pacific Coast Highway
Redondo Beach, CA 90277

San Pedro Public Library
931 S. Gaffey St.
San Pedro, CA 90731

The State of California, through the California Department of Toxic Substances Control, concurs with the selected remedy.

3.0 ASSESSMENT OF SITE

The response action selected in this Interim Record of Decision (IROD) is necessary to protect the public health or welfare, or the environment, from actual or threatened releases of pollutants or contaminants into the environment, which may present an imminent and substantial endangerment to public health, welfare, or the environment.

4.0 DESCRIPTION OF SELECTED REMEDY

The Palos Verdes Shelf (PV Shelf) is a large sediment site off the coast of the Palos Verdes Peninsula that is contaminated with dichloro-diphenyl-trichloroethane (DDT) and polychlorinated biphenyls (PCBs). PV Shelf is operable unit 5 of the Montrose Chemical Corporation Superfund Site, located in Torrance, CA. Montrose Chemical Corp. was the world's largest manufacturer of DDT. From the 1950s through 1971, DDT waste from Montrose and PCBs from other industrial sources entered the Los Angeles County sanitation system, ultimately to be discharged from submarine outfalls onto PV Shelf.

The PV Shelf is isolated from the rest of the Montrose Superfund site and its remediation is not dependent upon actions carried out at the other operable units. Section 2.1 of the Decision

Summary discusses the various operable units. Each has its own plan of study and enforceable schedule to prepare a Record of Decision (ROD) or complete the Remedial Design/Remedial Action (RD/RA).

PV Shelf poses an unacceptable risk to human health and the environment; therefore, a remedy is needed. The selected remedy includes capping, monitoring and institutional controls. The monitoring will enable EPA to evaluate both the effectiveness of the cap and of the natural recovery occurring across the site. Based on the results of this interim remedy, EPA will determine if additional actions are warranted in order to reach cleanup levels.

4.1 Overall Cleanup Strategy

The PV Shelf contaminated sediment is too deep for direct human contact, but the fish in the area contain levels of contaminants that pose risks to human health and ecological receptors. The remediation strategy is to reduce concentrations of DDT and PCBs in sediment with the expectation that that action will reduce concentrations in fish. Because of the complexity of the site and uncertainty relative to fish contamination exposure pathway, an interim action is proposed. After completing additional site studies and evaluating the results of the interim action, additional measures will be planned that build on this selected remedy.

4.2 Principal Threat Wastes at the Site

The NCP states that "EPA expects to use treatment to address the principal threats posed by the site…" and "…to use engineering controls, such as containment, for wastes that pose a relative low long-term threat." 40 CFR 300.430(a)(iii)(A) and (B). The outfall area targeted for containment under the selected remedy contains the highest surface concentrations of DDTs and PCBs on PV Shelf and appears to have the potential to erode during winter storms; however, it is not known to what extent contaminants from this area, relative to other parts of the PV Shelf Study Area or the Southern California Bight, enter the food chain or contribute to contamination in fish. One of the studies included in the selected remedy will track fish movement to help answer this question. At present, there are no known principal threat wastes at the site.

4.3 Components of the Selected Remedy

The selected remedy is an interim action that allows an iterative approach to remediation. After assessing the implementability and effectiveness of the interim remedy, additional actions may be planned in a final Record of Decision. The selected remedy for this interim action to remediate the Palos Verdes Shelf includes:

- Placement of an in situ isolation cap over the erosive edge of the deposit that also contains the most highly contaminated sediments,
- Continuing and strengthening the existing Institutional Controls (ICs) program, and
- Monitoring natural recovery to achieve specific Remedial Action Objectives.

4.3.1 Cap Component

A cap of clean sediment to cover the area near the outfalls where surface concentrations of the chemicals of concern (COCs) are highest will be designed, installed and monitored in accordance with an approved RD/RA workplan. The objectives of cap construction would be to bury the contaminated sediment under clean silty sand to block further erosion and to limit contaminant flux or transport from this area. Successful cap placement will immediately bring mean PCB concentrations in surface sediment across the shelf (but not the slope) to the interim cleanup level of 7 mg/kg OC (organic carbon). Mean DDT concentrations in shelf (but not slope) surface sediment will be reduced approximately by half (from 150 mg/kg OC to 78 mg/kg OC). The cap will be designed and implemented in combination with monitored natural recovery to achieve the cleanup levels listed in section 8.2. Natural recovery is estimated to reduce the remaining DDT in surface sediment to 46 mg/kg OC by the first Five-Year Review and to the cleanup level of 23 mg/kg OC (i.e., 230 μg/kg at 1% TOC) by 2039. This DDT cleanup level correlates to the interim ROD target fish tissue concentration of 400 μg /kg DDT in white croaker.

During the remedial design, EPA will reassess the 45-cm cap design prepared in *Options for In Situ Capping* (Palermo et al., 1999). The reassessment will include optimum cap thickness and placement techniques.

The DDT ambient water quality criterion (AWQC) for protection of human health is 0.22 ng/L. The estimate of when AWQC for DDT will be achieved ranges from 2052 to 2136, depending on the rate of contaminant flux from the sediment. Studies are currently underway to measure contaminant flux, which will allow EPA to refine this estimate.

4.3.2 Institutional Controls Component

The Institutional Controls (ICs) Program provides immediate protection to the public. The ICs program relies on partnerships with other federal, state, and local agencies as well as community-based organizations to reduce exposure to consumers from PV Shelf contaminated fish. There are three major components to the ICs Program:

- **Public Outreach and Education** – to increase awareness and understanding of the existing fish consumption advisories and fishing restrictions,
- **Monitoring** – to evaluate and track contaminant concentrations in fish (primarily white croaker) caught at or near the site as well as those sold in retail fish markets, and
- **Enforcement** – based on the existing commercial and recreational restrictions on white croaker fishing established by the California Department of Fish and Game (CDFG).

The ICs program limits human exposure to contaminated fish through an aggressive outreach program that uses a variety of channels to educate the public on safe fishing practices. Public outreach and education is carried out by the EPA-sponsored Fish Contamination Education Collaborative (FCEC), and entails angler outreach, outreach to at-risk ethnic communities, and outreach to commercial fishing operations and markets. The State of California Office of Environmental Health Hazard Assessment (OEHHA) issues fish consumption advisories. OEHHA is a member of the FCEC and FCEC's outreach messages are based on OEHHA fish advisories.

The ICs monitoring component consists of monitoring contaminant levels in fish (particularly white croaker) at selected locations in the ocean, markets, landing areas and piers. Monitoring data support IC actions by enabling the FCEC to strategically target areas for greater outreach and enforcement. Under the monitoring component, the selected remedy will conduct a fish consumption survey to identify by population group which fish species are consumed and in which quantities. This information will be used to update the ICs Implementation Plan, a living document used to implement the ICs program.

Enforcement consists of enforcing existing white croaker regulations for commercial and recreational anglers, inspection of retail food facilities, and enforcement of market protocol under the California Health & Safety Code. CDFG wardens patrol the commercial catch ban area and enforce the recreational daily catch limit and the commercial no-take zone for white croaker. CDFG works with local agencies that inspect fish markets and other establishments.

The ICs program uses a feedback loop getting input from stakeholders to develop new programs and strengthen existing programs. Workplans are reassessed on an annual basis to assure their effectiveness.

4.3.3 Monitored Natural Recovery Component

In addition to cap placement and the ICs program, natural recovery processes will be used to reduce contaminant concentrations to below the cleanup levels. Natural recovery processes to be relied on as part of this component include dispersion and burial and, in the case of DDT, degradation. Monitoring will be employed in accordance with the approved RD/RA documents to evaluate the effectiveness of the cap and the natural recovery processes.

The monitored natural recovery (MNR) component of the remedy includes additional studies to improve modeling of contaminant fate and transport. Studies included under MNR are transformation of DDE, rates of contaminant loss, and a fish tracking study to identify habitat usage by fish species.

Monitoring will also be done to evaluate the effectiveness of the cap. These studies are scheduled to be completed by the first Five-Year Review. The studies will assist in determining whether it is possible to use a treatment technology to permanently reduce the toxicity of the contaminants or whether additional capping is necessary to attain cleanup levels. EPA will use these studies and monitoring data to develop a final Record of Decision.

5.0 Statutory Determinations

This selected interim remedy is protective of human health and the environment in the short term and is intended to be protective until a final ROD is signed. The remedy complies with Federal and State requirements that are applicable or relevant and appropriate to the action, except with respect to the PCB AWQC for human health, which will be waived for this interim action until further data can be collected and analyzed to determine if the PCB AWQC can be met. The remedy is cost-effective.

This action is not intended to utilize permanent solutions and alternative treatment technologies to the maximum extent practicable for this operable unit. This interim action does not meet the statutory preference for treatment because there is no known effective treatment option available at this time. Treatment following removal is infeasible because of the size, depth and complexity of the contamination. Treatments that accelerate contaminant degradation are still being researched. As noted, this action does not constitute the final remedy for the operable unit; the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element will be addressed by the final response action. Although capping is not considered treatment, it will reduce mobility of the contaminated sediment.

Because this remedy will result in hazardous substances remaining on-site above health-based levels, a review will be conducted to ensure that the remedy continues to provide adequate protection of human health and the environment within five years after commencement of the remedial action. For this interim action ROD, review of this site and the remedy will be ongoing as EPA continues to develop remedial alternatives for the site.

6.0 ROD Data Certification Checklist

The information provided in the following table, which consists of key remedy selection data, is derived from the Decision Summary (Part II of this Interim ROD). Additional information can be found in the Administrative Record file for this OU.

Table 1: Palos Verdes Shelf (Montrose OU5) ROD Data Certification Checklist

Information	Location
Chemicals of concern and their respective concentrations	Tables 5-1, 5-2, 5-3, 7-1 and 7-2
Baseline risk represented by the chemicals of concern	Tables 7-6 thru 7-9
Cleanup levels established for chemicals of concern and the basis for these levels	Section 8.1
How source materials constituting principal threats are addressed	Section 11.0
Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses	Section 6.0
Potential use that will be available at the site as a result of the selected remedy	Section 6.2
Estimated capital, continuing implementation costs, and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected	Table 12-1
Key factors that led to selecting the remedy	Section 12.1

7.0 Authorizing Signature

Signature for the Interim Remedial Action Record of Decision for the Palos Verdes Shelf Site, Operable Unit 5 of the Montrose Chemical Corporation Superfund Site, selected by the U.S. Environmental Protection Agency.

Michael M. Montgomery, Assistant Director
Superfund Division, Region 9
U.S. Environmental Protection Agency

9/30/09
Date

PART II: DECISION SUMMARY

1.0 SITE NAME AND LOCATION

The Palos Verdes Shelf Superfund site (PV Shelf) is an 88 square kilometer (km^2) area of sediment on the continental shelf and slope off the coast of the Palos Verdes Peninsula, Los Angeles County, California, that has been contaminated with dichloro-diphenyl-trichloroethane (DDT) and polychlorinated biphenyls (PCBs).

PV Shelf is Operable Unit 5 of the Montrose Chemical Corporation Superfund site. Its national Superfund electronic database (i.e., CERCLIS) identification number is CAD008242711. EPA Region 9 is the lead agency for site remediation, and is using special account funds from various Consent Decrees entered into with the potentially responsible parties (see section 2.2) to clean up the site.

The California coast from Pt. Conception to the Mexican border curves inward, forming a large bay called the "Southern California Bight." The Palos Verdes Peninsula is a small but prominent land mass extending into the Southern California Bight (SCB). It is bordered by Santa Monica Bay to the north and the San Pedro Shelf to the south. The Channel Islands lie to the west and northwest. The narrow underwater shelf off the Palos Verdes Peninsula is called the Palos Verdes Shelf. It is approximately 14.5 kilometers (km) long and 2.4 km wide. The seabed over most of the shelf slopes at a gentle 1 to 3 degrees. The shelf breaks at a depth of 70 to 100 meters (m), then drops steeply over 800 m to the ocean floor. (See Figure 1.)

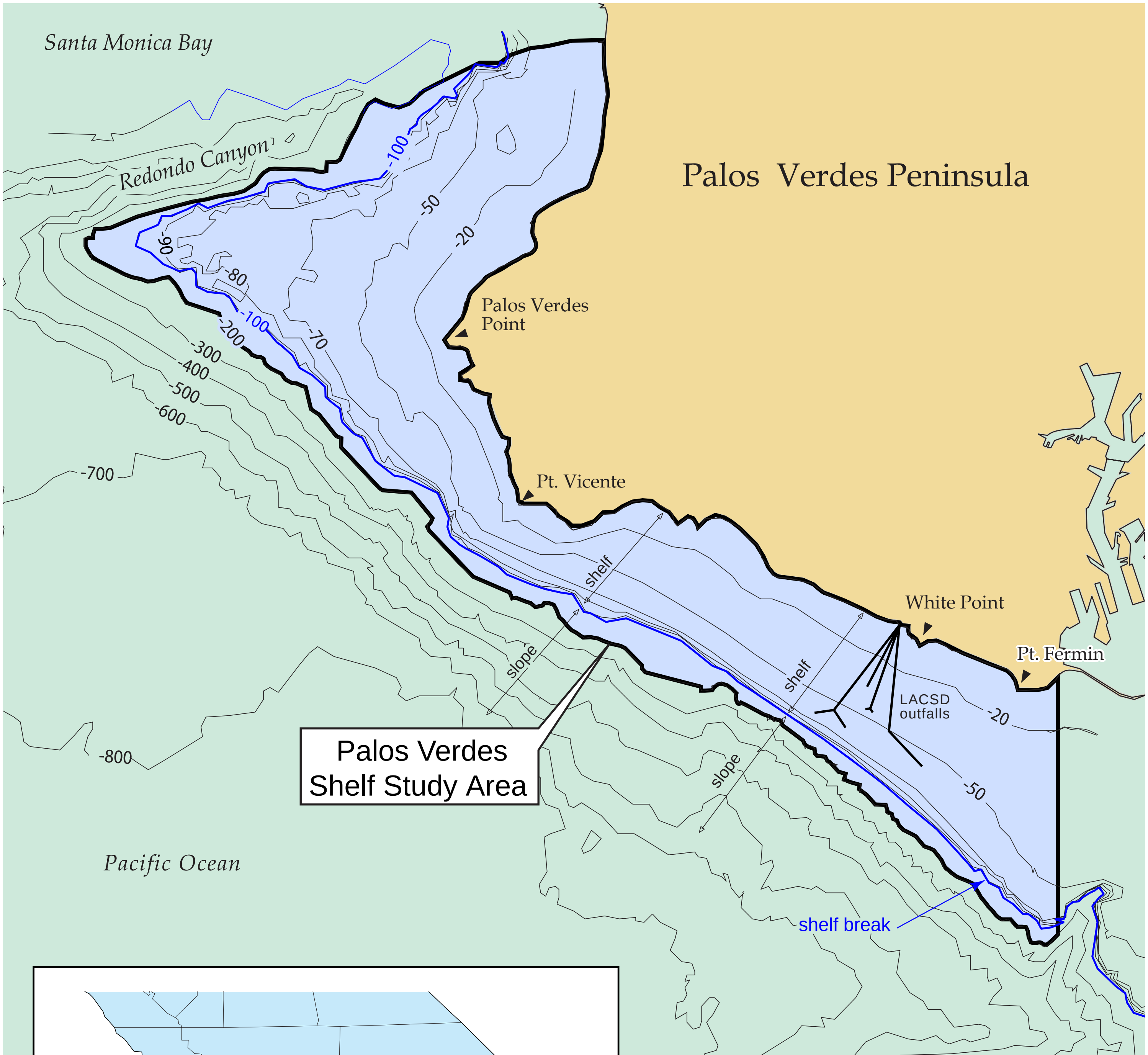
The primary historical source of chemical contaminants on the PV Shelf is effluent discharged through submarine outfalls at White Point on the Palos Verdes Peninsula. Since 1937, wastewaters have been discharged to the ocean off Palos Verdes Peninsula from submarine outfalls of the Joint Water Pollution Control Plant (JWPCP), operated by the Sanitation Districts of Los Angeles County (LACSD). Contaminants in the effluent included chlorinated hydrocarbons (e.g., DDTs and PCBs) as well as trace metals (e.g., cadmium, copper, lead, zinc, and other metals), and organic matter. The total discharge of suspended solids from 1937 to 1995 has been estimated to be 4.1 million metric tons (Lee et al., 2002). It is estimated that approximately 1,000 metric tons (mtons) of DDT were discharged from the outfalls from the 1950s through 1971. Traces of DDT can be found throughout the Southern California Bight; however, approximately 10 percent of the discharge settled on PV Shelf, forming an identifiable layer of contaminated sediment from 5 centimeters (cm) to 60 cm thick over a 44 km^2 area.

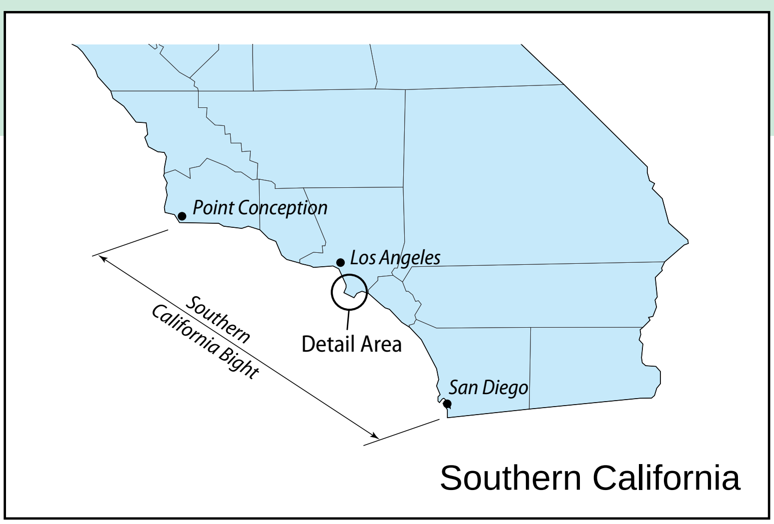
2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

At one time, the Montrose Chemical Corporation of California, Inc. operated the nation's largest DDT manufacturing plant. The former plant property is in Torrance, California. Waste from the manufacturing plant has contaminated soil, groundwater in the vicinity of the former plant property, sewer and storm drainage pathways as well as the PV Shelf contamination, offshore.

2.1 Montrose Chemical Corp. Superfund Site

From 1947 until 1982, Montrose Chemical Corp. of California, Inc. (Montrose) operated a DDT-manufacturing plant on 13 acres at 20201 Normandie Avenue in Los Angeles County, California. The land was owned by Stauffer Chemical Company. The Montrose plant operated 24 hours a day, seven days a week, 365 days a year. During its 35 years of operation, Montrose produced approximately 800,000 tons of DDT.





Abbreviations

LACSD - Sanitation Districts of Los Angeles County

Notes

1. Isobaths are in meters.

0 2 4

Approximate Scale (Miles)

Feasibility Study/Record of Decision Support
Palos Verdes Shelf
Los Angeles County, California

FIGURE 1
Location of Palos Verdes Shelf Study Area

When the plant first opened, it discharged DDT-contaminated wastewater from its production operations to a city sewer line via a private pressure sewer line owned by Stauffer Chemical. This connecting line periodically clogged, resulting in the discharge of Montrose DDT-contaminated wastewater to the natural stormwater drainage. When EPA investigated the natural stormwater drain in the 1990s, residual levels of DDT in the drainage immediately downstream of the Montrose plant property were in excess of 8,000 parts per million (ppm).

The Normandie Avenue plant property itself was contaminated by Montrose operations. Investigations directed by EPA beginning in 1985 found significant contamination (primarily DDT and chlorobenzene) in the shallow and deep soil at the Montrose plant property, groundwater beneath and downgradient from the Montrose plant property, soil adjacent to and in the vicinity of the property, the sewer line adjacent to and downstream of the Montrose plant property, and, as mentioned above, portions of the stormwater pathway leading from the Montrose plant to the Consolidated Slip in Los Angeles Harbor. Groundwater at the Montrose site is contaminated with monochlorobenzene and other contaminants across six hydrostratigraphic units and to distances up to 1.3 miles from the former Montrose plant site.

The Montrose Chemical Corp. Superfund Site was included on the National Priorities List (NPL) of federal sites (i.e., Superfund) on October 4, 1989. There are seven operable units at the Montrose Chemical Superfund Site. Operable unit (OU) 1: on/near property soil, addresses the contaminated soils at the former Montrose plant and adjacent areas. The Remedial Investigation (RI) Report was completed in 1998. Additional soil sampling to supplement the RI Report occurred in 2005. OU1 is now in the Feasibility Study (FS) phase. OU2: current stormwater pathway, refers to the drainage pathway that exists from the former Montrose facility to the Los Angeles Harbor. An ecological risk assessment has been drafted, and EPA plans to evaluate options regarding the harbor sediments in an engineering evaluation / cost analysis (EE/CA). OU3: ground water and dense non-aqueous phase liquids, is the OU that addresses contaminated ground water from Montrose and the adjacent Del Amo Superfund site. EPA completed a Joint Groundwater Feasibility Study (JGWFS) in May 1998, and issued a Record of Decision (ROD) for the Dual Site Groundwater Operable Unit on March 30,1999. OU3 is in the remedial design phase. OU4: historic stormwater pathway-north, and OU6: historical stormwater pathway-south, refers to the remnants of former stormwater drainage ditches that came from Montrose and ran through residential and industrial areas. EPA authorized removal actions for both OUs. In 2001 and 2002 EPA excavated DDT-contaminated soil from the residential areas that form OU4. OU6 areas were excavated in 2007 and 2008. OU7: Jones Chemicals Inc. is a major chlorine manufacturer located in the old Montrose plant footprint. This OU is in the RI phase. PV Shelf is OU5 of the Montrose site.

2.1.1 Sewer Lines to Palos Verdes Shelf

From 1953 until 1971, Montrose discharged DDT-contaminated wastewater from its operations at the Montrose plant to two sewers operated by the Los Angeles County Sanitation District (LACSD). These sewers conveyed the wastewater to the Joint Water Pollution Control Plant (JWPCP), where it received primary treatment and was discharged through the White Point outfalls located on the PV Shelf.

In the early 1970s, LACSD initiated an investigation to identify and eliminate discharge of DDTs and PCBs into their sewer system. LACSD identified the Montrose plant as the only significant source of DDT in sewer flows to the JWPCP. PCBs entered the LACSD sewer system from several industrial sources in the Los Angeles area, most notably from the

Westinghouse Electric Corporation, which manufactured and repaired electrical equipment at its Los Angles County plant; from a paper-manufacturing plant in Pomona owned by Potlatch Corporation; and from Simpson Paper Company. Like DDT from the Montrose plant, PCBs from these plants were sent to the JWPCP and, after treatment, were discharged from the White Point outfalls onto the PV Shelf.

LACSD estimated that the discharge from the Montrose plant was contributing 654 pounds (lbs) of DDT per day to the LACSD system. The peak annual mass emissions of effluent solids (167,000 metric tons (mt)), DDT (21.1 mt), and PCBs (5.2 mt) occurred in 1971. Montrose ceased discharging waste into the county sewer system in 1971. LACSD conducted cleaning operations in the two sewer lines adjacent to and downstream of the Montrose property. Sediments in the two sewer lines contained in excess of 7,700 lbs of DDT, according to LACSD.

Despite these efforts by LACSD, significant quantities of DDT-contaminated sediment remained in the sewer line. After the plant closure in 1983, under EPA order, Montrose removed approximately 162,000 lbs of sediment from the sewer line downstream from the plant. Sewer sediment samples from this removal operation showed levels of DDT in the sediment at 490,000 mg/kg and chlorobenzene at 2,200 mg/kg.

2.2 Palos Verdes Shelf Enforcement Activities

PV Shelf enforcement activities occurred along two parallel paths: litigation and response actions. In 1989, CERCLA natural resource trustees[1] determined that DDT and PCB contamination of the marine environment off the southern California coast, including the Palos Verdes Shelf, could be causing significant damage to natural resources. In June 1990, the United States and the State of California filed suit in the case of United States v. Montrose et al. The suit contained two claims:

- A claim by the natural resource trustees ("Trustees") for natural resource damages caused by the release of DDT and PCBs, through sanitary sewer and stormwater runoff pathways, into the environment off the Los Angeles coast, i.e., the Natural Resource Damage (NRD) site, and
- EPA's claim for response costs with respect to the Montrose NPL Site.

The named defendants in the Montrose case were Potlatch Corporation and Simpson Paper Corporation, owners and operators of a paper mill that released PCBs into the LACSD sewer system; Westinghouse Electric Corporation, owner and operator of a facility that released PCBs into the LACSD sewer system; the Los Angeles County Sanitation Districts, owners and operators of the municipal sewer system that discharges wastewater to the PV Shelf through the White Point outfalls; and Montrose Chemical Corporation, owner and operator of the facility at the Montrose plant property. Named along with Montrose were several other corporations that were related to Montrose as corporate parents, successors and/or owners of the real property.

[1] The Federal and State Trustees supporting the damage assessment were the U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, U.S. Dept. of the Interior, Fish and Wildlife Service and National Park Service; State of California State Lands Commission, Dept. of Fish and Game, and Department of Parks and Recreation.

EPA entered into Consent Decrees with LACSD/Municipalities in 1997, with Central Broadcasting System (CBS) Corporation in 1998, with Potlatch Simpson Paper in 1998, and Montrose offshore in 2000. The first Consent Decree established a special account to be used for response and remedial actions on PV Shelf. Monies from the other settlements were added to the special account. Funds from the consent decrees were also allotted to the natural resource trustees. The Trustees formed the Montrose Settlements Restoration Program (MSRP) to restore or replace injured resources and lost services.

2.3 Site Investigations

Federal and state natural resource trustees, with NOAA as the lead trustee, completed a CERCLA natural resource damage assessment (NRDA) for the Southern California Bight, including PV Shelf. As part of the NRDA, the U.S. Geological Survey (USGS) collected sediment cores in 1992-1993 from 56 stations at the PV Shelf. Core samples from discrete 2 or 4 cm intervals were analyzed for total DDT and total PCBs, as well as several physical parameters. The results of this sampling indicated that DDT and PCBs were present throughout the effluent-affected sediment deposit and that trends in PCB levels tended to follow trends in DDT concentrations. The NRDA also found that the DDT and PCBs in contaminated sediment were entering the food chain and posed a variety of threats to sediment dwelling organisms, fish and higher predator species, including some protected by state or federal endangered species laws.

The NRDA expert reports were issued in October 1994, confirming that DDT and PCBs in sediment on the PV Shelf have caused and continue to cause major damage to the marine environment. Given the breadth and depth of information contained in these reports, EPA decided in December 1994 to consider whether to initiate EPA Superfund response actions with regard to DDT and PCB contamination on the PV Shelf. In July 1996, EPA initiated a non-time critical removal action to evaluate risks posed by the DDT and PCB effluent-affected sediment on PV Shelf and the feasibility of response actions that could reduce threats to human health and the environment.

2.4 Engineering Evaluation/Cost Analysis and Action Memorandum

In July 1996, EPA determined that the elevated concentrations of DDT and PCBs in sediment on the PV Shelf represented a threat to human health, welfare and the environment, and initiated a non-time-critical removal action under CERCLA to further investigate the threats. Non-time-critical removal actions are defined in the National Oil and Hazardous Substances Pollution Contingency Plan as response actions that can start later than six months after the need for action has been established. 40 CFR §300.415(b)(4). The NCP requires an Engineering Evaluation/Cost Analysis (EE/CA) for all non-time critical removal actions. The EE/CA for PV Shelf was issued in 2000.

As an initial step in the EE/CA process, EPA identified and screened possible response action technologies for contaminated sediment on the PV Shelf. Based on the results of the initial screening, a subset of actions was selected for further evaluation and comparison in the EE/CA. Response actions were screened using three criteria: effectiveness, implementability, and cost.

The EE/CA Proposed Plan identified Institutional Controls (ICs) as the preferred alternative. In September 2001, EPA issued an Action Memorandum to implement the ICs program. Public comment on the proposed plan shaped the ICs program to rely more substantively on outreach and education. Institutional Controls (ICs) would serve as an interim removal action (with a limited duration of 10 years) while EPA completed its investigation of PV Shelf. As an interim removal action, EPA waived the applicable or relevant and appropriate requirements (ARARs) for surface water quality standards for DDT and PCBs.

In 2000, EPA conducted a pilot study to assess the feasibility of using capping to clean up the site. Three 45-acre cells at different depths were capped with sand from two different sources, using different placement methods. Post-cap monitoring in 2002 showed that contaminant levels over the capped areas were comparable to uncapped areas. Additionally, the LACSD collected sediment cores across the PV Shelf in 2001 and noted that the peak concentration of contaminated sediment in one core collected from a capped cell was closer to the surface than it had been historically. The surface recontamination and possible sediment scouring prompted EPA to conduct four field studies in 2004 to evaluate 1) sediment geotechnical properties, 2) impacts of large, deep-burrowing worms and shrimp, 3) resuspension of sediment from capping, and 4) oceanographic conditions during winter storms. The study reports were completed in 2005 and posted on EPA's website (www.epa.gov/Region09/Superfund/pvshelf) under "Site Documents and Reports." The results of these and other studies were used to develop the Remedial Investigation and Feasibility Study for PV Shelf.

EPA issued a Human Health Risk Evaluation for PV Shelf in 1999 (SAIC, 1999). The EE/CA acknowledged the need to gather additional information on the extent of COCs in fishes. From 2002 to 2004, EPA and MSRP collected 23 species of fish from 30 locations along the Southern California coast and analyzed them for DDT, PCBs and other contaminants. White croaker from the vicinity of PV Shelf was generally the most highly contaminated species. In most cases, DDT concentrations were higher than PCBs, particularly in the PV Shelf area. EPA used the survey to recalculate the health hazards from consumption of certain species of fish.

3.0 COMMUNITY PARTICIPATION

This section describes how the public participation requirements of CERCLA and the NCP were met in the remedy selection process. 40 CFR 300.430(f)(3). The lead agency must conduct a number of public participation activities throughout the process.

3.1 Ongoing Community Activities

EPA prepared a Community Involvement Plan (CIP) for PV Shelf in 1997. Information gathered to create the CIP indicated that members of the public had concerns over the health of fish and marine mammals, as well as human consumption of demersal fish from the area.

Since the EE/CA, removal and remedial activities for PV Shelf have used two groups as sounding boards for decisions: the Fish Contamination Education Collaborative (FCEC) and the Palos Verdes Shelf Technical Information Exchange Group (PVSTIEG).

The Institutional Controls program put in place by the 2001 Action Memorandum established the creation of the Fish Contamination Education Collaborative (FCEC). Members of FCEC include federal, state and local agencies as well as community-based organizations working together to raise awareness of local fish contamination and protect at-risk populations, i.e., anglers, children, women of child-bearing age, and ethnic minority communities. Through the

FCEC EPA has provided continual updates on the status of the PV Shelf remedial investigation and feasibility study as well as briefings on the proposed plan.

Community outreach also includes media outreach. For example, members of the FCEC appeared on Chinese language radio show, "*Good Man, Good Woman*" for a 50-minute program to discuss the PV Shelf and safe fish-eating practices, and on Chinese-language television station, LA 18/KSCI TV, morning "*Power Breakfast*" show. Additionally, the Vietnamese newspaper, *Saigon Times*, ran a story explaining the problem and emphasizing safe-fish eating practices. As the date for release of the PV Shelf Proposed Plan approached, EPA conducted interviews with local and national press to raise awareness and create interest in the plan: *Palos Verdes Peninsula News, Ventura County Star, Daily Breeze, Los Angeles Times*, and the Associated Press.

EPA formed a technical team of stakeholders to peer review and to provide technical expertise to the EPA for the RI and FS. The Palos Verdes Shelf Technical Information Exchange Group (PVSTIEG) consists of representatives from federal, state and local agencies, as well as local non-governmental organizations. This group contributed to design of the post-pilot capping studies and reviewed the RI and FS. Their comments helped shape the Proposed Plan and support the decision to issue an interim ROD.

3.2 Activities to Support the PV Shelf Proposed Plan

Before release of the Proposed Plan, EPA engaged in numerous informal public participation activities to increase awareness of the PV Shelf issues and to publicize the upcoming Proposed Plan meetings. An Open House held at the Cabrillo Marine Aquarium on March 31, 2009, to discuss the FS and its alternatives was particularly successful. The open house featured display tables on natural resource restoration, engineering technologies for sediment sites, information on the ICs program, a video loop of the PV Shelf site and hourly presentations on the FS and viable alternatives, followed by a question and answer session. Over 250 people attended the 4-hour open house.

EPA also gave presentations on the FS to local environmental groups, including the Sierra Club Los Angeles Chapter, Santa Monica Bay Restoration Commission (SMBRC) Technical Advisory Group, to the SMBRC Board of Directors, and the Palos Verdes Peninsula Conservancy.

After completing the AR, copies were sent to the U.S. EPA Superfund Record Center in San Francisco, Ca, and the 3 local site repositories:

Redondo Beach Public Library
303 N. Pacific Coast Highway
Redondo Beach, CA 90277

San Pedro Public Library
931 S. Gaffey Street
San Pedro, CA 90731

NOAA Office
501 W. Ocean Blvd., Suite 4470
Long Beach, CA 90802

The Proposed Plan was distributed to EPA's Palos Verdes Shelf mailing list. It was posted on Region 9's website and the FCEC website. Public Notices announcing the formal public comment period were published in several large and small local newspapers: Los Angeles Times, San Pedro Daily Breeze, Long Beach Press-Telegram, and the Santa Monica Press.

The Proposed Plan formal public comment period ran from June 15, 2009 to July 15, 2009. There were no requests for extensions. EPA held three public meetings in Southern California to provide ample opportunities for affected parties from different communities to comment on the Proposed Plan. Each public meeting began with a one-hour open house that included display tables from the Natural Resource Trustees on ecological restoration, FCEC information in Spanish, Vietnamese, Chinese and English on the contaminated fish, an EPA display on sediment remedies, and information on the new State fish advisory. The open house before the public meetings allowed members of the public to converse with EPA, FCEC, and Natural Resource Trustee representatives. The first meeting included a presentation from the State of California Office of Environmental Health Hazard Assessment (OEHHA), announcing the new fish advisory for the Palos Verdes Shelf area. Seven newspaper and radio reporters attended the public meetings, including two reporters who had written articles earlier in the month announcing the PV Shelf proposed plan meetings. The AP reporter attended the first public meeting and prepared a story explaining the proposed plan that was picked up by 200 outlets.

Over 80 people attended the proposed plan public meetings. Seventy-five individuals signed up for the FCEC e-newsletter, 12 individuals gave oral comments, primarily asking questions on remedy implementation.

EPA's response to the comments received during the comment period is included in the Responsiveness Summary, which is Part III of this Interim Record of Decision.

4.0 SCOPE AND ROLE OF THE RESPONSE ACTION

This section describes the overall cleanup strategy for the Palos Verdes Shelf, including the planned sequence of actions, the scope of the problems the actions will address, and the authorities under which action will be implemented.

PV Shelf is OU5 of the Montrose Chemical Superfund site; however, its response actions, enforcement activities, and investigations have proceeded apart from the other Montrose site operable units. The Consent Decrees entered into by the potentially responsible parties (PRPs) are for PV Shelf and the special account funds are for PV Shelf activities. Because of the special account, EPA has been able to direct response and remedial actions for PV Shelf as if it were a fund-lead site. While remediation issues at PV Shelf are unique, coordination with the investigation and cleanup activities for the other Montrose OUs is done to ensure that any common or interdependent issues are identified. For example OU2, the current stormwater pathway that terminates in the Consolidated Slip in Los Angeles Harbor, is also a surface water/sediment OU with DDT as a contaminant of concern. However, the slip is protected and in shallow water. Also, its source of contamination is different from that of PV Shelf, i.e., current stormwater pathway vs. the JWPCP outfalls.

5.0 SITE CHARACTERISTICS

The following sections provide an overview of the area's geology, meteorology, local oceanography, and ecology. Other sections discuss the nature and extent of contamination, and the conceptual site model for the PV Shelf Study Area.

5.1 Site Overview

The PV Shelf is a narrow part of the continental shelf off the Palos Verdes Peninsula along the coast of Southern California. North of PV Shelf is Santa Monica Bay and south, San Pedro Basin. About 42 kilometers from PV Shelf is Catalina Island, the Channel Island nearest to PV Shelf. The PV Shelf is about 1.5 to 4 kilometers (km) wide, up to 25 km long, and has a slope of 1 to 4 degrees. A shelf break (i.e., a zone of transition from the relatively flat shelf to the steeper continental slope) occurs at water depths of 70 to 100 meters (m). The continental slope extends seaward from the shelf, with a width of approximately 3 km and an average slope of 13 degrees, to a depth of approximately 800 m (Lee, 1994). The PV Shelf Study Area is defined as the area of the shelf and slope between Point Fermin and Redondo Canyon from the shore to the 200-m isobath, as shown in Figure 1.

5.1.1 Geologic Conditions

The PV Shelf and Palos Verdes Peninsula are parts of the California continental borderland, which extends from Santa Barbara to Vizcaino Peninsula in Baja California. This area includes the Los Angeles Basin and the offshore islands of Southern California (Francis et al., 1999). The Palos Verdes Peninsula is a tectonic fault block of seafloor sediment and volcanic debris draped atop a submerged mountain of metamorphic rocks that began rising out of the Pacific Ocean 1.5 million years ago (Morris, 2000). The PV Shelf is a submerged continuation of the peninsula and extends approximately 4 km offshore to the southwest.

5.1.1.1 Seismology

The Palos Verdes Fault Zone is one of several major fault zones in the Los Angeles Basin and adjoining offshore areas in the California continental boundary. The Palos Verdes Fault is a major fault in the fault zone that extends northwest to southeast, approximately parallel to the southwest coastline. The fault cuts the land northeast of the Palos Verdes Peninsula approximately 6 km from the southwest shore, and continues southeastward through the San Pedro Shelf (USGS 2004). The Palos Verdes Fault has been estimated to be capable of producing a major earthquake, i.e., magnitude 7 on the Richter scale (McNeilan et al., 1996). Recent earthquakes at Whittier Narrows (1987, magnitude 5.9) and Northridge (1994, magnitude 6.7) provide a measure of the regional seismic hazard along onshore faults. Because ongoing landslide activity exists on Palos Verdes Peninsula under relatively calm seismic conditions, large, sudden-mass-wasting events from the Peninsula could occur during a significant earthquake. Approximately 0.8 cubic kilometers of sediment was involved in the submarine Palos Verdes debris avalanche that occurred 7,500 years ago (Normark et al., 2004).

5.1.1.2 Sedimentology

Sediment in the PV Shelf come from several sources: natural sources, such as local urban rivers, cliff erosion, and the San Pedro Basin, as well as anthropogenic sources, such as the Portuguese Bend Landslide and the discharge from the LACSD outfalls at White Point (Lee et al., 2002). The primary sources of sediment in the last half century were the Portuguese Bend Landslide (PBL), an ancient landslide that was reactivated in 1956 during road construction, and the LACSD outfalls. After the landslide material reaches the beach, littoral currents move it southeast toward White Point, while bottom currents at depths of 30 m or more tend to move the material northwest (LACSD, 2005).

The LACSD outfalls began discharging in 1937. Discharge of solids from the LACSD outfalls peaked in 1971 and has steadily declined in response to a series of treatment plant upgrades. The implementation of full secondary treatment in November 2002 reduced total suspended solids (TSS) in the effluent to approximately 8,000 tons/year (LACSD, 2005). Kayen et al. (2002) estimates that between 1937 and 1987, the LACSD outfalls contributed 4.0 million metric tons of sediment to the PV Shelf and that the Portuguese Bend Landslide contributed between 5.7 and 9.4 million metric tons. Myers (1974) has documented that the effluent solids have a significantly higher organic matter content that the PBL sediment.

The thickness of naturally occurring shelf sediments varies, ranging from 32 m on the southeastern part of the shelf to less than 10 m near Pt. Vicente. As a result of near-bottom currents, a patchy, thin sediment layer with areas of bare rock occurs at the shelf break (Palermo, 1994). Similar bedrock outcrops also occur over the seafloor to the east of the outfall and over the Redondo Shelf to the west (Lee, 1994a). Less than one meter of sediment covers the Redondo Shelf (Drake et al. 1994).

5.1.2 Physical Oceanographic Conditions

Dominant circulation patterns in the Southern California Bight include the southward flowing California Current, the northward-flowing California Countercurrent, and seasonal influences by the northward-trending Davidson Countercurrent (Drake et al. 1994; Hickey, 1992). Surface and bottom waters are typically separated from spring through fall by a pycnocline (a zone having strong vertical gradients in seawater density) occurring at depths of 10 to 30 m. Currents below the pycnocline on the shelf generally flow to the northwest, parallel to bathymetric contours. In contrast, surface currents flow predominantly southeastward, although they shift to a westerly flow in late autumn and winter when westerly winds weaken (Hickey, 1992).

5.1.2.1 Waves

Local wind-generated waves are relatively unimportant because: 1) wind waves are small due to limited fetches, and 2) depths of contaminants are relatively deep, so only long-period waves reach the bed. Waves from the open Pacific are important, and although sheltering by the Channel islands partially protects PV Shelf, Pacific swells are frequently large enough to suspend sediment in shallow water (30 m). Waves are largest in winter, and can occasionally (~ 10 storms/year) resuspend sediment across the PV Shelf. Winter storm waves typically have maximum heights of 3 to 4 m, although wave heights up to 7 m were observed during major storms occurring in the 1980s (LACSD, 1995).

5.1.2.2 Currents

Regional oceanography is not dominated by tides or winds. The general circulation is mostly forced by meteorology and water properties over a region extending hundreds, even thousands, of kilometers from the site. Waves and currents at the site are not controlled by local winds. Tides are complicated because: 1) regional topography is complicated, 2) PV Shelf is a narrow strip of shallow water adjacent to a deep basin, and 3) water in the SCB is stratified by temperature and salinity gradients, so in addition to currents forced by regional meteorology and tides, currents are caused by internal oscillations of the stratified waters. These include internal tides, internal waves, and solitons (solitary internal waves). Seasonal changes in water temperature influence the internal motions.

Currents in the vicinity of the JWPCP outfalls vary seasonally as a result of changes in wind patterns and periodic storms, typically in winter or early spring. Average current velocities near the bottom are 7-10 centimeters per second (cm/sec) throughout the year (LACSD, 1995).

5.1.2.3 Flow

Flow on the PV shelf has a long-term mean direction toward the northwest, but flow strength varies seasonally and sometimes reverses in surface waters in summer. The cumulative effect of tidal and low-frequency currents at the study area is to disperse materials predominantly along isobaths in both upcoast and downcoast directions, with an overall upcoast (NW) tendency. Overall strength and variability of near-bottom currents is higher at both ends of the study area (on the San Pedro Shelf to the southeast and near Pt Vicente to the northwest). Flows are generated near the bottom by internal motions, and the strength of these varies with location (and maybe season).

Sediment transport follows the predominant direction of the near-bottom flow, extending northwestward along the shelf (Drake et al. 1994). This is also reflected in the along-shore shape of the contaminated sediment deposit and resulting contaminant footprint, extending away from the JWPCP outfalls.

5.1.3 Ecology

In general, the PV Shelf region is characterized by: 1) hard-bottom (rocky) habitat, including some kelp bed areas and associated invertebrate, fish, and algae communities, from shore to at least 20 m of water depth; 2) soft-bottom habitat, including invertebrate and fish communities, over most of the rest of the shelf and slope region to a water depth of at least 600 m; and 3) pelagic or water column zones, representing important habitat for fish, invertebrates, birds, and mammals from near the sea floor to the water surface. The exception to this pattern is the hard-substrate, artificial reef habitat represented by the White Point outfall pipes that extend primarily over soft-bottom areas to a water depth of approximately 60 m, with some hard-bottom areas scattered along the shelf, and more extensive hard-bottom areas paralleling the shelf break.

Diverse marine habitats and biological communities typify the PV Shelf and the broader SCB. Under the National Pollutant Discharge Elimination System (NPDES) permit requirements, LACSD conducts an ocean monitoring program that monitors water quality, sediment, and biota. The following sections draw upon the extensive monitoring record compiled by LACSD. Figures 2 and 3 show the sediment and trawl monitoring stations.

5.1.3.1 Invertebrate Community

The infaunal community (invertebrates living in soft sediment) on the PV Shelf and slope include the full range of feeding types, such as deposit feeders, suspension feeders, and predators representing numerous phyla. The macrofauna community is numerically dominated by surface and subsurface deposit-feeding polychaete worms, which comprised 75 percent of the total abundance in benthic macrofauna collected at 44 monitoring stations in 2004 (LACSD, 2005), followed by crustaceans at 9 percent, and small bivalves at 7 percent. Most of the dominant species show significant correlations in their distribution with depth, grain size, and sediment chemistry.

In addition to the infaunal community surveys, LACSD has conducted trawl surveys of fish and invertebrates along the PV Shelf and slope since the early 1970s. Populations have fluctuated significantly over the years primarily in response to climatic factors. Temporal variability has exceeded spatial variability, with major shifts in abundance associated with El Nino events. In the 2004 survey (LACSD, 2005) crustaceans were the most diverse group, followed by echinoderms and mollusks. The most abundant species were the northern heart urchin and the seastar, who together comprised 95 percent of the epibenthic invertebrate catch.

5.1.3.2 Fish Community

The PV Shelf and upper slope sediment are characterized by several species of flatfish (*Pleuronectiformes*) that have been dominant over 33 years of trawl sampling, with relative abundance increasing since the mid-1990s. Rockfishes (*Scorpaeniformes*) also are common and diverse, as are several families represented by a single, or few, species. Single surveys have regularly recorded more than 100 species in quarterly trawl surveys from 12 stations at different depths. The most recent sampling (2005) collected representatives of 31 families.

White croaker (*Genyonemus lineatus*) is an inner shelf species that has DDE tissue burdens that are of human health concern. They are a dominant species in the Los Angeles Harbor and generally common in near-shore waters of the Southern California Bight (Cross and Allen, 1994). The distribution of white croaker in relation to contaminants is of particular importance because of historically high levels of DDT bioaccumulation in the species, which led to a commercial-catch ban and recreational-batch limits for this fish in the PV Shelf Study Area. White croaker was one of the top three fish species taken on the 23- and 61-m isobaths during the mid-1970s and early 1980s. In the past 20 years, its abundance at the 61-m depth has declined significantly and it is no longer a dominant member of the demersal fish catch.

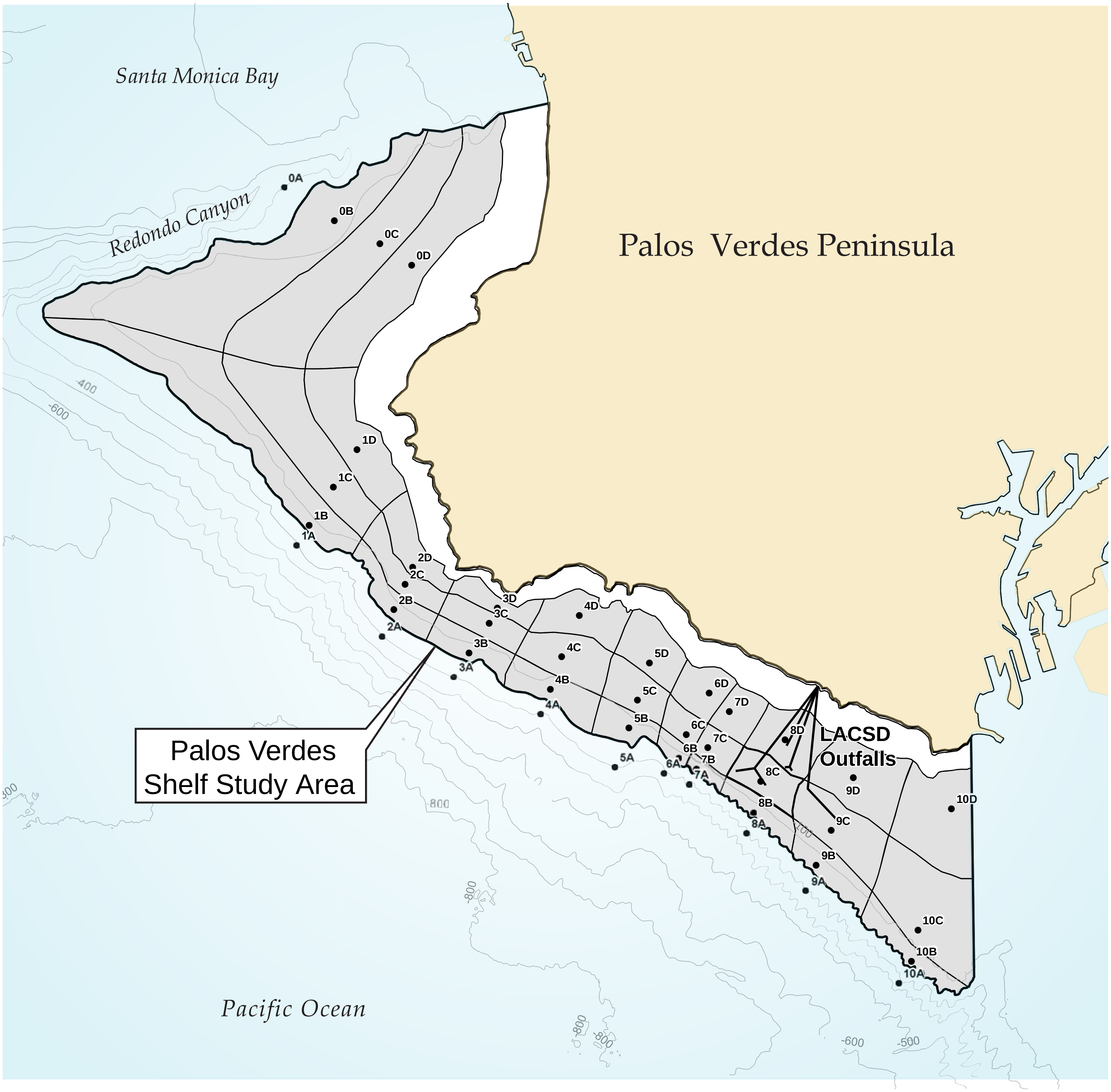
Pelagic fish include many relative large, far-ranging species (e.g., tuna, mackerel, bonito, and barracuda) but also numerous small forage fish (e.g., anchovies, sardines, and smelts). Mackerel and forage fish, in particular, can be abundant in the Palos Verdes region.

5.1.3.3 Kelp Community

The giant kelp (*Macrocystis pyrifera*) is a keystone species that provides refuge and a source of food for many fish and invertebrate species. The extent of kelp beds has been extremely variable over time. In 1911 surveys, kelp canopy coverage near the PV Shelf Study Area was estimated to be over 1,500 acres (LACSD, 1996). By the late 1950s, giant kelp had disappeared from PV Shelf rocky subtidal areas, attributed, in part, to wastewater discharges that reduced light penetration, buried the substrate and introduced toxicants (Stull, 1995). Transplantation efforts helped reestablish kelp near the Palos Verdes Peninsula, although the kelp beds suffered severe damage during winter storms in 1983 and 1988.

5.1.3.4 Marine Birds and Mammals

Many migratory and resident marine and aquatic-feeding bird species occur near the PV Shelf Study Area. These include a variety of pelagic, shelf, and near-shore species, many of which are far-ranging throughout the Bight or are seasonally migratory. Some of the most common species are cormorants (*Phalacrocorax spp.*), California brown pelicans, gulls (*Larus spp.*), terns (*Sterna spp.*), storm petrels (*Hydrobatidae*) and grebes (*Podicipedidae*).



Abbreviations

LACSD - Sanitation Districts of Los Angeles County

Legend

• LACSD Sediment Sample Station

Notes

1. Isobaths are in meters.

0 2 4

Approximate Scale (Miles)

Feasibility Study/Record of Decision Support
Palos Verdes Shelf
Los Angeles County, California

FIGURE 2
Layout of Grid Cells

Projects\07163.0000 EPA Region 9\0010 TO 9 PV Shelf FS ROD\7.0 Graphics\6.2 Tech Memo Graphics\PVS_0060 FS.ai

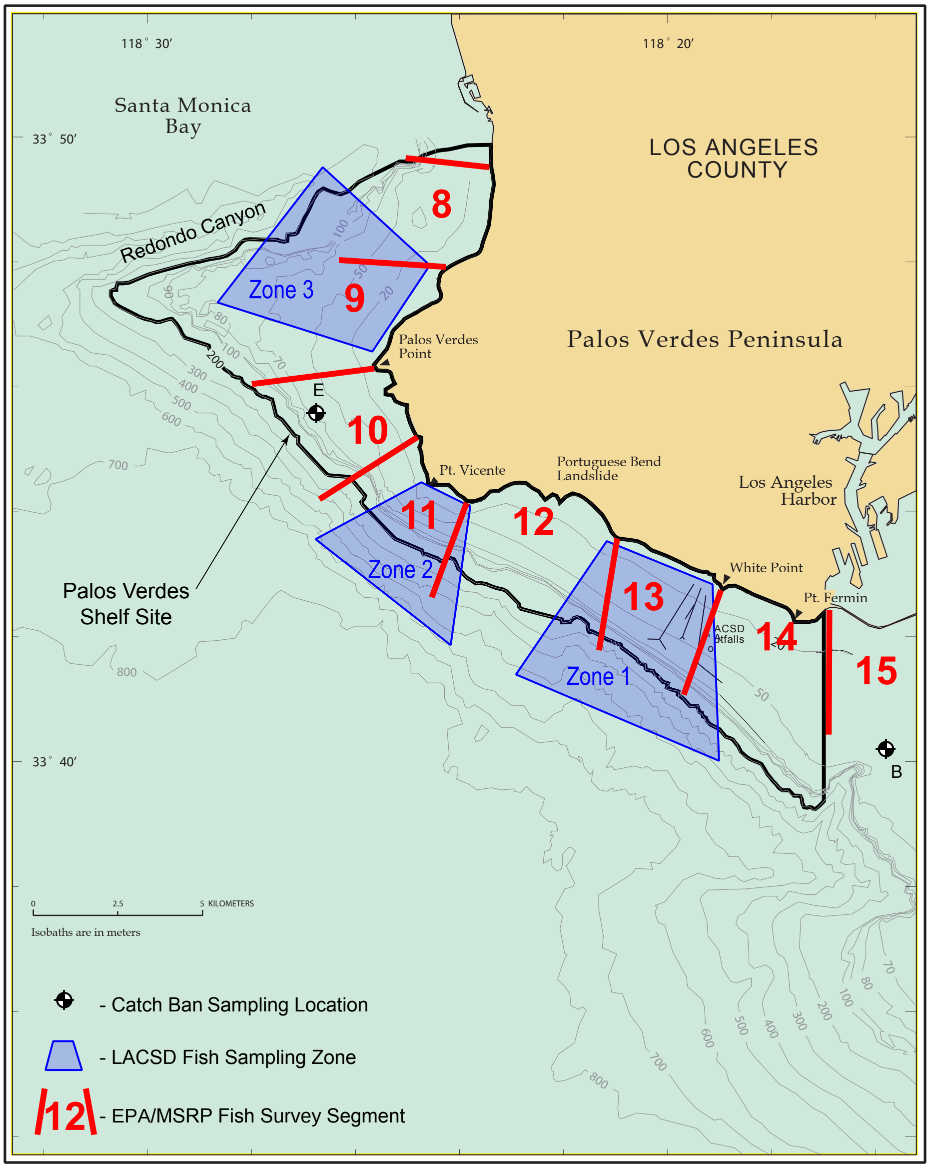


FIGURE 3
EPA, MSRP and LACSD 2002
Fish Sampling Locations

Birds listed by the Federal or State of California government as threatened or endangered include the bald eagle (threatened), peregrine falcon (recently delisted), and California brown pelican (2008 petition for delisting under review). Brown pelicans nest on the Northern Channel Islands, offshore of Southern California and feed near the PV Shelf. Additional breeding colonies exist on Islas Los Coronados in Mexico off the Baja California peninsula. Historically, bald eagles and peregrine falcons nested on the Channel Islands (Kiff, 1980). Efforts to reintroduce peregrine falcons and bald eagles to the Channel Islands are succeeding. Peregrine falcon populations are nesting on San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara (Walton, 1997) and bald eagles are nesting on Santa Cruz, Santa Catalina, and Santa Rosa islands (MSRP, 2009).

Marine mammals (e.g., pinnipeds and dolphins) are important predators of many fishes and some invertebrates, particularly in the pelagic zone, with many pinnipeds also feeding extensively in kelp bed habitats. Marine mammals occurring in the Palos Verdes region include both migratory and year-round residents. Seals and sea lions have well-established breeding colonies in several areas of the Bight, particularly in the northern Channel Islands.

5.2 Conceptual Site Model

Information on the sources of contaminants, fate and transport mechanisms, exposure pathways and receptors is used to develop a conceptual understanding of a contaminated site. Figure 4 shows the conceptual site model (CSM) for the PV Shelf Study Area, including past sources of contamination (outfalls) existing sources of contamination (effluent-affected sediment), affected media (sediment and water), known and potential routes of migration (water), and known or potential human and environmental receptors (benthic organisms, fish, anglers).

5.2.1 Nature of Contaminants

The chemicals of concern (COCs) are DDT and PCBs. These compounds are almost insoluble and tend to be sorbed to particles and colloids, particularly the organic fraction. Both DDT and PCBs are considered persistent organic pollutants. Nevertheless, there is evidence that DDT is breaking down within the sediment deposit; however, there is no evidence that PCBs are being degraded or transformed. Both DDT and PCBs are probable carcinogens that bioaccumulate and also have non-carcinogenic impacts.

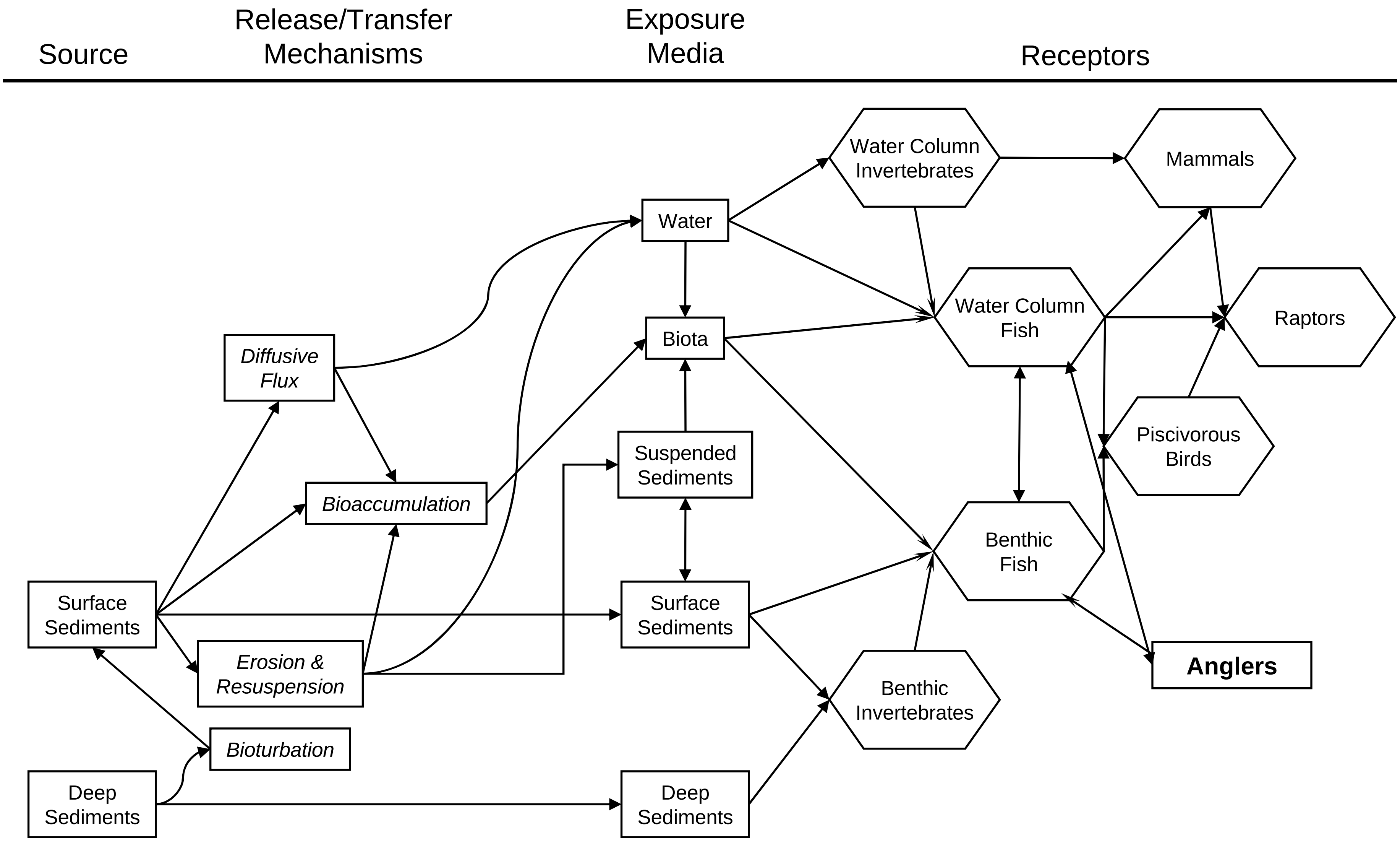
5.2.2 Location of the Contaminants

5.2.2.1 Southern California Bight

COCs sorbed to particulates and dissolved in seawater have been widely dispersed throughout the Southern California Bight from the PV Shelf. Much of the effluent never settled on the PV Shelf but was transported to deeper water or adjacent regions (i.e., Santa Monica Bay, San Pedro Shelf) by tidal currents and regional circulation patterns. Some of the effluent settled temporarily on the PV Shelf, but was subsequently remobilized and dispersed. Through this process, the PV Shelf has acted as a source of contamination for the region long after the discharge of contamination stopped.

The Southern California Coastal Water Research Project (SCCWRP), a consortium of Southern California agencies and organizations, has studied the SCB extensively. Its 2003 survey of the SCB found 71 percent of the SCB had detectable levels of DDT and 12.8 percent of the SCB had

Figure 4: Conceptual Site Model



Key: Surface sediments: top 15 cm
Deep sediments: below 30 cm

detectable levels of PCBs (see Figures 5 and 6). The Bight '03 survey determined that the greatest mass of DDTs and PCBs reside in the upper slope (200-500 m depth) (SCCWRP, 2006).

5.2.2.2 Palos Verdes Shelf Study Area

Of the estimated 800 to 1000 tons of DDT that was discharged from the outfalls (DOJ 2000), about 10 percent settled on PV Shelf and slope. Studies in 1992 for the Natural Resource Damage Assessment (NRDA) (Lee et al., 1994) indicated that a 5-cm to 60-cm-thick elliptical-shaped, deposit of effluent-affected sediment extended over most of the shelf and slope from White Point to Point Vicente. The EA deposit of cohesive, fine-grained, organic-rich, contaminated material combined with material from other sources (most notably, erosion from the Portuguese Bend Landslide) formed an estimated total volume of over 9 million cubic meters that covered more than 40 square kilometers. Of that total volume, 70 percent occurred on the shelf and 30 percent on the slope. The masses of DDTs and PCBs remaining in sediments at the PV Shelf have been estimated at 110 and 10 metric tons, respectively.

The shore side of the EA deposit ends relatively sharply at the 30-m depth contour, while the ocean side extends over the PV Shelf break to the mid- to lower slope. Cross-shore, the thickest part of the EA deposit extends along the 60-m isobath. Along-shore, the deposit is thickest (60+ cm) near the 90-inch outfall. It thins rapidly toward the southeast, just exceeding 15 cm a kilometer from the outfall. It tapers much more gradually toward the northwest. About 12 km northwest from the outfalls, the effluent-affected deposit is still 25 cm thick. This elliptical shape of the deposit is consistent with bi-directional dispersion from the outfall that has been skewed upcoast in the direction of the long-term average current. On the northwest end, the increased thickness of the effluent-affected deposit and lower contaminant concentrations also suggest mixing of Portuguese Bend Landslide sediment.

5.2.2.3 COCs in Sediment

Contaminant concentrations are lowest in the surface sediment (top 5-20 cm of the deposit) and much higher in the older and more deeply buried layers of the deposit. Despite reductions in the discharge of suspended solids, a large mass of effluent-affected sediment remains on the PV Shelf and slope. The sediments can be categorized into three layers (Eganhouse and Pontolillo, 2000):

- Native Sediment –Native sediment pre-dates the outfall construction. The native sediment is coarser, has less organic material, and is less cohesive. It was supplied by local rivers and by erosion of the coastline, including the Portuguese Bend Landslide. Generally, the EA deposit lies on top of the native sediment. However, in waters less than 40 m deep, where bottom wave activity is higher, sediments are generally sandy, and there is no obvious layer of EA sediment on top of pre-effluent sediment. Some EA material may be worked into surface sediment at these inshore regions; however, wave activity kept EA sediment from accumulating. Native sediments are characterized by higher bulk densities and lower organic carbon content.

- Heavily Contaminated Sediment – Above the native sediment exists a heavily contaminated layer approximately 20 to 25 cm thick. These sediments have the highest levels of contamination and slightly higher water content, consistent with more rapid deposition when large amounts of highly contaminated sediment were discharged from the outfalls. They are characterized by clay and silts, significantly elevated organic carbon content, and low bulk densities, i.e., high water content. These sediments were deposited when discharges from the outfalls contained high levels of suspended solids, DDTs, and PCBs.

Figure 5: Total DDT, Bight '03

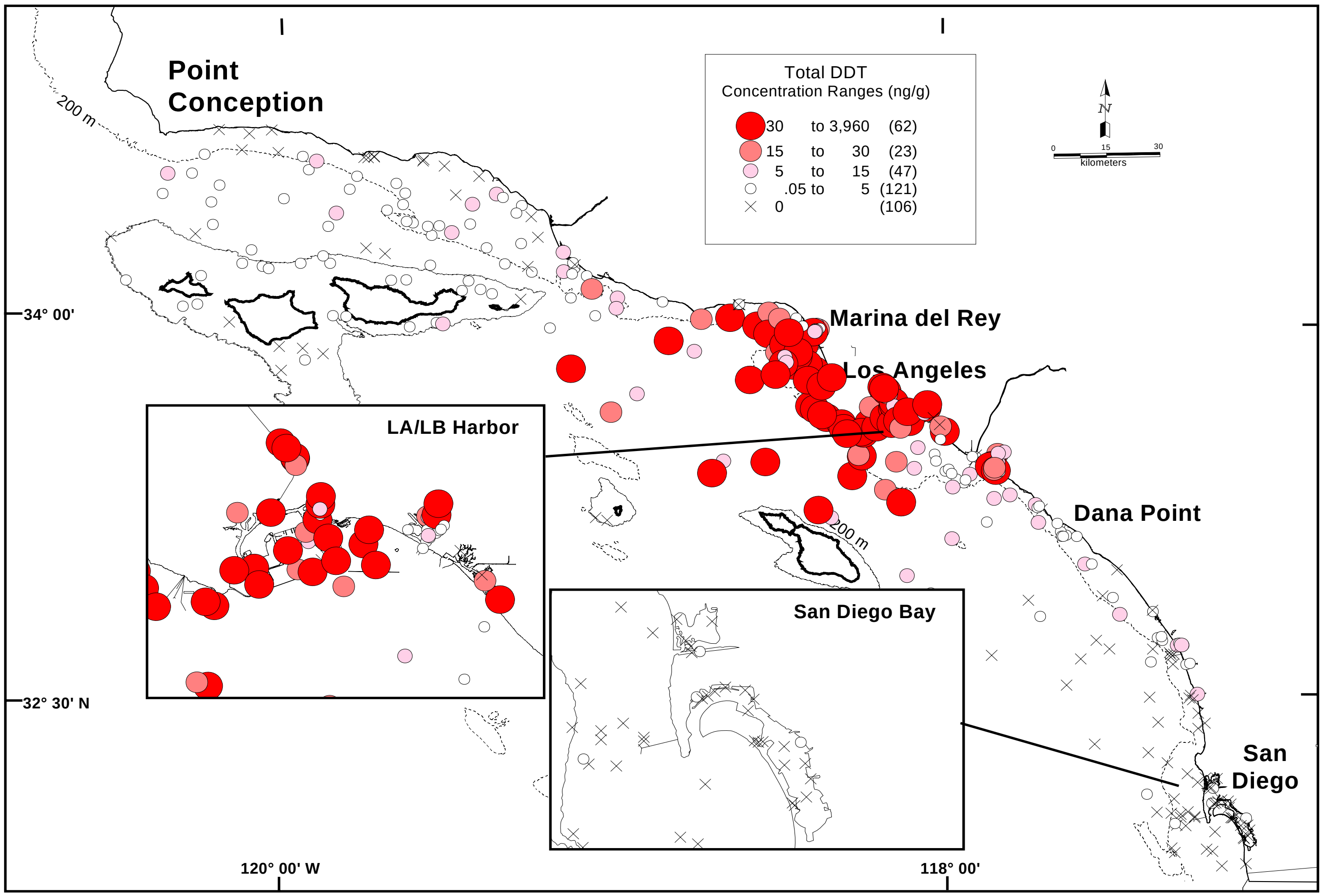
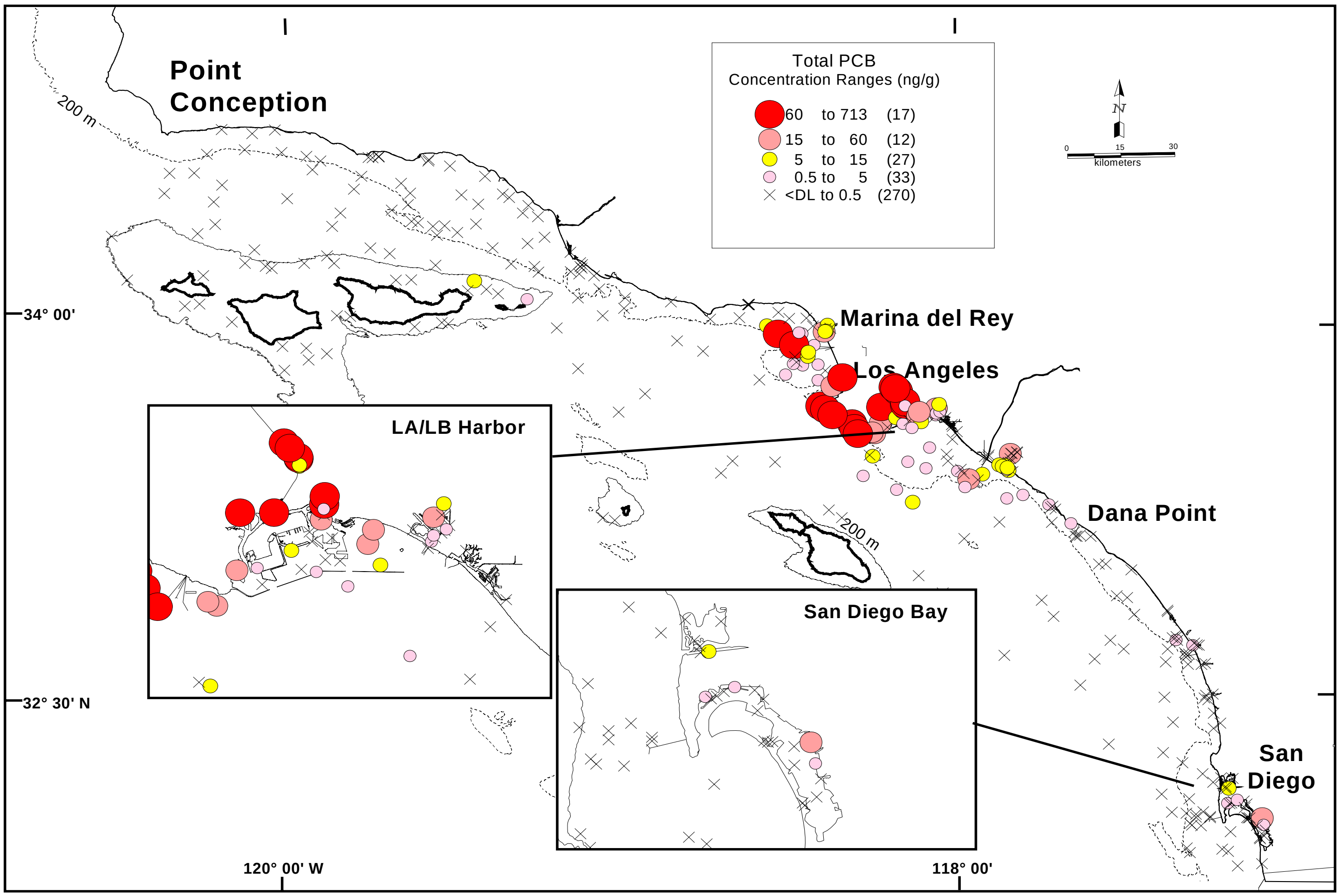


Figure 6: Total PCB, Bight'03



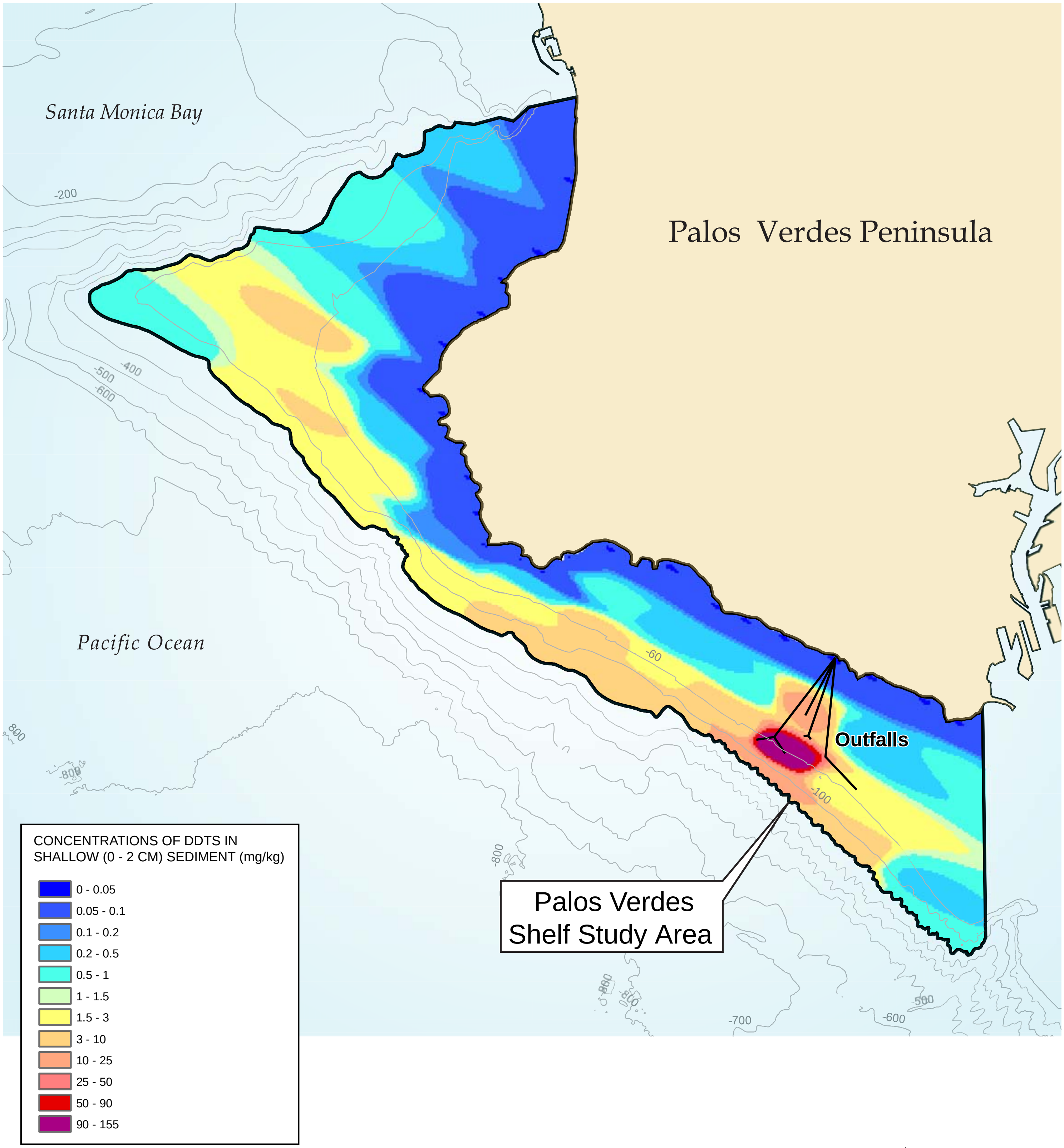
- Surficial Sediment – These sediments in the upper 15 to 20 cm are characterized by lower concentrations of DDTs and PCBs, they are more uniform, and have higher bulk densities, and slightly elevated organic carbon concentrations. The properties of the surface layer are consistent with lower deposition rates of less contaminated material and physical reworking by waves, currents and benthic invertebrates. This is the most biologically active layer of sediment.

Table 5-1 shows changes in COCs in surface sediment over time. Figures 7 and 8 show current extent of COCs in surface sediment.

Table 5-1: Trends in Surface Sediment (0 to 2 cm) Concentrations of DDTs and PCBs in mg/kg dry weight

Data from LACSD Biennial Monitoring Reports. See Fig. 2 on p. 19 for sampling station locations.

LACSD Station	1992		2002		2004		2006	
	DDTs	PCBs	DDTs	PCBs	DDTs	PCBs	DDTs	PCBs
0B	0.6	ND	0.9	0.1	0.8	0.1	0.9	0.1
0C	0.9	ND	0.9	0.1	0.8	0.1	0.6	ND
0D	0.2	ND	0.2	ND	0.3	ND	0.2	ND
1B	2.4	0.3	2.1	0.2	1.3	0.2	1.3	0.1
1C	3.4	0.4	1.9	0.2	2.4	0.3	1.8	0.2
1D	0.6	ND	0.2	ND	0.5	0.1	0.2	ND
3B	4.0	0.5	4	0.6	3.2	0.4	2.6	0.3
3C	5.1	0.5	2.4	0.5	2	0.3	1.5	0.2
3D	1.2	ND	0.4	ND	0.5	0.1	0.3	ND
5B	19.9	2.5	2.3	2.1	10.3	1.6	5.9	1.0
5C	11.3	1.6	3.8	1.1	1.4	0.4	2.9	0.2
5D	0.9	0.1	0.7	0.1	0.3	ND	0.3	ND
6B	17.3	3.2	11	2.3	7.2	1.9	6.5	0.6
6C	12.4	1.6	4.3	1.0	3.6	0.5	2.9	0.2
6D	0.8	ND	0.6	0.2	0.4	ND	0.3	ND
7B	18.7	1.5	15	3.6	11.3	1.7	12.7	2.7
7C	15.3	2.1	3.8	0.6	2.9	0.4	2.1	0.1
7D	0.6	ND	0.6	ND	0.5	ND	0.3	ND
8B	27.7	2.4	13	1.8	18.6	3.6	10.8	1.8
8C	21	2.1	76	2.8	205	3.3	53	1.6
8D	0.6	ND	26	0.1	0.4	ND	0.3	ND
9B	9	0.9	10	1.7	5.8	0.8	3.2	0.3
9C	1.8	ND	1.2	0.1	2.0	0.1	0.9	ND
9D	0.6	0.1	0.4	ND	0.3	ND	0.2	ND

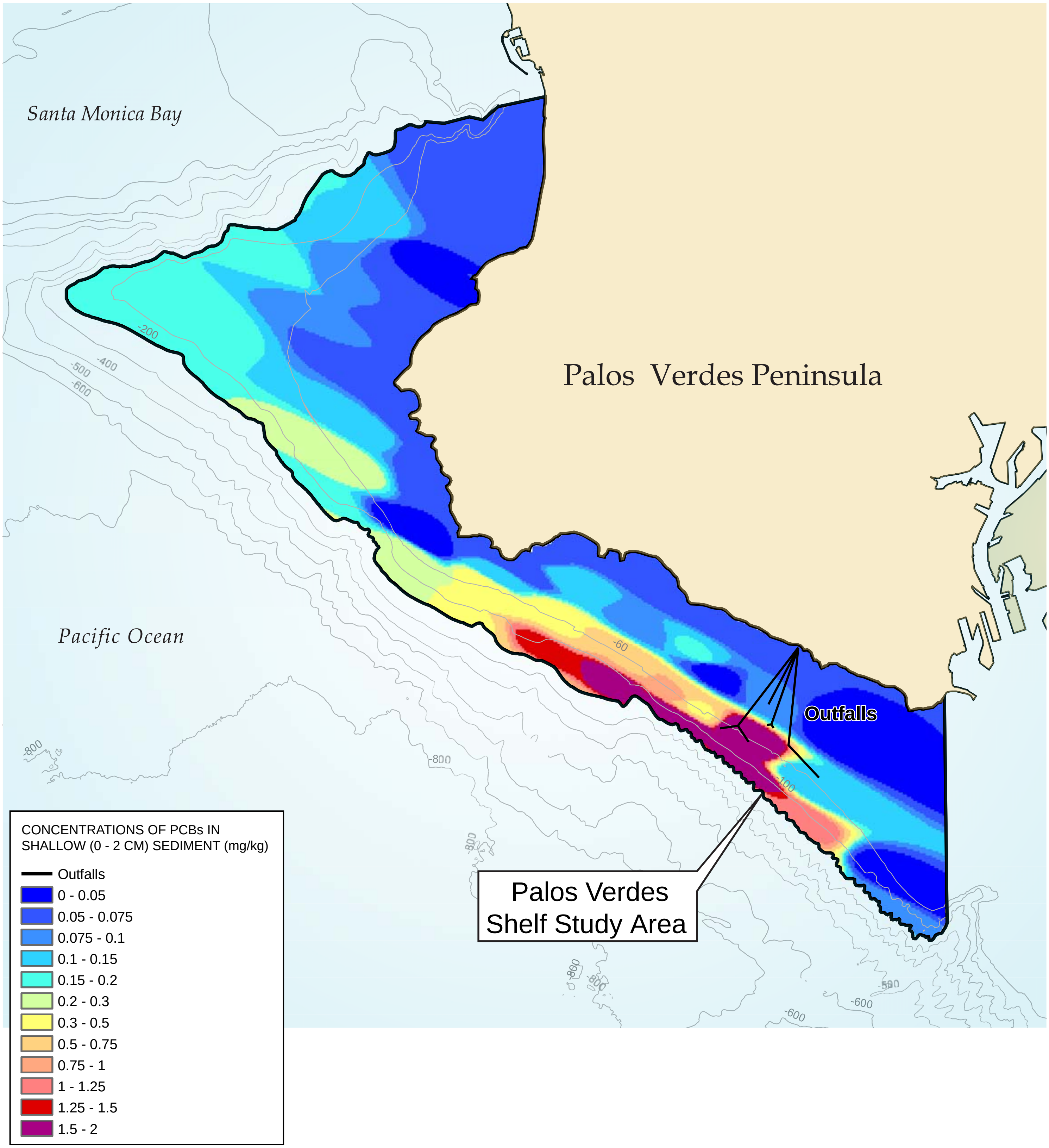


Notes

1. Isobaths are in meters.
2. In addition to the 2002/2004 LACSD data, this figure uses four Bight '94 samples, one 1993 LACSD sample, and two 1992 NOAA samples to provide actual concentrations of DDTs between the 0 and 1 transects and north of the 0 transect. Shoreline concentrations have been set at 0.05 mg/kg for contouring.

Record of Decision
Palos Verdes Shelf
Los Angeles County, California

FIGURE 7
Interpretive DDT Concentrations



Notes

1. Isobaths are in meters.
2. In addition to the 2002/2004 LACSD data, two simulated transects were inserted between the 0 and 1 transects to approximate sediment concentrations where no data exist. The simulated transects were set as an average of the 0 and 1 transect concentrations. Shoreline concentrations have been set at 0.05 mg/kg for contouring.

0 2 4
Approximate Scale (Miles)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	**Record of Decision** Palos Verdes Shelf Los Angeles County, California	**FIGURE 8** Interpretive PCB Concentrations

5.2.2.4 COCs in Water

Water column data collected in 1997 (Zeng, 1999) measured concentrations of DDE and PCBs at different locations and depths across PV Shelf in winter and summer. DDE and PCB concentrations exceeded the ambient water quality criteria (AWQC) for human health in all samples. All samples except one exceeded the ecological health criterion for DDT. No water sample exceeded the PCB ecological standard of 30 ng/L.

Table 5-2: Contaminant Concentrations in Water Column 1 m to 35 m from Seabed

AWQC for human health: 0.22 ng/L DDE and 0.064 ng/L for PCBs				
LACSD Station	Winter Sampling (1997)		Summer sampling (1997)	
	DDE (ng/L)	PCBs (ng/L)	DDE (ng/L)	PCBs (ng/L)
3C -1 meter	4.5	0.28	7.6	0.94
5C -1 meter	9.2	0.51	10.4	1.14
6C -1 meter	14.2	0.88	8.7	0.84
6C -2 meter	15.8	0.89	10.3	1.11
6C -5 meter	7.6	0.41	8.6	0.94
6C -20 meter	2.8	0.21	2.0	0.28
6C -35 meter	0.8	0.06	0.6	0.21
7C -1 meter	9.9	0.65	5.5	0.56
9C -1 meter	5.3	0.31	5.0	0.30
6B -1 meter	5.4	0.33	5.6	0.52
6D -1 meter	7.2	0.48	3.0	0.67

Key: ng/L = nanograms per liter

In summer 2003, the water column 2 meters above the sediment bed over station 6C (see Figure 2) was sampled for PCBs. PCB concentrations totalled 1.11 ng/L in 1997 and 0.56 ng/L in 2003 (Zeng, 2004). While this is only one data point, it suggests contaminant concentrations in water may be dropping. Additional sampling and analysis are necessary in order to calculate if the PCB human health criteria of 0.064 ng/L can be achieved.

5.2.2.5 COCs in Fish

Similar to reductions in sediment and water, LACSD monitoring has shown reductions of COCs in fish. White croaker are a local bottom-feeding species that typically has the highest concentrations of DDTs and PCBs of any fish caught in the PV Shelf area. Every year the LACSD analyzes 10 white croaker from three locations (see Figure 3) as part of its NPDES requirements. Zone 1, near the outfalls, is the area where the most contaminated fish are found. Zone 3, across from Redondo Canyon, is sheltered from the prevailing currents and serves as a reference point.

Table 5-3. Trends in White Croaker Contaminant Concentrations (mg/kg), LACSD Bioaccumulation Trend Data

Year	Zone 1		Zone 2		Zone 3	
	DDTs	PCBs	DDTs	PCBs	DDTs	PCBs
1999	26.41	1.60	6.01	0.68	4.25	0.02
2001	25.39	1.88	5.45	0.54	2.51	0.14
2002	33.74	2.95	8.61	0.88	1.47	0.03
2004	10.82	1.19	7.05	0.92	1.61	0.08
2005	3.85	0.40	NA	NA	NA	NA
2006[a]	3.88	0.44	2.74	0.35	1.55	0.19

[a] In 2006, LACSD's changed its fish analysis to include PCB congeners instead of Aroclors and to analyze composites of 10 fish from each zone instead of individual fish.

5.2.2 Contaminant Fate and Transport Processes

As part of the Natural Resource Damage Assessment of the Palos Verdes margin, the U.S. Geological Survey (USGS) and its co-investigators were asked to provide a quantitative prediction of the fate of the effluent-affected (EA) sediment deposit and associated contaminants, DDT and PCBs, that had accumulated on the PV Shelf and slope. The research specifically addressed the question of the fate of the contaminated sediment under natural recovery conditions. The expert report (Drake et al., 1994), produced in 1994, used data collected in 1992 and earlier. A supplement to the report was issued in 1996 (Sherwood et al., 1996) using additional sediment data from 1991 and 1993. In 2000, the USGS revisited natural recovery predictions using new data to further refine the predictive model developed in 1994 (Sherwood et al., 2002). These reports form part of the PV Shelf Feasibility Study as Appendix B (EPA, 2009).

The reports concluded that the majority of the buried EA deposit north of the outfalls most likely would stay buried. Episodic events, primarily winter storms, would winnow out surface contamination associated with fine, EA sediment and bring in uncontaminated sediment, causing contaminant concentrations to drop in the short-term, i.e., the next ten years. The model indicated surface concentrations most likely would increase temporarily near the outfalls as sediment sources lapsed. However, surface contaminant concentrations would drop again below 1 mg/kg as new, uncontaminated material is added to the system.

Sherwood et al. (2002) continued to refine the model using field measurements, laboratory analyses, and calculations to set parameters for the model. Analyses of available data, including measurements made every two years from 1981 to 1997 by the LACSD, suggest that the area northwest of the White Point outfalls, represented by stations 3C and 6C, will remain depositional, even as anthropogenic particulate supplies decrease. At these sites, model predictions for 1991-2050 indicate that most of the existing inventory of DDE will remain buried and that surface concentrations will gradually decrease. Analyses of data southeast of the outfalls suggest that erosion is likely to occur in the southeast edge of the existing EA deposit, and model predictions for show that erosion and biodiffusion will re-introduce the DDE to the upper layer of sediment in this area, with subsequent increases in surface concentrations and loss to the overlying water column.

USGS is presently updating the predictive model using data collected since full secondary treatment was instituted at the JWPCP. The predictive model focused on DDE as the dominant contaminant on the shelf. Historical investigations found that PCBs were collocated with DDE, but at approximately one-tenth the concentration. Therefore, it was assumed that loss rates could be applied equally to both contaminants. However, data from 2005 confirmed that DDE is breaking down via a process called reductive dechlorination, while PCBs are not. New model parameters added transformation rates for DDE along with loss estimates; however, PCB-specific model runs were not performed. Data on the nature and extent of PCBs in the sediment deposit have not been collected since the 1992 NRDA. Filling this PCBs data gap is one of the studies needed before the predictive model can be applied to PCBs.

All of the important pathways for DDT and PCBs to humans and the environment pass through the PV Shelf surface sediment. The most important, measurable parameter is the level of contaminants in the biologically active top few centimeters of sediment. As the following table indicates, surface concentrations have dropped overall for both DDTs and PCBs.

Table 5-4: COCs in Surface Sediment 1992 vs. 2002/2004

Chemical Concentration	Total DDT		Total PCBs	
	> 10 mg/kg	> 1 mg/kg	> 1 mg/kg	>0.3 mg/kg
1992	8.2 km^2	44.5 km^2	8.4 km^2	22.5 km^2
2002/2004	3.6 km^2	39.1 km^2	6.2 km^2	13.7 km^2
Percent change	56% smaller	12% smaller	26% smaller	61% smaller

6.0 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

6.1 Current Use

The outfalls at White Point serve a population of 5.1 million people of Los Angeles County. Use of the outfalls will continue. Although PV Shelf is closed to commercial fishing for white croaker, the area is open for other commercial fishing and sports fishing. Sport fishing includes lobster and crab near-shore in the shallow waters of PV Shelf.

6.2 Anticipated Future Use

The State of California passed the Marine Life Protection Act in 1999, which directed the California Department of Fish and Game to reevaluate all existing marine protected areas (MPAs) and potentially design new MPAs that together function as a statewide network. The development and selection of MPAs is currently underway and it is likely that a new MPA will be designed that includes part of the PV Shelf Study Area. Under the MPA, fishing would be limited or banned outright; however, fishing will continue to be a popular activity in other, non-MPA parts of the PV Shelf Study Area.

7.0 SUMMARY OF SITE RISKS

The baseline risk assessment estimates risks the site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the IROD summarizes the results of the human health risk evaluation performed for the EE/CA and the baseline human health risk assessment technical memorandum performed for the Remedial Investigation, as well as the ecological risk assessment and food web model prepared for this site.

7.1 Chemicals of Concern

The chemicals of concern (COCs) are DDT and PCBs, which are found in the sediment and waters of PV Shelf, and in the biota residing on PV Shelf. Fish caught in the region contain unhealthy concentrations of COCs. The PCBs are the primary risk driver for human health while DDTs are the greater threat to ecological receptors. As described under the CSM, sediment and water do not pose a direct human health risk; rather, the health risk comes from fish that bioaccumulate contaminants found in the sediment and water. Since COCs in fish can not be controlled directly, the IROD sets cleanup levels for COCs in sediment and water, which are correlated to fish concentrations.

7.1.1 COCs in Surface Water and Sediment

As discussed in section 5.2.2.3, water column data collected in 1997 (Zeng, 1999) measured concentrations of DDTs and PCBs at different locations and depths across the PV Shelf. DDT and PCB concentrations exceeded the AWQC for human health in all samples. All samples except one exceeded the ecological health criterion for DDT. No water sample exceeded the PCBs ecological standard of 30 ng/L. See Table 5-2.

Table 7-1: COCs in Surface Sediment	**Chemicals of Concern**	
Medium: Sediment 2002/2004	Total DDT (detected in 88 of 88 samples)	Total PCBs (detected in 68 of 88 samples)
Minimum Concentration[1] (ppm)	0.13	ND
Maximum Concentration[1] (ppm)	205	3.56
Mean Concentration (ppm)	12	0.69
Median Concentration (ppm)	1.9	0.2
Background Concentration (SCB) (ppm)	0.020	0.003
Screening Toxicity Value ERM (ppm)	0.046	0.042
Screeming Toxicity Value Source[2]	NOAA ER-M	NOAA ER-M
Notes: 1 minimum/maximum detected concentration above the sample quantitation limit (SQL) 2 NOAA ER-M National Oceanic and Atmospheric Administration Effects Range - Medium		

Table 7-1 shows DDTs and PCBs in sediment across PV Shelf. These sediments are the source of COCs that enter the food chain, causing fish to pose a risk to receptors.

7.1.2 COCs in Fish

The *2002/2004 Southern California Coastal Marine Fish Contaminants Survey* (EPA/NOAA 2007) caught 23 species of fish from Ventura to Orange counties. The Supplemental HHRE used fish caught from Point Fermin to Redondo Canyon (*Fish Survey* segments 9, 12, 13/14, 15 and EPA B) (Figure 3). Table 7-2 lists twelve fishes that were caught along the PV Shelf and analyzed for DDTs and PCBs.

Table 7-2 Distribution of COCs in Fish collected in 2002/2004 Coastal Marine Fish Survey Coastal Area vs. PV Shelf Subset						
	Palos Verdes Shelf (Pt. Fermin to Redondo Canyon)			Coastal Area (Ventura Harbor to San Mateo Pt.)		
Fish Species	**No. of Samples**	**Total DDT (µg/kg)**	**Total PCBs (µg/kg)**	**No. of Samples**	**Total DDT (µg/kg)**	**Total PCBs (µg/kg)**
Barred Sandbass	*21*	744	84	*66*	344	62
Black Croaker	*5*	127	22	*35*	71	21
California Corbina*				*40*	54	30
California Halibut*				*24*	103	30
California Scorpionfish	*18*	605	67	*84*	314	57
California Sheephead*				*3*	609	68
Jacksmelt	*10*	10	2	*20*	26	5
Kelp Bass	*10*	249	40	*69*	227	63
Opaleye	*10*	0.66	6	*54*	1	30
Pacific Barracuda*				*20*	92	42
Pacific Chub Mackerel	*10*	29	9	*30*	52	16
Pacific Sardine	*5*	262	93	*20*	204	67
Queenfish*				*79*	65	22
Rockfish	*13*	225	29	*29*	181	32
Sargo*				*38*	98	58
Shovelnose Guitarfish*				*30*	87	33
Surfperches	*20*	122	15	*156*	87	33
Topsmelt	*10*	198	75	*30*	217	113
White Croaker	*45*	794	187	*349*	549	91
White Seabass	*9*	66	13	*9*	66	13
Yellowfin Croaker*				*30*	38	29

* Species not collected from PV Shelf
Note: Means were calculated as the non-weighted average of segment means for each species from *2002-2004 Southern California Coastal Marine Fish Contaminants Survey* (EPA/NOAA, 2007)

7.2 Exposure Assessment

As discussed under the conceptual site model, direct contact with the COCs is unlikely because of their depth. The pathway to human exposure is through consumption of fish. Both the streamlined Human Health Risk Evaluation (HHRE) conducted for the PV Shelf site in 1999 and the Supplemental HHRE technical memorandum conducted in 2006, concluded that fish consumption is the exposure pathway that poses the greatest level of risk to receptors.

Both the 1999 HHRE and the Supplemental HHRE relied on the *Santa Monica Bay Seafood Consumption Study* (SMBRP, 1994) to calculate fish consumption rates and exposure durations.

The study documented fish consumption rates of 338 boat anglers who reported consuming fish in the previous 4 weeks (28 days). Exposure durations used to quantify human health risks were based on the reported fishing durations of boat anglers in the study (SMBRP, 1994). Reported fishing duration reflected only the number of years the surveyed individuals had been fishing up to the time of the survey. Because no information was available on how long these individuals would continue to fish in the future, the reported fishing duration is not equivalent to total exposure duration. The 90th percentile reported fishing duration of 30 years was used to quantify the RME scenario; the mean reported fishing duration of 13.8 years was used to quantify the CTE scenario. Exposure point concentrations were assumed to remain constant for the selected exposure duration.

The following equation was used to calculate intake associated with the ingestion of carcinogenic and noncarcinogenic constituents in fish:

$$Intake = \frac{C_{fish} \ X \ IR_{fish} \ X \ EF \ X \ ED}{BW \ X \ AT}$$

Where:

Intake = constituent daily intake (mg/kg body weight/day)
C_{fish} = Chemical concentration in fish (mg/kg) (DDT and PCBs reported as micrograms per kilogram were converted to units of mg/kg for Exposure Point Concentration [EPC])
IR_{fish} = Fish ingestion rate (kilograms per day [kg/day])
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kilograms [kg])
AT = Average time (days)

For the six species of fish evaluated, the potential exposures and human health risks and hazards posed by tDDT and tPCBs were estimated using the minimum, 95 percent upper confidence limit (UCL) on the mean, maximum concentrations of tDDT and tPCBs. For PCB data from the LACSD survey, results reported as nondetect were evaluated at one-half the detection limit. The detection limit was 10 μg/kg; therefore, a proxy value of 5 μg/kg was used.

Table 7-3 presents the chemicals of concern (COCs) and exposure point concentration (EPC) for each species used in the Supplemental HHRE. The table includes the range of concentrations detected for each COC as well as the frequency of detection, the exposure point concentration (EPC), and how the EPC was derived.

7.2.1 2006 Supplemental HHRE Exposure Assumptions

The supplemental HHRE calculated increased cancer risk from white croaker and other fish for different eating habits: 1) recreational angler or "average" consumer who may eat white croaker once a week (called "central tendency exposure"), and 2) someone who consumes white croaker on a subsistence basis, often daily (called "reasonable maximum exposure"). The *Santa Monica Bay Seafood Consumption Study* (SMBRP, 1994) included data on ethnicity of anglers and fish preparation preferences. The study noted more frequent fish consumption by Asian anglers; therefore, the 2006 Supplemental HHRE technical memorandum calculated different reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios for all ethnic groups and for Asian anglers.

Table 7-3 Exposure Point Concentrations based on COCs in Fish caught on PV Shelf
Scenario Timeframe: Current
Medium: Fish fillet
Exposure medium: Ingestion of fish fillet

Exposure Point	Concentration Detected				No. of Samples/ detection frequency	EPC	EPC Units	Statistical Measure
Fish Species used in Risk Assessment	COC	Min	Max	Units				
Benthic-feeding Surfperches	DDT	37	430	ppb	20/20	169	ppb	Approx. gamma UCL
	PCBs	8	60	ppb		24	ppb	
Barred Sand bass	DDT	46	4318	ppb	28/28	897	ppb	Approx. gamma UCL
	PCBs	5	294	ppb		100	ppb	
California Scorpionfish	DDT	22	2630	ppb	28/28	830	ppb	95% H-UCL
	PCBs	6	243	ppb		68	ppb	
Kelp Bass	DDT	20	1420	ppb	51/51	346	ppb	Approx. gamma UCL
	PCBs	5	250	ppb		45	ppb	
Rockfish	DDT	35	567	ppb	23/23	270	ppb	Approx. gamma UCL
	PCBs	12	124	ppb		51	ppb	
White Croaker	DDT	6	78,800	ppb	65/65	19,189	ppb	95% H-UCL
	PCBs	25	6,500	ppb		1,624	ppb	

For all anglers of all ethnic groups and income levels, the upper 90 percent consumption rate was 107.1 grams per day (g/day). The upper 90 percent consumption rate for Asian anglers was 115.7 g/day. The median (50 percent) consumption rate was 21.4 g/day for all anglers and for Asian anglers. The fish fillet ingestion rates for RME and CTE cases for the high-end fish consumer scenario used in the tech memo were 107.1 and 21.4 g/day, respectively. The Asian-angler ingestion rates for RME and CTE cases were 115.7 and 21.4 g/day, respectively. These are the 90^{th} percentile and mean consumption rates for all fish consumed, identified from the *Santa Monica Bay Seafood Consumption Study* (Table 12 in SMBRP, 1994). Additionally, the supplement HHRE used skin-off fish fillet to calculate exposure although some anglers reported consuming whole fish or skin-on fillets.

7.3 Toxicity Assessment

Both DDT and PCBs are considered probable human carcinogens. EPA's Integrated Risk Information System (IRIS) (EPA, 2006) was consulted to obtain toxicity criteria (i.e., noncarcinogenic reference doses and cancer slope factors) for total DDT and total PCBs.

Carcinogenic Effects of DDT: Studies in animals have shown that oral exposure to DDT can result in an increased occurrence of liver tumors. An oral slope factor of 0.34 $(mg/kg\text{-}day)^{-1}$ has been derived for DDT and DDE; and an oral slope factor of 0.24 $(mg/kg\text{-}day)^{-1}$ has been derived for DDD. All are based on liver tumors in rats and mice exposed via diet (EPA. 2006). A cancer slope factor (CSF) of 0.34 $(mg/kg\text{-}day)^{-1}$ is used to evaluated carcinogenic risks for DDT and its metabolites.

Carcinogenic Effects of PCBs: Occupational studies show some increase in cancer mortality in workers exposed to PCBs. A CSF of 2.0 $(mg/kg\text{-}day)^{-1}$, appropriate for food chain exposure, was used.

Noncancer Toxicity of DDT: The major adverse health effects of DDT involve the nervous system, the liver, and reproduction and development of offspring. The reference dose used in the risk calculations is 5×10^{-4} mg/kg-day, which is the current oral reference dose (RfD) listed in the IRIS database.

Noncancer Toxicity of PCBs: Liver effects and skin irritations characterized by acne-like lesions and rashes are the only significant adverse health effects reported in workers exposed to PCBs. An oral RfD of 2×10^{-5} mg/kg-day was derived for Aroclor 1254 (Aroclor 1254 is the commercial name of a PCB mixture) from monkey clinical immunological studies. Because RfDs are not available for Aroclors 1242 and 1260, the oral RfD for Aroclor 1254 was applied to total PCBs.

The following tables summarize the toxicity data used in the risk assessments. Table 7-4 provides carcinogenic risk information that is relevant to the COCs via the ingestion pathway.

Table 7-4: Cancer Toxicity Data Summary

Pathway: Ingestion

Chemicals of Concern	Oral Cancer Slope Factor (CSF)	Slope factor Units	wt of evidence/ cancer guideline	Source	Date
total DDTs	0.34	(mg/kg)/day	B2	IRIS	2006
total PCBs	2.0	(mg/kg)/day	B2	IRIS	2006

Key: IRIS: Integrated Risk Information System, U.S. EPA
A – Human Carcinogen; B1 – Probable human carcinogen (limited human data are available); B2 – Probable human carcinogen (sufficient evidence in animals and inadequate or no evidence in humans); C – Possible human carcinogen; D – Not classifiable as to human carcinogen; E – Not likely to be carcinogenic to humans

Table 7-5 provides non-carcinogenic risk information relevant to the COCs found in fish. Both DDTs and PCBs have toxicity data indicating their potential for adverse non-carcinogenic health effects in humans.

Table 7-5: Non-Cancer Toxicity Data Summary

Pathway: Ingestion

Chemicals of Concern	Chronic/ Subchronic	Oral RfD value	Oral RfD Units	Primary target organ	Uncertainty/ modifying factors	Source of RfD	Date
total DDTs	chronic	5×10^{-4}	mg/kg-day	Liver	----	IRIS	2006
total PCBs	chronic	2×10^{-5}	mg/kg-day	Skin, liver, stomach, thyroid	----	IRIS	2006

Key: IRIS: Integrated Risk Information System, U.S. EPA

The chronic toxicity data available for both COCs for oral exposure have been used to develop oral reference doses (RfDs). The oral RfDs for DDT and PCBs are 5×10^{-4} and 2×10^{-5}, respectively (Source: IRIS, 2006). The available toxicity data, from chronic and subchronic animal studies indicate that DDT primarily affects the liver, while PCBs affect the skin, liver, stomach, and thyroid gland.

7.4 Risk Characterization

Because of fundamental differences in the mechanisms through which carcinogenic and noncarcinogenic processes occur, risks are characterized separately for these two types of health effects. Cancer risks and noncancer hazard quotients (HQs) were calculated for the RME and CTE scenarios.

Potential health risks associated with carcinogens were estimated by calculating the increased probability of an individual developing cancer during his or her lifetime as a result of exposure to a carcinogenic compound. For example, a cancer risk of 2×10^{-6} means that for every 1 million people exposed to the carcinogen during the agreed upon exposure period (e.g., 30 years for RME scenario), the average incidence of cancer might increase by two cases. EPA uses an excess lifetime cancer risk (ELCR) of 10^{-6} (one in 1,000,000) as the point of departure for cancer risk estimates that are of concern. EPA uses an acceptable risk range of 10^{-4} to 10^{-6} to determine whether a site warrants remediation to protect human health (40 CFR §300.430) (EPA, 1999). ELCRs are estimated using the following formula:

$$ELCR = CSF \ X \ intake$$

Where:

ELCR	=	excess lifetime cancer risk
CSF	=	cancer slope factor (risk per mg/kg-day) or $(mg/kg\text{-}day)^{-1}$
Intake	=	chronic daily intake averaged over a lifetime (mg/kg-day)

Although synergistic or antagonistic interactions might occur between cancer-causing chemicals and other chemicals, information is generally lacking in the toxicological literature to predict quantitatively the effects of these potential interactions. Therefore, the Supplemental HHRE treated cancer risks as additive within an exposure route. For estimating the cancer risks from exposure to multiple carcinogens from a single exposure route, the following equation is used to sum risks:

$$Risk_T = \sum\nolimits_1^n Risk_i$$

Where:

$Risk_T$	=	total cancer risk from route of exposure
$Risk_i$	=	cancer risk fron the i^{th} chemical
N	=	number of chemicals

For noncancer health effects, the likelihood that a receptor will develop an adverse effect was estimated by comparing the predicted level of exposure for a particular chemical with the highest level of exposure that is considered protective, i.e., the RfD appropriate to that exposure period. When the estimated exposure exceeds the RfD, the HQ of a chemical exceeds 1 (i.e., HQ > 1). To assess the potential for noncancer effects posed by exposure to multiple chemicals, a hazard index (HI) approach is used (EPA, 1989). This approach assumes that the noncancer hazard associated with exposure to more than one chemical is additive; therefore, synergistic or antagonistic interactions between chemicals are not accounted for. The HI may exceed 1 even if all the individual HQ values are less than 1. In this case, the chemicals may be segregated by similar mechanisms of toxicity and toxicological effects. Separate HI's may then be derived based on mechanisms and effect. The HI is calculated as follows.

$$HI = \sum_{1}^{n} Intake_i \ / RfD_i$$

Where:

HI	=	hazard index
Intake	=	daily intake of the i^{th} chemical (mg/kg-day)
RfD	=	reference dose of the i^{th} chemical (mg/kg-day)
N	=	number of chemicals

Because both DDT and PCBs exert toxic effects on the liver, these constituents were considered additively in the Supplemental HHRE.

7.4.1 Summary of Data Used

The supplemental HHRE used data from the MSRP/EPA *2002-2004 Southern California Coastal Marine Fish Contaminants Survey* (EPA/NOAA, 2007) and the 2002 LACSD ocean fish sampling survey. Figure 3 shows the LACSD stations and MSRP/EPA stations used in the updated HHRE.

Of the fish species collected on PV Shelf by the MSRP/EPA and LACSD, six were included in the supplemental HHRE because they represented a sufficient number of samples to make the assessment statistically valid. The fish species evaluated represent a mix of water-column and bottom feeders, and pelagic and local dwelling species: white croaker, kelp bass, surfperch, barred sand bass, and California scorpionfish. Unlike the LACSD data, which analyzed PCBs as Aroclors, the *Fish Survey* analyzed and reported PCBs as congeners, i.e., the single, unique chlorinated compound in the PCB category. Combining the data increases overall variation and effect point estimates in the risk and hazard results; however, the supplemental HHRE attempted to minimize this effect by estimating risk using minimum, 95 percent UCL, and maximum concentrations of PCBs for each fish species evaluated.

7.4.2 Risk by RME and CTE Scenarios

As discussed below, under the RME and CTE conditions (using 95 percent UCLs), DDTs contributed the most to the total cancer risk for five species, while PCBs contributed the most to cancer risk for one species (rockfish). Under the RME and CTE conditions, PCBs contributed most to HI values for all six species. Tables 7-6 and 7-7 show the risk range for all anglers and Asian anglers under the RME and CTE scenarios. Tables 7-8 and 7-9 show the hazard estimates by contaminant for cancer and noncancer risks.

7.4.2.1 RME Scenario

For both all-angler and Asian-angler consumers under RME consumption of fish fillets, excess lifetime cancer risks from DDTs and PCBs for three species (white croaker, California scorpionfish, and barred sand bass) ranged from 3×10^{-4} to 7×10^{-3}, based on 95 percent UCL concentrations. Of the six species tested, the highest risk was from white croaker fillets with a risk of 6×10^{-3}. White croaker fish typically contain higher levels of DDTs and PCBs than other fish from the PV Shelf. This is primarily because white croaker is a nonmigratory fish that feeds off the ocean floor. Risks from the other three species (kelp bass, rockfish, and surfperch) ranged from 7×10^{-5} to 1×10^{-4}.

As with the HQ (which is for a single chemical), when the HI (Hazard Index) for exposures to multiple chemicals exceeds 1, the calculated intake exceeds the daily reference dose. The HI values for all six species were 2 to 198. White croaker fillets also had the highest HI values.

7.4.2.2 CTE Scenario

For both all-angler and Asian-angler consumers under CTE conditions (using 95 percent UCLs), for consumption of fish fillets, cancer risks from DDTs and PCBs for one species (white croaker) was 6×10^{-4} based on 95 percent UCL concentrations. Risks from the other five species ranged from 6×10^{-6} to 3×10^{-5}. The HI values from three of the six species (white croaker, California scorpionfish, and barred sand bass) were 2 to 37. Kelpfish, rockfish, and surfperch have HI values below 1.

7.4.3 Uncertainties and Limitations

These risk calculations are quantitative estimates of current and future potential cancer risks and noncancer adverse health hazards. However, these numbers do not predict actual health outcomes. Using approaches and methodologies based on EPA guidance documents, the potential cancer risks and health hazards are estimated in a conservative, public health-protective manner.

The estimation of exposure in the supplemental HHRE requires numerous assumptions regarding the likelihood of exposure, frequency of ingestion of contaminated fish, the concentration of contaminants in fish and the period of exposure. Another main assumption of the exposure assessment is that the period of constituent intake is assumed to be constant and representative of the exposed population. Assumptions used in the supplemental HHRE tend to simplify and conservatively approximate actual conditions, thereby serving to maximize confidence in decision-making.

The following uncertainties should be considered when interpreting the results for the supplemental HHRE:

- *Fish Sampling and Laboratory Analysis.* Uncertainty associated with fish sampling and laboratory tissue analysis includes representativeness of the fish samples collected, sampling errors, the variable nature of fish exposures to DDTs and PCBs from the PV Shelf, and the inherent variability (standard error) in the laboratory analyses.

- *Human health risks were evaluated using DDTs and PCBs.* Although other contaminants are present in PV Shelf sediments and fish tissue, potential risks from exposure to or consumption of DDTs and PCBs are of greatest concern. Therefore, the evaluation focused on these compounds. Exclusion of other chemicals detected in PV Shelf fish tissue could result in a significant underestimation of cumulative risk, but only in the event that the other chemicals bioaccumulated, were of high toxicity, were present in high enough concentrations in the fish fillet of fish typically caught by recreational and commercial fishers, and were typically eaten by fish consumers.

TABLE 7-6

SUMMARY OF RISK AND HAZARD ESTIMATES FOR ALL ANGLER INGESTION OF FISH FILLET

	Reasonable Maximum Exposure			Central Tendency Exposure		
	Based on Minimum Conc.	Based on 95% UCL Conc.	Based on Maximum Conc.	Based on Minimum Conc.	Based on 95% UCL Conc.	Based on Maximum Conc.
Cancer Risks						
White Croaker	3×10^{-5}	6×10^{-3}	3×10^{-2}	3×10^{-6}	6×10^{-4}	2×10^{-3}
Kelp Bass	1×10^{-5}	1×10^{-4}	6×10^{-4}	1×10^{-6}	1×10^{-5}	6×10^{-5}
Rockfish	2×10^{-5}	1×10^{-4}	3×10^{-4}	2×10^{-6}	1×10^{-5}	3×10^{-5}
Surfperches (benthic feeding)	2×10^{-5}	7×10^{-5}	2×10^{-4}	2×10^{-6}	6×10^{-6}	2×10^{-5}
California Scorpionfish	1×10^{-5}	3×10^{-4}	9×10^{-4}	1×10^{-6}	3×10^{-5}	8×10^{-5}
Barred Sand bass	2×10^{-5}	3×10^{-4}	1×10^{-3}	2×10^{-6}	3×10^{-5}	1×10^{-4}
Noncancer HI						
White Croaker	2	183	738	0.4	37	148
Kelp Bass	0.4	5	23	0.1	0.9	5
Rockfish	1	5	11	0.2	0.9	2
Surfperches (benthic feeding)	0.7	2	6	0.1	0.5	1
California Scorpionfish	0.5	8	27	0.1	2	5
Barred Sand bass	0.6	10	36	0.1	2	7

TABLE 7-7

SUMMARY OF RISK AND HAZARD ESTIMATES FOR ASIAN ANGLER INGESTION OF FISH FILLET

	Reasonable Maximum Exposure			Central Tendency Exposure		
	Based on Minimum Conc.	Based on 95% UCL Conc.	Based on Maximum Conc.	Based on Minimum Conc.	Based on 95% UCL Conc.	Based on Maximum Conc.
Cancer Risks						
White Croaker	4×10^{-5}	7×10^{-3}	3×10^{-2}	3×10^{-6}	6×10^{-4}	2×10^{-3}
Kelp Bass	1×10^{-5}	1×10^{-4}	7×10^{-4}	1×10^{-6}	1×10^{-5}	6×10^{-5}
Rockfish	3×10^{-5}	1×10^{-4}	3×10^{-4}	2×10^{-6}	1×10^{-5}	3×10^{-5}
Surfperches	2×10^{-5}	7×10^{-5}	2×10^{-4}	2×10^{-6}	6×10^{-6}	2×10^{-5}
California Scorpionfish	1×10^{-5}	3×10^{-4}	1×10^{-3}	1×10^{-6}	3×10^{-5}	8×10^{-5}
Barred Sand bass	2×10^{-5}	4×10^{-4}	1×10^{-3}	2×10^{-6}	3×10^{-5}	1×10^{-4}
Noncancer HQ						
White Croaker	2	198	798	0.4	37	148
Kelp Bass	0.5	5	25	0.1	0.9	5
Rockfish	1	5	12	0.2	0.9	2
Surfperches	0.7	3	6	0.1	0.5	1
California Scorpionfish	0.5	8	29	0.1	2	5
Barred Sand bass	0.6	11	39	0.1	2	7

TABLE 7-8

SUMMARY OF NONCANCER RISK AND HAZARD ESTIMATES FOR ALL ANGLER INGESTION OF FISH FILLET

	Reasonable Maximum Exposure			Central Tendency Exposure		
	Based on Minimum Conc.	**Based on 95% UCL Conc.**	**Based on Maximum Conc.**	**Based on Minimum Conc.**	**Based on 95% UCL Conc.**	**Based on Maximum Conc.**
PCBs Noncancer HQ						
White Croaker	2	124	497	0.4	25	99
Kelp Bass	0.4	3	19	0.1	0.7	4
Rockfish	0.9	4	9	0.2	0.8	2
Surfperches (benthic feeding)	0.6	2	5	0.1	0.4	1
California Scorpionfish	0.4	5	19	0.1	1	4
Barred Sand bass	0.4	8	23	0.1	2	5
DDT Noncancer HQ						
White Croaker	0.02	58	241	0.003	12	48
Kelp Bass	0.06	1	4	0.01	0.2	0.9
Rockfish	0.1	0.8	2	0.02	0.02	0.3
Surfperches (benthic feeding)	0.1	0.5	1	0.02	0.1	0.3
California Scorpionfish	0.07	3	8	0.01	0.5	2
Barred Sand bass	0.01	3	13	0.03	0.5	3

TABLE 7-9

SUMMARY OF CANCER RISK AND HAZARD ESTIMATES FOR ALL ANGLER INGESTION OF FISH FILLET

	Reasonable Maximum Exposure			Central Tendency Exposure		
	Based on Minimum Conc.	**Based on 95% UCL Conc.**	**Based on Maximum Conc.**	**Based on Minimum Conc.**	**Based on 95% UCL Conc.**	**Based on Maximum Conc.**
PCBs Cancer Risks						
White Croaker	3×10^{-5}	2×10^{-3}	9×10^{-3}	3×10^{-6}	2×10^{-4}	8×10^{-4}
Kelp Bass	7×10^{-6}	6×10^{-5}	3×10^{-4}	6×10^{-7}	5×10^{-6}	3×10^{-5}
Rockfish	2×10^{-5}	7×10^{-5}	2×10^{-4}	1×10^{-6}	6×10^{-6}	2×10^{-5}
Surfperches (benthic feeding)	1×10^{-5}	3×10^{-5}	8×10^{-5}	9×10^{-7}	3×10^{-6}	7×10^{-6}
California Scorpionfish	7×10^{-6}	9×10^{-5}	3×10^{-4}	7×10^{-7}	8×10^{-6}	3×10^{-5}
Barred Sand bass	7×10^{-6}	1×10^{-4}	4×10^{-4}	7×10^{-7}	1×10^{-5}	4×10^{-5}
DDT Cancer Risks						
White Croaker	1×10^{-6}	4×10^{-3}	2×10^{-2}	1×10^{-7}	4×10^{-4}	2×10^{-3}
Kelp Bass	4×10^{-6}	8×10^{-5}	3×10^{-4}	4×10^{-7}	7×10^{-6}	3×10^{-5}
Rockfish	8×10^{-6}	6×10^{-5}	1×10^{-4}	7×10^{-7}	6×10^{-6}	1×10^{-5}
Surfperches (benthic feeding)	8×10^{-6}	4×10^{-5}	1×10^{-4}	8×10^{-7}	3×10^{-6}	9×10^{-6}
California Scorpionfish	5×10^{-6}	2×10^{-4}	6×10^{-4}	4×10^{-7}	2×10^{-5}	5×10^{-5}
Barred Sand bass	1×10^{-5}	2×10^{-4}	1×10^{-3}	9×10^{-7}	2×10^{-5}	9×10^{-5}

- *Method of Fish Preparation.* No attempt was made in the study to quantitatively evaluate the effects of fish preparation methods on human health risks, which could result in an under- or overestimation of risk. Contaminant burdens in fish could decrease by 10 to 70 percent depending on how the fish is prepared and cooked (EPA, 1993b). Conversely, the risk analysis used only contaminant concentrations found in fish tissue (i.e., skin off fish fillets). DDT and PCBs concentrations in whole fish are 8 to 10 times higher. Therefore, the risk assessment underestimates risk to populations that consume whole fish.

- *Fish Consumption Rates.* The *Exposure Factors Handbook* (EPA, 2001b) provides a mean total fish consumption rate for the general population of 14.2 g/day for the Pacific region of the United States. This rate includes fish that are caught both recreationally and commercially, and meals that are eaten at home and away from home. The median consumption rate used in the supplemental HHRE, 21.4 g/day, is based on 338 boat anglers who reported consuming fish in the previous 4 weeks (28 days) in the *Santa Monica Bay Seafood Consumption Study* (SMBRP, 1994). The RME rates of 107.1 and 115.7 g/day represent the upper 90 percent consumption rates, respectively, for all anglers and Asian anglers, from the same study.

7.5 Ecological Risk Assessment

An Ecological Risk Assessment (EcoRA) was conducted for the PV Shelf site in 2003 (CH2M Hill, 2003). The EcoRA corresponds to the baseline EcoRA as described in EPA guidance, *Ecological Risk Assessment Guidance for Superfund Sites: Process for Designing and Conducting Ecological Risk Assessments* (EPA, 1997), and a Validation Assessment as described by DTSC guidance, *Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities* (DTSC, 1996).

7.5.1 Purpose and Scope of the Ecological Risk Assessment

The EcoRA was prepared in 2003 to evaluate: 1) ecological risk through identification and characterization of existing concentrations of contaminants at the site, and 2) potentially complete exposure pathways to ecological receptors. The EcoRA summarized data collected throughout the Southern California Bight (SCB) with an emphasis on the PV Shelf site, from as many different sources as was practical, for the period of 1990 to 2002 (birds were summarized for 1985 to 2000). The EcoRA relied on work completed for the Natural Resource Damage Assessment (NRDA), including a Food Web/Pathways Study (HydroQual, Inc., 1994). The EcoRA described the risk from DDTs and PCBs to marine biota that inhabit or may use the PV Shelf site and the SCB. The biota include benthic invertebrates, benthic and water-column fish, brown pelicans, double-crested cormorants, bald eagles, peregrine falcons, and sea lions and their pups. This assemblage of receptors represents the marine food web moving from contaminated sediments up through invertebrate and vertebrate prey to wide-ranging, higher order consumers.

7.5.1.1 Exposure Assessment

Exposure to contaminants of potential ecological concern (COPEC) was evaluated in multiple ways, depending on the receptor and available data. Internal exposure from measured and estimated concentrations of COPEC in tissues was considered for invertebrates, fish, birds, and mammals. External exposure from COPEC in environmental media (sediment and water) was considered for biota directly exposed to the media, such as benthic invertebrates and fish. In addition, a food exposure model for birds and marine mammals was used to estimate the daily dosages of COPEC from diet. The bird and sea lion exposure model was based on the establishment of relationships between COPEC concentrations in sediment and fish tissues at locations throughout the SCB. The sediment-to-fish relationship then was used to estimate potential concentrations of COPEC in fish tissue for any SCB location. Overlapping concentrations in a mixed dietary fish assemblage within their foraging range yielded an estimated daily dosage of COPEC for the bird and sea lion receptors. Peregrine falcon exposure estimates required the additional step of estimating tissue concentrations in their seabird diet (derived from estimated fish concentrations in the seabird diet). Bald eagle exposure required a combination of exposure through dietary fish as well as sea lion carcasses and seabirds (with tissue concentrations, in turn, as estimated from their fish diets). Sea lion pup exposures were estimated from maternal milk, as estimated from maternal dietary exposure and the use of literature-derived equations for transfer of contaminants to milk.

The food web model concluded that the SCB did not exceed DDT screening values for marine mammals but did exceed screening values for birds and fish. PCBs exceeded screening values for sea lion pups and double-crested cormorants, and to a lesser extent brown pelicans and peregrine falcons, but not fish.

7.5.1.2 Food Web Exposure Model Update

The food web model in the 2003 EcoRA used data for the period of 1990 to 2001. In 2006, the food web model was updated with more recent sediment and fish data from 2001 to 2005, i.e, LACSD sediment core data (2001 and 2003) and fish tissue data (2004 and 2005), and MSRP/EPA fish tissue data (2002). The updated food web model lacked data to credibly model COC uptake beyond the local, bottom-feeding fish of PV Shelf. Collaboration with the Natural Resource Trustees on data collection and analysis is necessary to update existing food web models of the Southern California Bight. A consensus was reached to return to the HydroQual (rev1997) food web model developed for the NRDA. Updating the model is one of the additional tasks to be performed under the interim ROD.

Recently, the SCCWRP completed a study of COCs in pelagic fish that form the principle diet of piscivorous birds and sea lions (Jarvis et al., 2007). Although concentrations of DDTs and PCBs have dropped significantly since the 1980s (see Table 7-10), DDT concentrations continue to exceed risk screening values for northern anchovy, Pacific sardine, and Pacific chub mackerel throughout the SCB. Virtually none of the fish sampled exceeded wildlife risk screening values for PCBs. Another recent study of pinnipeds (Blasius and Goodmanlowe, 2008) found concentrations of DDTs and PCBs in California sea lions to have dropped over the 12-year period of the study (1994 to 2006). However, concentrations of DDTs and PCBs in California sea lions and Pacific harbor seals continue to be among the highest values reported worldwide for marine mammals.

7.5.1.3 Bioaccumulation Modeling

The FS uses the food web model developed by HydroQual (rev1997) for the Natural Resources Damage Assessment (NRDA) to develop relationships between concentrations of DDTs and PCBs in sediment and in white croaker. The bioaccumulation model was developed to determine whether the sediment of the PV Shelf constituted the dominant source of the DDE and PCBs found in local fish. The similarity of the field-measured and model-calculated fish tissue concentrations confirmed that PV Shelf sediment constituted the dominant source of DDE and PCBs to white croaker. The same model framework was extended to include birds

Table 7-10: Comparison of total DDT and total PCBs measured in pelagic forage fishes and squid of the Southern California Bight in the early 1980s and 2003-2004 (Southern California Costal Water Research Project 2007 Annual Report – Chlorinated hydrocarbons in pelagic forage fishes and squid of Southern California Bight, Jarvis et al.)

Species/ Location	Year	Composite Type	*n*	Total DDT (µg/kg wet wt)		Total PCBs (µg/kg wet wt)	
California market squid				**Mean**	**SD**	**Mean**	**SD**
Coastal	1980-81[a]	Mantle	3	10.0	10.0	10.0	9.0
SCB	2003-04[b]	Whole	28	0.8	1.2	0.0	0.1
Northern anchovy							
Coastal	1980-81[a]	Muscle	5	47.0	33.0	8.0	9.0
LA/LB Harbor	1980[c]	Muscle	5	121.0	31.0	98.0	21.0
SCB	2003-04[b]	Whole	24	60.6	38.3	3.1	5.1
Pacific chub mackerel							
Coastal	1980-81[a]	Muscle	6	130.0	145.0	26.0	22.0
Santa Monica Bay	1981[d]	Muscle	5	57.0	37.0	15.0	7.0
Palos Verdes	1981[d]	Muscle	5	44.0	—	12.0	12.0
Laguna Beach	1981[d]	Muscle	1	129.0	86.0	34.0	22.0
SCB	2003-04[b]	Whole	13	41.4	40.2	2.3	3.1
Pacific Sardine							
Coastal	1980-81[a]	Muscle	5	484.0	112.0	105.0	40.0
SCB	2003-04[b]	Whole	34	34.1	28.7	1.6	2.5

a Schaefer et al. 1982
b Jarvis et al. 2007
c Mearns and Young 1980
d Gosset et al. 1983
Note: contaminant concentrations in whole fish tend to be 3 to 10 times greater than in fish muscle

and mammals as part of the NRDA. The model is included in Appendix C of the PV Shelf Feasibility Study (EPA, 2009) along with a technical memorandum that applied the model to current PV Shelf conditions to develop a relationship between DDTs and PCBs in white croaker and sediment.

The technical memorandum (Anchor QEA, 2009) analyzed white croaker fish data from the *2002/2004 Coastal Marine Fish Contaminant Survey* (EPA/NOAA, 2007) and recent sediment data (LACSD, 2008) to update the bioaccumulation model. The tech memo provides estimates of white croaker/sediment relationships for COCs. In general, the relationships were linear; contaminant concentrations differed among fish tissues primarily insofar as their lipid (i.e., fat) contents differed.

8.0 REMEDIAL ACTION OBJECTIVES

This section presents the remedial action objectives (RAOs) for the Palos Verdes Shelf. The RAOs provide a general description of cleanup objectives and serve as the design basis for the remedial alternatives described in Section 9.0.

8.1 Basis and Rationale for the Remedial Action Objectives

EPA guidance states that RAOs should specify the relevant COCs, the exposure route(s) to receptors by media (e.g., surface water, soil or sediment), and an acceptable contaminant level for each exposure route (*Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*, *Interim Final*, 1988a). The COCs are DDT and PCBs. Ingestion is the exposure pathway from invertebrates in the sediment, up the food web to fishes, piscivorous birds, marine mammals, and people who consume the fish. Surface water and sediment are the media of concern. Contamination of these media creates the risk to human health and ecological receptors. The risk assessments were used to develop acceptable contaminant levels for each exposure route. The supplemental HHRE calculated increased cancer risk from white croaker and other fish for CTE and RME eating habits. This produced two different sets of acceptable concentrations of COCs in fish, depending on how much fish an individual consumes and of what species. These concentrations in fish tissue were then used to calculate concentrations in sediment that would be necessary for fish tissue concentrations to drop to acceptable levels.

Section 121(d)(2)(A)(ii) of CERCLA requires that remedial actions meet federal ambient water quality criteria (AWQC) established under Section 304 or 303 of the Clean Water Act, where such AWQC are determined by EPA to be relevant and appropriate to remedial actions at the site. 42 U.S.C. §9621(d)(2)(A)(ii); 40 CFR §300.430(e)(2)(I)(E). The AWQC for DDTs and PCBs are promulgated standards for ecological and human health that establish response action levels at this site since aquatic organisms, wildlife, and humans may be exposed to these contaminants either directly or through consumption of contaminated organisms. The marine chronic AWQC for DDTs was based on the results of studies of reproductive impacts to the California brown pelican in the Southern California Bight.

Table 8-1: EPA Ambient Water Quality Criteria

Chemical	Saltwater Aquatic Life, 24-Hour Average (ng/L)	Human Health (ng/L)
DDTs	1[a]	0.22[b]
PCBs	30	0.064

[a] The sum of the 4,4'- and 2,4'- isomers of DDT, DDD, and DDE.

[b] For DDE and DDD, the AWQC for protection of human health are 0.22 and 0.31 ng/L, respectively.

ng/L – nanograms per liter

The RI/FS determined that addressing sediment contamination would have the greatest impact on reducing risks to humans and wildlife. Cleanup of surface water and reductions in fish tissue COC concentrations will occur naturally once the contamination in the sediment is removed, treated, or contained.

There are no federal or State of California promulgated standards for DDT and PCBs in sediment. EPA used the bioaccumulation model described in section 7.5.1.3 to calculate concentrations of COCs in sediment correlated to fish tissue concentrations within EPA's acceptable risk range. However, there is uncertainty associated with the bioaccumulation model, and the cleanup levels are interim. Under the selected remedy, EPA and NOAA will conduct a white croaker tracking study to learn more about white croaker feeding patterns on PV Shelf. Data from the white croaker tracking study and data from the baseline study of COCs in water and sediment will allow the bioaccumulation model to be refined to predict more accurately contaminant levels in sediment correlated to contaminant levels in fish. These studies will contribute to the development of the final remediation plan.

8.2 Specific Remedial Action Objectives

RAO: Reduce to acceptable levels the risks to human health from ingestion of fish contaminated with DDTs and PCBs.

- Achieve the goal of 400 μg/kg DDT, 70 μg/kg PCBs in white croaker,
- Maintain the institutional controls program that aims to prevent contaminated fish from reaching markets and educates anglers on safe fish consumption practices, and
- Achieve the interim goal of median DDT concentrations in surface sediment of 46 mg/kg OC (double the cleanup level of 23 mg/kg OC) and PCB concentrations of 7 mg/kg OC by the first Five-Year Review.

The human health risk assessments determined that exposure to DDTs and PCBs through consumption of fish is the exposure pathway with the greatest potential for adverse human health effects. There are two ways to reduce risk: reduce COC levels in fish, and/or prevent consumption of contaminated fish. Until white croaker concentrations of DDT and PCBs reach the protective levels described above, EPA will use the State of California fish advisory that recommends a mixed diet that adheres to a 10^{-5} cancer risk for children and women of childbearing age, and for the general population.

RAO: Reduce to acceptable levels the risks from DDTs and PCBs to the ecological community (i.e., benthic invertebrates and fish) at the PV Shelf.

- Support the Natural Resource Trustees' strategies to sustain wildlife recovery.

The Natural Resource Trustees through the Montrose Settlements Restoration Program (MSRP) are actively involved in restoring wildlife harmed by DDTs and PCBs. Programs to enhance fish habitat and restore sea birds and bald eagles are well underway. EPA can contribute to these efforts by its remedial actions on PV Shelf. Although PCB concentrations in sediment, water and fish do not appear to pose a threat to ecological receptors, DDT levels continue to pose a threat, particularly to piscivorous birds. As discussed above, existing food web models that predict changes in bird or marine mammal COC body burdens need to be reassessed with new data and improved understanding of sediment to fish bioaccumulation correlations. Until such work is completed, the ambient water quality criteria (AWQC) for ecological health, discussed under the next RAO, provide a quantifiable level of protection for fish and wildlife.

RAO: Reduce concentrations of DDTs and PCBs in the surface waters over the PV Shelf to acceptable levels that meet ambient water quality criteria (AWQC) for ecological health and human health.

- Achieve AWQC for protection of human health (i.e., 0.22 ng/L DDT) within 30 years of remedial action, and
- Collect and assess PCB data in order to determine the schedule to meet human health AWQC for PCBs (i.e., 0.064 ng/L) by first Five-Year Review.

Table 8-1 lists the AWQC for protection of ecological receptors and human health. The AWQC for human health is 0.22 ng/L DDT in water; this is the equivalent of 12 µg/kg DDT in fish tissue. The 0.064 ng/L PCBs in water is the equivalent of 1.4 µg/kg PCBs in fish. These concentrations represent a 10^{-6} excess lifetime cancer risk (ELCR). The AWQC for ecological health are 1 ng/L DDT and 30 ng/L PCBs. Since the AWQC for human health are more stringent than the AWQC for ecological health, the stricter criteria are selected as the cleanup level.

Water column data collected in 1997 (Table 5-2) measured concentrations of DDTs and PCBs at different locations and depths in winter and summer. DDT and PCB concentrations exceeded the AWQC for human health in all samples. All samples except one exceeded the ecological health criterion for DDT. No water sample exceeded the PCB ecological standard of 30 ng/L. Additional sampling and analysis are necessary in order to calculate when the human health criteria of 0.064 ng/L would be achieved.

RAO: Minimize potential adverse impacts to sensitive habitats and biological communities on the PV Shelf during remedial action.

- Before implementation of the remedy, prepare a monitoring program to assure the kelp beds on PV Shelf are protected from adverse impacts from sediment placement, and
- Use low-impact techniques for capping and other best management practices, e.g., plan field work when tides and currents are less energetic, measure current speeds before capping, monitor sediment resuspension, COCs in water column. Stop action if monitoring plan standards are exceeded.

9.0 DESCRIPTION OF REMEDIAL ALTERNATIVES

The FS identified and screened possible response actions and remedial technologies to address the EA sediment on Palos Verdes Shelf. The initial screening considered institutional controls, monitored natural recovery, containment (i.e., capping), removal, in-situ treatment and ex-situ treatment.

In accordance with the NCP, EPA evaluated each remedial option against implementability, effectiveness, and cost criteria. Based on this evaluation, the FS developed four alternatives that were included in the Proposed Plan:

- Alternative 1: the "no action" alternative,
- Alternative 2: institutional controls and monitored natural recovery,
- Alternative 3: institutional controls, monitored natural recovery, and containment (outfall area cap), and
- Alternative 4: institutional controls, monitored natural recovery, and containment (large area cap).

EPA's selected remedy is Alternative 3: institutional controls, monitored natural recovery, and containment (outfall area cap).

During development of the FS, it became clear that there are significant data gaps that need to be filled before EPA can propose a final remedy. Therefore, EPA is recommending an interim

ROD while additional studies are completed. For example, an analysis of PCB loss rates is needed in order to forecast when the AWQC of 0.064 ng/L PCBs may be reached. Other studies on fish consumption rates, contaminant fate and transport, DDE reductive dechlorination, and COC bioaccumulation, are necessary to calculate accurately the degree of risk reduction that is achievable. Uncertainties associated with the effectiveness of capping technology further support an interim ROD.

9.1 Description of Remedy Components

All of the alternatives (except no action) contain common elements. These common elements include continuation of the ICs program, collection of additional data, and monitoring natural recovery. Table 9-1 at the end of this section summarizes the elements of each alternative.

9.2 No Action Alternative

Estimated Capital Cost: $0
Estimated Annual Implementation Cost: $0
Estimated Present Worth Cost: $0
Estimated Construction Timeframe: None

The NCP requires evaluation of the "no action" alternative to establish a baseline for comparison to the other alternatives and to establish the baseline risk. Under the "no action" alternative, EPA would take no actions to reduce contaminant concentrations or limit consumption of fish with unacceptable levels of DDTs and PCBs. The institutional controls program put in place under the 2001 Action Memorandum would be discontinued. The "no action" alternative would pose an unacceptable risk to human health.

9.3 Alternative 2: Institutional Controls and Monitored Natural Recovery

Estimated Capital Cost: $4,350,000
Estimated Annual Implementation Cost: $1,430,000 (ICs)
Estimated Five-Year Monitoring & Review: $1,889,000
Estimated Present Worth Cost: $15,884,000 (7% discount rate)
Estimated Construction Timeframe: None

This alternative monitors the naturally occurring reductions in contaminants in the PV Shelf Study Area while reducing risks to human health associated with the consumption of contaminated fish through nonengineered controls. Alternative 2 is designed to limit human exposure to contaminated fish by a three-pronged program of public outreach and education, monitoring, and enforcement. The elements of Alternative 2 are:

- Institutional Controls Program, described in section 9.3.1, and
- Monitored Natural Recovery, described in section 9.3.2.

Data collected from the PV Shelf Study Area indicate natural degradation processes such as chemical transformation of DDE, contaminant loss through transport, and sediment burial are occurring, thereby reducing contaminant levels in sediment, water, and fish. This alternative would monitor the migration and degradation of contaminants and the impact of contaminants on ecological receptors at the PV Shelf. Until contaminant concentrations drop to RAO levels, this alternative maintains the institutional controls program to limit human consumption of potentially contaminated fish by educating the public on safe fishing practices, supporting state commercial fishing ban and fish advisories, and monitoring fish contamination levels from ocean to consumer. The ICs program relies on partnerships with other federal, state, and local agencies for implementation.

Preliminary calculations using available data to forecast sediment and water quality indicate the surface water quality goal, i.e., the ambient water quality criteria for DDT of 0.22 ng/L is estimated to be reached by 2037. The sediment cleanup level for DDT of 230 µg/kg is estimated to be reached by 2053. Additional field data will be collected to validate these assumptions. The forecasts are particularly sensitive to the rate of mass flux of DDT from the sediment to the water column, which has not been measured directly.

Data on PCBs in water and sediment are insufficient to predict future levels. The baseline monitoring planned for Fall 2009 and Spring 2010 will provide data on DDTs and PCBs that will be used to refine these forecasts.

Until contaminant concentrations drop to RAO levels, this alternative would keep in place the ICs program.

9.3.1 Institutional Controls (ICs)

EPA defines Institutional Controls as "non engineering instruments, such as administrative and legal controls, that help to minimize the potential for human exposure to contamination and protect the integrity of the remedy." ICs limit land or resource use and provide information to modify or guide human behavior at properties where hazardous substances prevent unlimited use and unrestricted exposure (EPA, 2004). ICs are often used at Superfund sites as a supplement to engineered remediation measures.

The NCP states that ICs should not be used as a substitute for active remediation measures unless such active remediation measures are not practicable, based on the balancing of trade-offs among alternatives that is conducted during remedy selection. 40 CFR §300.430(a)(1)(iii)(D).

As discussed in section 2.2, EPA selected an Institutional Controls Program under its removal authority. The 2001 Action Memorandum identified three major components of the ICs Program:

- **Public Outreach and Education** – to increase awareness and understanding of the existing fish consumption advisories and fishing restrictions,
- **Monitoring** – to evaluate and track contaminant concentrations in fish (primarily white croaker) caught at or near the site as well as those sold in retail fish markets and served in restaurants, and
- **Enforcement** – based on the existing commercial and recreational restrictions on white croaker fishing established by the California Department of Fish and Game (CDFG).

The ICs program limits human exposure to contaminated fish through an aggressive outreach program that uses a variety of channels to educate the public on safe fishing practices. Public outreach and education is carried out by EPA's Fish Contamination Education Collaborative (FCEC), and entails angler outreach, outreach to at-risk ethnic communities, and outreach to commercial businesses, e.g., fish markets, wholesalers, bait shops.

The ICs monitoring component consists of monitoring contaminant levels in fish (particularly white croaker) at selected locations in the ocean, markets, landing areas and piers.

Enforcement consists of enforcing existing regulations for commercial and recreational anglers, along with inspections of retail food facilities and enforcement of market protocol under the California Health & Safety Code. Efforts include monitoring and enforcing the daily catch limit and the commercial no-take zone for white croaker.

The ICs program relies on partnerships with other federal, state, and local agencies as well as community-based organizations to prevent PV Shelf fish from reaching consumers. The ICs program has used a feedback loop to develop new techniques and strengthen existing ICs programs. The most recent draft of the *Institutional Controls Program Implementation Pl*an (January 2009), Appendix D of the PV Shelf Feasibility Study (EPA, 2009) details roles and responsibilities of FCEC members by program. The ICs program under the remedial alternatives would contain a new fish consumption survey to gauge consumption patterns by populations. This will allow EPA to update the assumptions used in risk calculations and to assess the overall effectiveness of the "do not consume white croaker" messages.

9.3.2 Monitored Natural Recovery (MNR)

Data analyzed for the PV Shelf RI Report indicate contaminant loss is occurring across the site through transport, sediment burial, and, in the case of DDTs, chemical transformation. As discussed in section 5.2.3, natural recovery has been studied since the NRDA. The recovery model has been revised as new data become available. Currently, the model is assessing sediment transport in light of oceanographic data collected during Winter 2007-2008 and the changes brought on by LACSD's implementation of full secondary treatment of wastewater in November 2002. This assessment will refine COC loss rates used in predicting recovery.

EPA's guidance on sediment sites, *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (EPA OSWER 9355.0-55 Dec. 2005) presents criteria to consider in selecting an MNR remedy and lists site conditions conducive to MNR. These include:

- Anticipated land uses or new structures are not incompatible with natural recovery,
- Natural recovery processes have a reasonable degree of certainty to continue at rates that will contain, destroy, or reduce the bioavailability or toxicity of contaminants within an acceptable time frame,
- Expected human exposure is low and/or can be reasonably controlled by institutional controls,
- Sediment bed is reasonably stable and likely to remain so,
- Sediment is resistant to resuspension (e.g., cohesive or well-armored sediment),
- Contaminant concentrations in biota and in the biologically active zone of sediment are moving towards risk-based goals on their own,
- Contaminants already readily biodegrade or transform to lower toxicity forms,
- Contaminant concentrations are low and cover diffuse areas, and
- Contaminants have low ability to bioaccumulate.

PV Shelf meets most of these conditions; however, significant uncertainty remains regarding the time frame for natural recovery of fish. Recent studies (Eganhouse and Pontolillo, 2007) indicate DDE is naturally degrading in the sediment. Under MNR, studies to quantify the rate of DDE transformation and to identify the causes will be completed. The findings will be used to shape the final remedy, including the potential for treatment to enhance MNR.

Monitoring will be employed to evaluate the effectiveness of the natural recovery processes, as well as to assist in the development of additional remedial actions. Monitoring to confirm recovery includes:

- Monitoring the levels of PCBs and DDTs and DDE breakdown products in sediment,
- Monitoring the levels of DDTs and PCBs in water at the seabed, mid-water column, and surface, and
- Monitoring the levels of DDTs and PCBs in PV Shelf resident, demersal fish (i.e., white croaker) and pelagic forage fish.

Fate and transport analyses conducted as part of the FS indicate that the timeframe necessary to reduce the remaining DDE concentrations to acceptable levels under Alternative 2 ranges from approximately 44 years to over 140 years, depending on the mass flux rate selected. PCB rate of reduction will be calculated once additional PCB data are collected.

Also under MNR, studies to increase understanding of recovery processes will be conducted:

- Study of reductive dechlorination processes occurring in the EA deposit to determine breakdown rates and feasibility of accelerating transformation,
- Refinement of the natural recovery model to address sediment deposition and transport, and
- A fish tracking study of white croaker and barred sand bass resident times and movements across the Shelf to develop a more accurate correlation between COCs in sediment and fish.

The information from these studies will be used in selection and design of future remedial actions.

9.4 Alternative 3: Institutional Controls, Monitored Natural Recovery and Containment (Outfall Area Cap)

Estimated Capital Cost: $41,186,000
Estimated Annual Implementation Cost: $1,430,000 (ICs)
Estimated Five-Year Monitoring & Review: $2,498,000
Estimated Present Worth Cost: $53,761,000 (7% discount rate)
Estimated Construction Timeframe: 3-4 years

Alternative 3 is the selected remedy. It includes:

- The ICs program described in 9.3.1,
- The MNR program described in 9.3.2, and

- Cap placement over the area of the EA deposit that appears to be eroding, including the area of highest surface COC concentrations.

Alternative 3 would accelerate natural recovery by placing clean sand/coarse silt over the area of PV Shelf that has the highest surficial contaminant concentrations and appears to be eroding. Without a cap, continued erosion will cause more EA sediment to be released into the environment. Alternative 3 will use low-impact techniques to place a 45-cm layer of clean sand/coarse silt over approximately 300 acres of the Shelf. This alternative would require 864,000 cubic yards of clean silty sand. Cap material would come from harbor or maintenance dredging projects or from clean areas of the Shelf. The clean sediment cap would accelerate recovery through:

- Physical armoring of 300 acres of the shelf to prevent erosion of contaminated sediment by winter storms,
- Preventing flux of dissolved contaminants from the sediment into the water column, and
- Reducing exposure and uptake of contaminants by benthic organisms by replacing effluent-affected sediment with a clean layer for recolonization.

The selected remedy includes studies to verify effectiveness of low-impact engineering techniques and to characterize further the geotechnical and chemical properties of the area to be capped. Alternative 3 would cover an estimated 36.5 metric tons of DDT, accelerating attainment of water quality and sediment cleanup levels.

Under the selected remedy, the surface water quality goal for DDT of 0.22 ng/L is estimated to be reached by 2023. The sediment level for DDT of 230 µg/kg is estimated to be reached by 2039.

9.5 Alternative 4: Institutional Controls, Monitored Natural Recovery and Containment (Large Area Cap)

Estimated Capital Cost: $69,163,000
Estimated Annual Implementation Cost: $1,430,000 (ICs)
Estimated Five-Year Monitoring & Review: $3,420,000
Estimated Present Worth Cost: $81,992,000 (7% discount rate)
Estimated Construction Timeframe: 4-5 years

Alternative 4 is similar to alternative 3 but caps a larger area. Alternative 4 contains the following elements:

- The ICs program described in 9.3.1,
- The MNR program described in 9.3.2, and
- Cap placement over a greater area of the EA deposit.

This alternative would cap approximately 640 acres under a 45-cm cap of clean sand/coarse silt. The cap would cover an estimated 54.4 metric tons of DDT. It would include areas of potential erosion as well as areas that appear to be depositional but have the highest DDT and PCB concentrations. Alternative 4 would require 1,776,000 cubic yards of clean silty sand.

Cap material would come from harbor or maintenance dredging projects or from clean areas of the shelf. The clean sediment cap would accelerate recovery through:

- Physical armoring of 640 acres of the shelf bottom to prevent erosion of contaminated sediment by winter storms,
- Preventing dissolved contaminant flux from the sediment into the water column, and
- Reducing exposure and uptake of contaminants by benthic organisms by replacing effluent-affected sediment with a clean layer for recolonization.

Alternative 4 would use low-impact techniques to prevent resuspension of the soft, silty contaminated sediment that covers the PV Shelf at the 150 to 220 ft. depth. Studies to verify effectiveness of low-impact engineering techniques and to characterize accurately the geotechnical properties of the proposed capping area would precede construction.

Under this alternative, the surface water quality criteria for DDT of 0.22 ng/L is estimated to be reached in 2019. The sediment cleanup level of 230 µg/kg DDT is estimated to be reached in 2031. This alternative would achieve immediately the PCB sediment cleanup level of 7 mg/kg PCBs OC for the Shelf, but not the slope, of PV Shelf. The ICs program would continue to protect human health until fish reach remediation levels.

Table 9-1: Description of Alternatives, Estimated Cost by Element
(Totals do not equal sums because of rounding, contingencies, project management costs)

Alternative 1: No Action Alternative				
Program	Cost	Element	Details	Timeframe
NA	NA	NA	NA	NA
No cost associated with this alternative				

Alternative 2: Institutional Controls and Monitored Natural Recovery Summary				
Program	Cost	Element	Details	Timeframe
Institutional Controls Program				
Community Outreach and Education	$750,000	General population	Work with CBOs, media, and community relations specialists to inform people about behaviors that reduce risk of eating contaminated fish. Partner with health fairs, community fairs and local health depts. to provide educational materials and training. Includes feedback to gauge behavior change. Provide materials in multiple languages.	Ongoing
		High-risk population	Specific outreach materials and messages focused on fish preparation to reduce COCs for ethnic groups who include fish, particularly white croaker, as important part of their diet, and women of child-bearing age.	Ongoing
		Fish markets	Outreach to commercial fish market owners to inform them about dangers of buying fish from unlicensed dealers; coordinated with market enforcement element.	Ongoing
		Consumption survey	Conduct a new fish consumption survey to enable the FCEC to better target its outreach and education messages.	Year 1-2
Angler outreach	$226,000	Fishing piers and bait shops	Visit 8 fishing locations, 4-hr sessions at 4 times a week. Educate anglers about fish contamination, fish advisories, ID of contaminated fish species, and safer fish consumption practices. Keep bait shops supplied with educational materials.	Ongoing
	$65,000	Analyze pier-caught white croaker	Every year collect 10 white croaker from four fishing locations to analyze for DDTs and PCBs.	Annual
Enforcement and Monitoring	$210,000	Commercial fish markets; white croaker analysis	Long Beach, LA and Orange counties Env. Health Dept. market inspections. Estimate 250 market visits per year to 55 different markets. Check documentation of white croaker found in markets, purchase fish and analyze for DDTs and PCBs.	250 market visits per year to approx. 55 markets

Alternative 2: Institutional Controls and Monitored Natural Recovery Summary				
Program	Cost	Element	Details	Timeframe
		Wholesalers/ distributors	Local Env. Health Depts. check wholesaler/ distributor documentation. Work with CDFG/local depts. to develop inspection plan for random sampling of white croaker for analysis.	Ongoing, look for opportunities to expand program
	$136,000	Collect fish from catch ban area	Catch ban area monitoring: 5 areas, 10 white croaker and 10 kelp bass.	Every 5 years
	$100,000	Commercial catch ban, sport bag limit	CDFG patrols and enforcement. Patrol catch ban area.	Monthly patrols
Monitored Natural Recovery Program				
Natural Recovery Monitoring	$100,600	Fish in ocean monitoring	Sample fish from southeast and northwest of White Pt. outfalls. Collect 30 fish each of two species: 1 benthic feeding and 1 pelagic, for example: • white croaker, barred sand bass or CA scorpionfish, and • Pacific sardine or California chub mackerel. Analyze fish for DDTs & PCBs; analyze fillet and whole body.	Year 1 and at Year 5 and 10 for the Five-Year Review
	$1,028,000	Sediment sampling	Use LACSD sampling grid stations 1 through 10, B thru D. Take duplicates at C & B stations for total of 50 cores. Analyze 4-cm intervals for grain size, bulk density, TOC, DDT (6 isomers, DDMU, DDNU) and PCB congeners.	Year 1 baseline, fewer stations for Year 5 and 10 Five-Year Reviews
	$217,000	Water column sampling	Base monitoring plan on LACSD station grid. Measure water above seabed, mid-column and at water surface. Deploy multiple PED samplers at each location tbd. Analyze for DDT (6 isomers) and PCBs (congeners).	Year 1 baseline, fewer stations for Year 5 and 10 Five-Year Reviews
	$2,000,000	Site studies to support final ROD	Complete study of DDE reductive dechlorination. Perform 2-3 yr fish tracking study and studies to support revision of food web model.	Years 1 through 5

	Capital cost	Implementation net present value (7% discount rate, 10 year horizon)	Total	Grand Total
Total ICs	$ 1,637,000	$10,311,000	$11,948,000	
Total MNR	$ 3,713,000	$ 1,223,000	$ 4,936,000	
Alternative 2	$ 4,350,000	$11,534,000		$15,884,000

Alternative 3: Institutional Controls, Monitored Natural Recovery and Containment (outfall area cap) Summary					
Program	Cost	Element	Details		Timeframe
Institutional Controls Program (same as under Alternative 2)					
Monitored Natural Recovery Program (same as under Alternative 2)					
Outfall Area Capping (sand/silt cover) Program					
Silty/sand cap	$6,700,000	Treatability Studies	Define area to cover. Characterize sediment. Pilot low-impact techniques.		Year 1 & 2
	$27,036,000	Construction	Placement of 45-cm cover over approx. 340 acres. Requires 864,000 CY of coarse silt /fine to medium sand material.		Year 4
	$ 2,100,000	Construction Monitoring	Monitoring arrays to track resuspension plume and turbidity. Sample sediment and water column for COCs, cap evenness.		Year 4
	$1,704,000	Post-construction Monitoring	Sediment and water column sampling to assess cover thickness and movement and contaminant flux.		At 1st & 2nd Five-Year Reviews
	Capital cost	Net present value (7% discount rate, 10 year horizon)		Total	Grand Total
Total ICs	$ 1,637,000	$10,311,000		$11,948,000	
Total MNR	$ 3,713,000	$ 1,223,000		$ 4,936,000	
Total cover	$35,836,000	$ 1,041,000		$33,500,000	
Alternative 3	$41,186,000	$12,575,000			$53,761,000

Alternative 4: Institutional Controls, Monitored Natural Recovery and Containment (large area cap) Summary					
Program	Cost	Element	Details		Timeframe
Institutional Controls Program (same as under Alternative 2)					
Monitored Natural Recovery Program (same as under Alternative 2)					
Capping Program					
Silty/sand cap	$6,700,000	Treatability Studies	define area to cover; characterize sediment, pilot low-impact techniques		Year 1 & 2
	$53,813,000	Construction	placement of 45-cm cover over approx. 680 acres; requires 1,776,000 CY of sand/sediment material; assume 1/3 of placement using low-impact technique, 2/3 use spreading technique		Year 4 - 5
	$3,300,000	Construction Monitoring	monitoring arrays to track resuspension plume and turbidity, sediment and water column sampling		during construction
	$2,121,000	Post-construction Monitoring	sediment and water column sampling to assess cover thickness and movement and contaminant flux		At 1st & 2nd Five-Year Review
	Capital cost	Net present value (7% discount rate, 10 year horizon)		Total	Grand Total
Total ICs	$ 1,637,000	$10,311,000		$11,948,000	
Total MNR	$ 3,713,000	$ 1,223,000		$ 4,936,000	
Total Cover	$63,813,000	$ 1,295,000		$65,114,000	
Alternative 4	$69,163,000	$12,829,000			$81,992,000

10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The NCP requires the use of nine criteria to evaluate the different remediation alternatives individually and in comparison to each other. 40 CFR 300.430(f)(5)(i). The nine criteria are: 1) overall protection of human health and the environment, 2) compliance with applicable or relevant and appropriate requirements, 3) long-term effectiveness and permanence, 4) reduction of toxicity, mobility or volume through treatment, 5) short-term effectiveness, 6) implementability, 7) cost, 8) state acceptance, and 9) community acceptance.

These criteria are broken down into three categories. The first two criteria are *threshold criteria*, these are requirements that each alternative must meet in order to be eligible for selection. The next five criteria are *primary balancing criteria* that are used to weigh major trade-offs among alternatives. The last two, state and community acceptance, are *modifying criteria.*

This section of the interim ROD discusses the relative performance of each alternative against the nine criteria and the rationale for selecting the Preferred Alternative. The Feasibility Study contains a detailed analysis of each alternative against the nine criteria and a comparative analysis of the alternatives. Table 10-2 at the end of this section provides a summary of comparison of each alternative against the nine CERCLA criteria.

10.1 Threshold Criteria

10.1.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, and/or institutional controls.

Alternative 1, the No Action alternative, would not provide adequate protection of human health and the environment because no measures would be implemented to protect people from catching and/or consuming contaminated fish from PV Shelf. Because Alternative 1 fails the threshold criteria of overall protection of human health and the environment, it is not discussed further in this summary.

Alternative 2 protects human health through monitoring the reduction of contaminants in surface sediment, fish and water while maintaining a robust institutional controls (ICs) program. The ICs program funds angler and community outreach and a comprehensive enforcement program to reduce risks from consumption of fish that may contain unsafe levels of DDT and PCBs.

Alternatives 3 and 4 accelerate reduction of surface sediment concentrations of DDT and PCBs by capping areas of the shelf with the highest contaminant concentrations and the greatest potential to erode. The selected remedy would cap half the area capped under Alternative 4, which would cause less resuspension of sediment and release of COCs, and thus have less impact on worms, crustaceans and other invertebrates living in the sediment. Under Alternative 3, DDE concentration in surface water would reach the AWQC of 0.22 ng/L 14 years sooner than under the natural recovery scenario. Under Alternative 4, DDE concentration in surface water would reach the AWQC 18 years sooner. Under Alternatives 3 and 4, DDE in sediment would reach the cleanup level of 230 μg/kg 14 years and 22 years sooner, respectively, than Alternative 2.

Data on PCBs are insufficient to calculate loss rates in PV Shelf surface waters for any alternative. However, interim actions, such as ICs, taken to protect human health from DDT exposure will also protect people from PCBs exposure. After collecting additional data on PCBs, their loss rates in water and sediment will be calculated and PCBs will be addressed in the final ROD.

10.1.2 Compliance with ARARs

Section 121(d) of CERCLA and Section 300.430(f)(1)(ii)(B) of the NCP require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards criteria, and limitations, which are collectively referred to as ARARs, unless such ARARs are waived under CERCLA Section 121(d)(4). Compliance with ARARs addresses whether a remedy will meet all of the ARARs or provide a basis for invoking a waiver.

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

All alternatives include a waiver of the the PCBs ambient water quality criteria (AWQC) for human health. The selected remedy is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal requirements. CERCLA and the NCP allow ARARs waivers for interim measures. 42 U.S.C. §121(d)(4)(A); 40 CFR 300.430(f)(1)(ii)(C)(1). EPA will determine if the PCB AWQC can be achieved after further investigation of PCBs flux and background concentrations.

Under the selected remedy, the DDT AWQC for human health, 0.22 ng/L, and ecological receptors, 1 ng/L, would be achieved 14 years sooner than under Alternative 2. Alternative 4 would achieve the DDT AWQC 18 years sooner than under Alternative 2. Alternative 2 would take the longest to meet AWQC. The PCB AWQC for ecological receptors has been met.

Placement of capping material under either Alternative 3 or 4 would require compliance with the substantive requirements of Section 404 of the Clean Water Act, the Ocean Dumping Act, 33 U.S.C. Section 1404 et seq., federal ocean dumping regulations at 40 CFR Part 220 et seq. Dredged material must meet substantive federal testing guidelines before it can be approved for disposal; *see* 40 CFR Part 227.

10.2 Primary Balancing Criteria

10.2.1 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls. This is an interim action that includes studies to determine what further remedial actions can provide additional, permanent risk reduction.

Each alternative except "no action" provides some degree of long-term effectiveness and permanence. Alternative 2 would not provide as much long-term effectiveness and permanence as Alternatives 3 and 4. Alternative 3 places a 45-cm cover over the area of greatest contamination. Although the area has weaker currents than those measured at either end of the Shelf (Noble, et al. 2008), the characteristics of the contaminated sediment make it more susceptible to erosion (Ferré and Sherwood, 2008). These data indicate a 45-cm thick cover would provide long-term protection. Alternative 4 caps the high concentrations of DDTs and PCBs in the outfall area and to the north where existing measurements show the area is still net depositional; however, analysis of currents and sediment properties indicate erosion of contaminated sediments may occur in the future (Ferré and Sherwood, 2008).

Erosion, seismic events, bioturbation, and recontamination are the primary processes that have a potential to impact the long-term effectiveness and permanence of either cap (Palermo et al., 1999). Although cap thickness under either Alternative 3 or 4 is considered adequate to provide complete physical as well as biological isolation of the contaminated sediments, additional studies will be included under RD to verify appropriate cap thickness. Long-term monitoring will be necessary to check cap integrity and perform any repairs to the cap if breaches are found.

For the selected remedy, an important consideration for long-term effectiveness is the physical stability of the cap, the depth of bioturbation, and potential recontamination. The capping under Alternatives 3 and 4 would limit contaminant migration and uptake by invertebrates. Alternative 3 is less disruptive to the environment since it caps only about 1.6 percent of the PV Shelf, but covers an estimated 44 percent of the total mass of DDTs. The timeframe for PCB in sediment and water to attain RAOs would be calculated after gathering and analyzing additional data on PCB loss. Alternative 4 caps a larger area; however, by resuspending more sediment, it could increase the bioavailability of COCs, retarding the recovery time for fish in the long run.

10.2.2 Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

None of the alternatives reduces the toxicity, mobility, or volume of contamination at the PV Shelf Study Area through treatment. However, there are no principal waste materials onsite. Some permanent reduction in toxicity, mobility, or volume (without treatment) would occur through natural recovery processes over a period of time at the site.

The selected remedy is an interim remedial action. Studies of reductive dechlorination of DDE are underway. Once the mechanism responsible for the reductive dechlorination is understood, the potential to use treatment to accelerate the breakdown of DDE will be assessed. The selected remedy allows greater flexibility for future treatment, because it caps a smaller area than Alternative 4, leaving more surface sediment exposed, which a treatment technique could be applied to.

10.2.3 Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community or the environment during construction and operation of the remedy until cleanup levels are achieved.

Alternatives 2, 3 and 4 rely on the ICs program to protect human health in the short-term. Placement of capping materials will have an adverse short-term effect on the existing benthic organisms present in the surface sediments, but less so under the Alternative 3 than under Alternative 4. Cap placement could resuspend the surficial soft sediment, exposing the deeper, more contaminated sediment. Although Alternative 4 would achieve sediment levels sooner than Alternative 3, by 2031 vs. 2039, less disturbance of sediment and destruction of benthic organisms makes Alternative 3 preferable. Although PCB loss rates have not been modeled, PCBs are co-located with the DDT; therefore, capping would reduce PCBs concentrations in sediment and water. Both Alternatives 3 and 4 would cap the area of highest PCBs sediment concentrations.

10.2.4 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operations. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

10.2.4.1 Technical Feasibility. Implementation of the alternatives evaluated present technical challenges, especially the placement of sand material in Alternatives 3 and 4. However, all alternatives evaluated are considered technically implementable. Alternative 4 would be the most difficult alternative to implement.

Alternative 2 is most easily implemented. The technical feasibility of the Institutional Controls (ICs) program and monitored natural recovery (MNR) are high. The ICs program has been in place for many years and has a proven track record of successful implementation. Monitoring activities on PV Shelf have been conducted by local and federal agencies. The water depth poses challenges to collection of sediment cores; however, suitable equipment is available and has been used successfully. Collection of fish, sediment, and water are all technically feasible.

Technical feasibility for Alternatives 3 and 4 requires evaluation of source materials for the cap and the placement method. The availability of sand for capping at PV Shelf Study Area is difficult to predict because of the need of sand for beach replenishment or in-water and upland construction. However, the volumes required, 864,000 yd^3 for Alternative 3, and 1,776,000 yd^3 for Alternative 4, is less than sediment volumes projected to be generated by maintenance dredging. The Port of Los Angeles harbor deepening project is estimated to produce over 800,000 yd^3 in need of ocean disposal that potentially could be suitable for capping. It is likely that the most cost-effective source of cap material would be from areas on-site that have clean sediment or from maintenance dredging of Southern California ports and harbors. Material source(s) would be identified during the design phase.

Placement of subaqueous material under either Alternative 3 or 4 would be technically difficult because of the fine grain and high moisture content of the effluent-affected sediment. Cap material would need to be applied slowly and uniformly to reduce resuspension of contaminated sediments. Placement techniques considered in the FS include the spreading method using a split hull material barge or hopper dredge and low-impact placement methods such as submerged drag-arm, fallpipe or a tremie tube with diffuser. Low-impact techniques would be used to place an initial cap layer of 10 to 15 cm, then the rest of the cap could be applied using the spreading technique. The spreading method could be used to place most of the cap material while more precise placement methods could be designated for areas nearer to the outfalls. A buffer zone would be established around the outfalls so that cap material would not interfere with outfall operation or maintenance activities. Due to its increased scope, the technical feasibility for Alternative 4 is lower than Alternative 3.

10.2.4.2 Administrative Feasibility. The administrative feasibility of Alternative 1 would be difficult because it would require EPA to stop funding local agencies and organizations involved in implementation of the ICs program. Cessation of ICs would be a resource loss and would not be supported by the public. Alternatives 2, 3 and 4 require a high degree of coordination among numerous agencies to conduct education, enforcement, and monitoring activities for the institutional controls program. However, the existing ICs program has been operating for several years and the administrative issues can continue to be worked out. The plan for monitoring natural recovery is administratively feasible as the site has been monitored and sampled for many years.

Cap construction would increase ship traffic and would require coordination with other agencies that have jurisdiction in the area. Placement of capping material under either Alternative 3 or 4 would require coordination with the Port of Los Angeles if dredged material from the harbor is used.

10.2.5 Cost

A comparison of the costs for each alternative is provided in Table 10-1.

Table 10-1: Comparison of Remedial Alternative Costs (10-Year Implementation Horizon)

Alternatives	Capital Costs Non-Discounted Cost	Periodic Costs Net Present Value Cost	Total Costs
Alternative 1 – No Action	$0	$0	**$0**
Alternative 2 – Institutional Controls (ICs) and Monitored Natural Recovery (MNR)	$4,350,000	$11,534,000	**$15,884,000**
Alternative 3 –ICs, MNR and Target Area Capping	$41,186,000	$12,575,000	**$53,761,000**
Alternative 4 – Containment with MNR and Institutional Controls	$69,163,000	$12,829,000	**$81,992,000**

Since the selected remedy is an interim action, alternative costs are projected out over a 10-year period. The no action alternative would require no capital or operating costs and would be less expensive than current costs due to existing ICs program. Besides the no action alternative, Alternative 2 is the least expensive with total costs estimated at $15.9 million over 10 years. Alternative 3 is considerably more expensive, with total costs over 10 years of $53.8 million. Alternative 4 would be the most expensive remedial alternative, at $82 million over 10 years.

Both alternatives 3 and 4 include a budget of $6 million for treatability studies as part of remedial design and post-cap construction monitoring.

10.3 Modifying Criteria

10.3.1 State Agency Acceptance

DTSC supports the selected remedy, with the understanding that this is an interim action. DTSC raised questions about the physical characteristics of the sediments, and the seismic impact on sediment transport. DTSC will continue to work with EPA through the remedial design process to address technical issues.

10.3.2 Community Acceptance

Overall, the public is supportive of this action. The public comments, along with EPA's responses, are included in the Responsiveness Summary in Part III of this interim ROD.

Table 10-2 presents a comparison on alternatives against the nine CERCLA criteria in tabular form.

Table 10-2: Evaluation of Alternatives against CERCLA Criteria

CERCLA Criteria	Alt.1 No Action	Alt. 2 Institutional Controls & Monitored Natural Recovery	Alt. 3 ICs, MNR & target Area Cap	Alt 4: ICs, MNR & Large Area Cap
THRESHOLD CRITERIA				
Overall Effectiveness				
Human Health Protection RAO 1: reduce to acceptable levels the risks to human health from ingestion of fish contaminated with DDTs and PCBs Achieve the interim goals of median DDT concentrations in surface sediment of 46 mg/kg OC (double the target concentration) and PCBs concentrations of 7 mg/kg OC by the first 5-Year Review.	No reduction in risk. DDT concentrations will remain high around outfalls but drop in other areas.	Uses ICs to minimize exposure from ingestion of contaminated fish. COCs on the Shelf would drop over time, but unlikely to meet interim goal by 5-Year Review.	Uses ICs to minimize exposure from ingestion of contaminated fish. Would apply a cap to erosive area that also has highest levels of COCs (approx. 1.3 km^2), to prevent erosion and reduce COCs in sediment. Interim goals for COCs in sediment would be met.	Uses ICs to minimize exposure from ingestion of contaminated fish. Cap would cover approx. 2.74 km^2 of the Shelf, including erosive area and area of high COCs. Interim goals for COCs in sediment would be met sooner than under Alt. 3.
Environmental Protection RAO 2: Achievement of human health ARARs would also provide protection for wildlife.	No reduction in risk.	Does not provide additional protection. Median DDT conc. forecasted to fall below 200 µg/kg by 2053.	Isolates 1.3 km^2 area of highest COC concentra-tion. Median DDT conc. forecasted to fall below 200 µg/kg 14 yrs sooner than under no action.	Isolates 2.74 km^2 of sediment with highest COC concentrations. Median DDT conc. forecasted to fall below 200 µg/kg 22 yrs sooner than under no action.
Compliance with ARARs				
Chemical-Specific ARARs Environmental AWQC: DDT 1 ng/L; Human Health AWQC: DDT 0.22 ng/L; PCBs 0.064 ng/L	DDT levels in water projected to meet HH AWQC by 2037. Date for PCBs to reach HH AWQC unknown. This alt. doesn't monitor to confirm AWQC met.	DDT levels in water projected to meet HH AWQC by 2037. Alt. includes monitoring. Date for PCBs to reach HH AWQC being determined.	DDT levels in water projected to meet HH AWQC by 2023. Alt. includes monitoring. Date for PCBs to reach HH AWQC being determined.	DDT levels in water projected to meet HH AWQC by 2019. Alt. includes monitoring. Date for PCBs to reach HH AWQC being determined.
Location-Specific ARARs **See table 13-1**	none	Must comply with substantive requirements of ESA and CZMA	Alt. 2, plus capping must comply with Section 404 of CWA & Section 10 of Rivers and Harbor Act	Alt. 2, plus capping must comply with Section 404 of CWA & Section 10 of Rivers and Harbor Act

Table 10-2: Evaluation of Alternatives against CERCLA Criteria

CERCLA Criteria	Alt.1 No Action	Alt. 2 Institutional Controls & Monitored Natural Recovery	Alt. 3 ICs, MNR & target Area Cap	Alt 4: ICs, MNR & Large Area Cap
Action-Specific ARARs **See table 13-1**	none	Monitoring must comply with relevant CA Fish & Game Title 14 regulations, Fish & Game Codes §2080 & §4700	See Alt. 2., plus capping must comply with MRPSA, Federal ocean dumping regulations, & Section 403 of CWA	See Alt. 2., plus capping must comply with MRPSA, Federal ocean dumping regulations, & Section 403 of CWA
BALANCING CRITERIA **Long-Term Effectiveness**				
Magnitude of Residual Risk	Existing risk will drop over time, but this alt. does not track changes.	DDT loss processes are predicted to reduce DDT risk over 30-60 years.	Action predicted to reduce DDT risk over 15-40 years. Because waste is only contained, hazard remains. Cap would prevent exposure and COC loss.	Action predicted to reduce DDT risk over 10-30 years. Because waste is only contained, hazard remains. Cap would prevent exposure and COC loss.
Adequacy & Reliability of Controls	No controls over remaining contamination.	ICs minimize exposure.	ICs minimize exposure. Reliability of a cap can be high. Would need monitoring & maintenance.	ICs minimize exposure. Reliability of a cap can be high. Would need monitoring & maintenance.
Need for 5-Yr Reviews	Yes.	Yes. Review would be required to ensure adequate protection of human health and the environment.	Yes. DDTs & PCBs left in sediment. DDTs degrading, but not PCBs.	Yes. DDTs & PCBs left in sediment. DDTs degrading, but not PCBs.
Reduction of Toxicity, Mobility, or Volume thru Treatment				
Treatment Process	None	None	None	None.
Reduction of Toxicity, Mobility or Volume	Reduction in volume thru loss processes & DDE transformation. Toxicity of daughter	See Alt. 1.	See Alt. 1. Cap would reduce mobility but is not considered treatment.	See Alt. 1. Capping would reduce mobility but is not considered treatment.

Table 10-2: Evaluation of Alternatives against CERCLA Criteria

CERCLA Criteria	Alt.1 No Action	Alt. 2 Institutional Controls & Monitored Natural Recovery	Alt. 3 ICs, MNR & target Area Cap	Alt 4: ICs, MNR & Large Area Cap
	products unknown.			
Statutory Preference for Treatment	No principal threat wastes identified.	No principal threat wastes identified.	No principal threat wastes identified.	No principal threat wastes identified.
Short-Term Effectiveness				
Community Protection	Risk to community increased since existing ICs would stop under this alternative.	Risk to community managed through ICs.	Risk to community managed thru ICs. May cause short-term increase in COC bioavailability from resuspended sediment.	Risk to community managed thru ICs. May cause short-term increase in COC bioavailability from capping resuspended sediment.
Worker Protection	N/A	N/A	No significant risk from monitoring & capping activities.	No significant risk from monitoring & capping activities.
Environmental Impacts	N/A	N/A	Resuspension of EA sediment; burial of benthic organisms.	Resuspension of EA sediment; burial of benthic organisms.
Time Until Action is Complete	N/A	RAOs predicted to be met in 30-45 years under natural loss processes.	RAOs predicted to be met 14 years sooner than thru natural loss processes.	RAOs predicted to be met 18 to 22 years sooner than thru natural loss processes.
Implementability				
Ability to Construct & Operate	No construction or operation.	No construction. ICs program in operation since 2001. MNR program easy to implement.	Capping difficult because of location, depth & characteristics of sediment. ICs & MNR easy to implement.	Capping difficult because of location, depth & characteristics of sediment. ICs & MNR easy to implement.
Ease of Doing More Action if Needed	By pursuing an interim ROD, additional action would be easy.	Interim ROD leaves door open for further action at time of final ROD.	Interim ROD leaves door open for further action at time of final ROD.	Interim ROD leaves door open for further action at time of final ROD.

Table 10-2: Evaluation of Alternatives against CERCLA Criteria

CERCLA Criteria	Alt.1 No Action	Alt. 2 Institutional Controls & Monitored Natural Recovery	Alt. 3 ICs, MNR & target Area Cap	Alt 4: ICs, MNR & Large Area Cap
Ability to Monitor Effectiveness	No monitoring.	ICs & MNR programs monitor COCs in sediment, water, fish & behavior changes from outreach.	See Alt. 2 plus monitor cap stability and effectiveness.	See Alt. 2 plus monitor cap stability and effectiveness.
Ability to Obtain Approvals & Coordinate with Other Agencies	N/A	Successful ongoing coordination with State, federal & local agencies.	See Alt. 2., anticipate no difficulties coordinating with other agencies for monitoring. Need CA Coastal Commission approval & possibly USACE permit if marine sediment is dredged for cap material.	See Alt. 3. Need CA Coastal Commission approval & possibly USACE permit if marine sediment is dredged for cap material.
Availability of Equipment and Materials	N/A	No special equipment.	Cap material sources available.	Cap material sources available.
Availability of Technologies	N/A	Monitoring equipment and procedures well established.	Technologies available; RD studies needed to determine best method.	Technologies available; RD studies needed to determine best methods.
MODIFYING CRITERIA				
State Acceptance	Not acceptable	State DTSC is partner in the ICs program, not opposed to this Alt. but feels the more aggressive approach of Alt. 3 is better.	State DTSC supports iterative approach to remediation, is active in ICs program and supports additional studies before preparing final ROD.	State prefers Alt. 3 as more measured approach to cleanup.
Community Acceptance	Not acceptable	Four commenters concerned capping not effective. Felt Alt. 2 preferrable.	Overall, public supportive of Alt. 3 as iterative approach that accelerates recovery.	Two commenters felt Alt. 4 would be more protective, but understood value of an iterative approach.

11.0 PRINCIPAL THREAT WASTES

The NCP states that, "EPA expects to use treatment to address the principal threats posed by the site…" and "…to use engineering controls, such as containment, for wastes that pose a relatively low long-term threat." 40 CFR 300.430(a)(iii)(A) and (B). There are no known contaminant source materials at PV Shelf.

Contaminant emissions decreased after 1971 due to the disconnection of Montrose from the sewer system and improved wastewater treatment of the effluent prior to discharge. Since then, continuous improvements in treatment have reduced the load of total suspended solids. In November 2002, all of the wastewater discharged from the JWPCP started receiving full secondary treatment. Discharge of suspended solids is now less than 8,000 metric tons a year (mt/yr). The concentrations of DDT in effluent have been near or below the detection limit since 1989 and have not been detected since 2002. PCBs have not been detected above the detection limit since 1985 (LACSD, 2006). The reporting limits are currently 0.01 microgram per liter (µg/L) for the various isomers of DDT, and between 0.05 µg/L and 0.5 µg/L for the PCB Arochlors (LACSD, 2007).

The EA deposit appears to be eroding in the vicinity of the outfalls. As a result, surface concentrations of COCs appear to have increased over the previous two decades in that area. Modeling of the sediment bed (Sherwood, 2002) indicates the potential for sediment from the outfall area to spread. Under this scenario, the outfall area poses a long-term threat to the rest of the site. Alternatives 3 and 4 would address the threat by capping the area. Alternatives 2, 3 and 4 would further evaluate DDE transformation to assess the viability of treatment to accelerate this process.

12.0 SELECTED REMEDY

This interim ROD presents the selected interim remedial action for the Palos Verdes Shelf, OU5 of the Montrose Chemical Corp. Site, Los Angeles County, California, in accordance with CERCLA, as amended by SARA, and to the extent practicable, the NCP. This decision is based on the information contained in the Administrative Record, which includes the public comments on the Proposed Plan for this OU.

The following subsections provide details on the rationale for the selected remedy, the description of the selected remedy, the summary of estimated remedy costs, and expected outcomes.

12.1 Summary of the Rationale for the Selected Remedy

As discussed in section 2.4, the 2001 Action Memorandum put in place an Institutional Controls program as a non-time-critical removal action to serve as an interim measure to protect human health while EPA completed its investigation of PV Shelf. The interim remedial action continues the ICs program, caps the area of highest surface sediment contamination, and includes studies to help develop a final remedial alternative. The background and rationale for this interim remedial action are discussed below.

After DDT and PCBs ceased to be discharged into the Los Angeles County sanitation system, effluent from the outfalls buried the contaminated sediment. As LACSD adopted progressively more advanced water treatment systems--from primary to partial secondary to full secondary--the amount of total suspended solids (TSS) discharged from the outfalls declined. Since full secondary treatment was instituted in Fall 2002, 97 percent of the TSS are removed from the wastewater before discharge. Although historical sedimentation rates for PV Shelf are net depositional (Lee, 2009), analysis of sedimentation rates across the 60 m depth contour (Sherwood, 2006) indicate the southeast near the outfalls area appears to be erosive. Since this area contains the highest concentrations of COCs in surface sediment and at depth, erosion could lead to more COCs entering the environment. Therefore, although uncertainties remain regarding contaminant fate and transport and achievable reductions of COCs in fish, an interim action to stop erosion is warranted and will not be inconsistent with a final remedial action.

Further analysis of sediment transport found that rates of sedimentation have dropped from historical highs but that the Shelf remains net depositional. Two areas, however, may be losing more sediment than they are gaining. One of these areas is between the outfall pipes, where the EA deposit is thickest and has the highest surface concentrations found on the Shelf. Because of the potential to release this contaminated sediment into the larger environment, this interim ROD targets this area for immediate action with additional remedial actions to be determined after completing the studies discussed here.

The *2002/2004 Coastal Marine Fish Contaminants Survey* (EPA/NOAA, 2007) sampled 23 species of fish across a three-county area. The survey found that contaminant concentrations in fish, particularly white croaker on PV Shelf, ranged widely over a small geographic area. The bioaccumulation model used to set cleanup levels contains uncertainty (section 8.1). A better understanding of the sediment-to-fish pathway is needed. EPA is working with the MSRP lead agency, NOAA, to collect data on white croaker movements and home ranges. A two-year fish tracking study will establish whether the outfalls at White Point form a barrier to white croaker movement, and if white croaker from PV Shelf migrate past Redondo Canyon into Santa Monica Bay to the north or travel south to the Los Angeles and Long Beach harbors. Findings from the fish tracking study will help determine whether the most contaminated fish are getting their body burden from PV Shelf sediment and this information will guide future decisions about the effectiveness of capping.

The Coastal Marine Fish Contaminants Survey indicated that PCBs pose a greater threat to human health than DDT (OEHHA, 2009). The quantity of PCBs in the PV Shelf sediment is one-tenth the amount of DDT, with its distribution pattern matching that of DDT. However, changes in PCBs concentrations within the EA sediment deposit and water column have not been monitored. Therefore, EPA lacks sufficient data to calculate future PCBs concentrations in sediment and water. The selected remedy includes baseline sediment and water sampling across PV Shelf for PCBs and DDTs. These data will allow EPA to develop loss rates for PCBs, which can be used to forecast future PCB levels in water and sediment for the final remedial action.

Changes in the contaminated sediment deposit show that DDE (the dominant isomer) concentrations are declining. Although the NRDA noted this phenomenon, calculations at that time indicated this process was occurring on a scale of centuries. More recent data indicate the process is occurring much more rapidly, with a half-life of 36 years to as low as 7 years (Eganhouse and Pontillo, 2007). The interim remedial action includes further investigation of the DDE transformation process.

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12.2 Detailed Description of the Selected Remedy

The selected interim remedy for the Palos Verdes Shelf is Alternative 3: continuation of the existing ICs program, monitoring of the natural recovery, and placement of a cap over the most contaminated and erosive area of sediments. As part of the monitored natural recovery component of the remedy, EPA will undertake additional studies. After these studies are completed, but no later than five years after completion of the Interim Remedial Action, EPA will decide whether additional capping or other measures are warranted.

12.2.1 Institutional Controls Component

The ICs program is succeeding in its outreach and education goals and has established a program with multiple partners. The ICs program will continue and be expanded to address ocean-to-market pathway. The ICs program is described in the *Institutional Controls Program Implementation Plan* (January 2009), included as Appendix D in the PV Shelf Feasibility Study. The EPA Fish Contamination Education Collaborative (FCEC) includes agencies and organizations interested in safe fishing practices. The FCEC conducts public outreach and education ICs and maintains a website, www.pvsfish.org. The site provides information to the public regarding the contaminated fish problem and local activities and events that promote healthy fish consumption.

The FCEC currently includes various agencies and organizations that receive funding from EPA, including California Department of Fish and Game, Los Angles County Dept. of Public Health, Orange County Health Care Agency, Long Beach Environmental Health, and numerous community-based organizations (CBOs). The ICs program currently includes or will incorporate the following activities.

1) **Community Outreach and Education**

   General Population: Work with Community-based organizations, media, and community relations specialists to inform people about behaviors that reduce risk of eating contaminated fish. Partner with health fairs, community fairs and local health departments to provide educational materials and training; solicit feedback to gauge behavior change; produces materials in multiple languages.

   High-risk population: Distribute specific outreach materials and messages focused on women of child-bearing age and ethnic groups who consume fish, particularly white croaker, as an important part of their diet.

   Fish markets: Conduct outreach to commercial fish market owners to inform them about dangers of buying fish from unlicensed dealers; coordinated with market enforcement element.

   Fish consumption survey: Conduct a fish consumption survey to update the 1994 *Santa Monica Bay Seafood Consumption Survey*. A new survey will enable the FCEC to better target its outreach and education messages.

2) **Angler Outreach**

   Fishing piers and bait shops: Visit popular fishing locations to educate anglers about fish contamination, fish advisories, how to identify fish species, and how to prepare fish to reduce COCs. Keep bait shops supplied with educational materials.

Analysis of pier-caught white croaker: Collect white croaker from fishing locations and analyze for DDTs and PCBs.

3) **Enforcement and Monitoring**

Commercial fish markets: Inspect markets for white croaker. Check documentation of white croaker found in markets, purchase fish and analyze for DDTs and PCBs.

Wholesalers/Distributors: Visit wholesale locations to check wholesaler/distributor documentation. Develop inspection plan for random sampling of white croaker.

Collect fish from commercial catch ban area: Analyze contaminant concentrations in white croaker and kelp bass from areas within the white croaker commercial catch ban.

Commercial catch ban, sport bag limit: Patrol commercial catch ban area and enforce sport fishing white croaker bag limit.

12.2.2 Monitored Natural Recovery (MNR)

Natural attenuation processes include abiotic degradation, dispersion, and burial. Monitoring will evaluate the effectiveness of the capping and natural recovery processes.

Fate and transport analyses conducted as part of the RI/FS indicate that the timeframe necessary to reduce the remaining DDE concentrations to acceptable levels through MNR ranges from approximately 45 to 140 years. Field data collected in 2007-2008 combined with baseline monitoring data and reductive dechlorination studies will be used to reduce the uncertainty associated with the natural recovery timeframe. For baseline monitoring, LACSD sediment monitoring locations will be used.

PCB data are insufficient to project attainment of PCBs cleanup levels. Therefore, part of the interim action includes collection of PCBs data in sediment and water that can be used to forecast PCBs loss rates. This information will be used to develop subsequent remedial actions.

Monitoring will be conducted over the life of the remedial action to evaluate performance and optimize effectiveness. Monitoring shall be conducted in accordance with the approved RD/RA documents. Points of compliance and specifications for monitoring cap effectiveness will be developed as part of the RD/RA. Cap monitoring will provide data on performance, including whether the cap is stable and performing in a manner to satisfy remedy requirements.

Additional studies included under this interim ROD will be used to develop timelines for achievement of water and sediment cleanup levels for PCBs and DDTs.

Monitoring plans will be developed during RD to:

- Demonstrate whether or not capping and MNR will reduce surface concentrations of all COCs to cleanup levels within 30 years,
- Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other changes) that may reduce the efficacy of the cap and/or natural recovery processes,
- Identify any potentially toxic transformation products, and
- Verify attainment of remediation objectives.

Natural recovery monitoring will track changes in sediment, water and fish species through sampling and analysis at Year 1 (after interim ROD is signed), and at five-year intervals for the Five-Year Review until a final ROD is in place.

12.2.3 Capping Component

The selected remedy will install a cap to prevent erosion and eliminate exposure to high concentrations of COCs in sediment. The capping component consists of the following:

- Delineate area to be capped. Sampling and analysis will take place in 2009-2010 to better define horizontal and vertical boundaries of the area, including identifying the edge of the deposit. Collect data on sediment characteristics (grain size, bulk density, shear stress) necessary for cap design. Modeling and treatability studies to pilot low-impact techniques are scheduled for 2010-2011.
- Place 45 cm fine sand/silt layer over approximately 300 acres to stop COC flux and transport, and eliminate benthic invertebrates feeding in area of most contaminated sediment. Cap would require an estimated 864,000 cubic yards of material. Cap construction will follow assessment of modeling and treatability studies and is tentatively scheduled for Spring 2012.
- Monitor during construction, including tracking resuspension plume and turbidity and sampling of sediment and water column.
- Monitor the site post-construction to assess cap thickness, cap movement, including compaction, and contaminant flux, to verify effectiveness and stability of the cap.

12.2.4 Five-Year Review Component for the Selected Remedy

A review is required at a minimum every five years if a remedy is selected that results in hazardous substances, pollutants or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. 40 CFR §300.430[f][4][ii] Because the selected remedy will not achieve levels that allow for unlimited use and unrestricted exposure within five years, EPA will conduct five year reviews in accordance with EPA policy. Reviews will begin five years after initiation of the remedial action to help ensure that the selected remedy is protective of human health and the environment. When a final remedy is selected the five-year reviews will become part of that action.

12.3 Summary of the Estimated Remedy Cost

Table 12-1 summarizes the present net worth for the selected remedy, while Table 12-2 provides a more detailed summary of costs. The present worth cost of the selected remedy is $53.8 million.

The cost elements and the resulting present worth cost estimate provide an order-of-magnitude engineering cost estimate that is expected to be +50% to -30% of the actual project cost. Changes in the cost elements are likely to occur because of new information and data collected during the engineering design of the selected remedy.

Table 12-1: Summary of Selected Remedy Present Worth Analysis										
	Capital Costs			**Annual**	**Periodic Costs (5-Year Reviews)**			**Total Cost**	**Discount Factor 7%**	**Present Worth**
Year	ICs	MNR	Capping	ICs Implementa-tion Costs	ICs	MNR	Post-Cap			
0	1,637,000	3,713,000	35,836,000					41,186,000	1.000	$41,186,000
1				1,430,000				1,430,000	0.9346	1,337,000
2				1,430,000				1,430,000	0.8734	1,249,000
3				1,430,000				1,430,000	0.8163	1,167,000
4				1,430,000				1,430,000	0.7629	1,091,000
5				1,430,000	219,300	1,001,000	852,000	3,502,000	0.7130	2,498,000
6				1,430,000				1,430,000	0.6663	953,000
7				1,430,000				1,430,000	0.6227	890,000
8				1,430,000				1,430,000	0.5820	832,000
9				1,430,000				1,430,000	0.5439	778,000
10				1,430,000	219,300	1,001,000	852,000	3,502,000	0.5083	1,780,000
TOTALS: Capital Cost $41,186,000				14,300,000	5-Yr Review total: $4,145,000			59,630,000		$53,761,000

Key: ICs – Institutional Controls component
MNR – Monitored natural recovery component

Table 12-2: Summary of Selected Remedy Costs
a) Institutional Controls Details

Description	Quantity	Unit Cost	Unit	Total	Comment
Year 1 Costs					
Institutional Controls Program Management & Coordination	1	$ 208,000	EA	$ 208,000	Based on 2009 EPA work plan
Monitoring					
Monitoring - Market					
Plans	1	$ 14,000	LS	$ 14,000	FSP, WAPP, HSP
Sample Collection	1	6,600	LS	6,600	Assumes 10 markets; based on hours in 2009 EPA work plan
Sample Materials	1	1,000	LS	1,000	
Shipping/Transport	1	1,000	LS	1,000	Samples and equipment
Data Assessment	1	25,000	LS	25,000	Includes data management, and QA/QC oversight and data validation; based on hours in 2009 EPA work plan
Analysis	50	750	EA	$ 37,500	10 markets, 5 white croaker at each; sample preparation, lipid content, DDT (6 isomers) and PCB congener analysis
Monitoring- Catch Ban Area					
Plans	1	$ 10,000	LS	$ 10,000	FSP, HSP – same QAPP for market monitoring
Mobilization/Demobilization	1	3,400	LS	3,400	Includes travel and per diem
Boat Rental	4	4,500	LS	18,000	Includes boat and labor for 4 days
Sampling Materials	1	1,000	LS	1,000	
Shipping/Transport	4	1,000	LS	4,000	Samples and equipment
Data Assessment	1	25.000	LS	25,000	Includes data management and QA/QC oversight and data validation; based on hours in 2009 EPA work plan
Analysis	100	750	EA	75,000	5 catch ban area locations, 10 white croaker and 10 kelp bass each; sample preparation, lipid content, DDT (6 isomers) and PCB congener analysis
Monitoring – Pier					
Plans	0	$ -	LS	$ -	same as market monitoring plan
Sample Collection	1	5,300	LS	5,300	Assumes 4 piers
Sampling Materials	1	1,000	LS	1,000	
Shipping/Transport	1	1,000	LS	1,000	Samples and equipment
Data Assessment	1	25,000	LS	25,000	Includes data management, QA/QC oversight and data validation; based on hours in 2009 EPA work plan
Analysis	40	750	EA	30,000	4 piers, 10 white croaker at each; sample preparation, lipid content, DDT (6 isomers) and PCB congener analysis

Outreach					
Community Outreach Angler Outreach	1 1	$ 551,000 226,000	LS LS	$ 551,000 226,000	Based on 2009 EPA work plan Based on 2009 EPA work plan
Enforcement					
City & County Health Agencies CA Dept. of Fish and Game	3 1	$ 42,000 $100,000	EA EA	$ 126,000 $ 100,000	Training, tracking, and reporting for Long Beach, LA and OC market inspections; based on 2009 estimate Annual agreement to support CDFG patrols of catch ban area and piers, and CDFG assistance to Co. Health Agencies
Subtotal A Contingency (20% of Subtotal A) Subtotal B Project Mgmt (6% of Subtotal B)				1,287,000 257,400 1,544,400 92,600	 10% scope and 10% bid From USACE and EPA estimating Guide July 2000
Total Capital Costs for ICs				1,637,000	
ICs Implementation Costs for Years 1 – 5 Monitoring – Market Analysis Monitoring – Market Monitoring – Pier Analysis Monitoring – Pier Community Outreach Enforcement Subtotal A Contingency (20% of Subtotal A) Subtotal B Project Mgmt (6% of Subtotal B)	5 250 5 200 5 5	$ 48,000 750 $ 32,300 $ 750 $750,000 226,000	LS EA LS EA LS LS	$240,000 187,500 $161,500 $ 150,000 3,750,000 1,130,000 $5,619,000 1,123,800 $240,000	Includes sample collection, data management, an QA/QC oversight and data validation; based on hours in 2009 EPA work plan 10 markets, 5 white croaker at each; sample preparation, lipid content, DDT (6 isomers) and PCB congener analysis. Includes sample collection, materials, shipping/transportation, data management and QA/QC oversight and data validation; based on hours in 2009 EPA work plan 4 piers, 10 white croaker at each;; sample preparation, lipid content, DDT (6 isomers) and PCB congener analysis same as initial LOE same as initial LOE 10% scope and 10% bid From USACE and EPA Estimating Guide July 2000
Annual ICs Implementation Costs Subtotal for Years 1-5				$1,430,000	annual cost
Total ICs Implementation Costs for Yrs 1 -5				$7,150,000	
Total ICs Implementation Costs NPV for Yrs 1 -5				$5,863,,500	7% discount rate

Year 5 Only Monitoring – Catch Ban Area	1	$ 61,400	LS	$ 61,400	Year 5 only; includes mob/demob, boat rental, labor, materials, shipping/transport, data management, and QA/QC oversight and data validation; based on hours in 2007 EPA work plan
Analysis Monitoring – Catch Ban Area	100	$ 750	EA	75,000	Year 5 only; 5 catch ban locations, 10 white croaker and 10 kelp bass each; sample preparation, lipid content, DDT (6 isomers) and PCB congener analysis
5-Yr Review Report	1	$ 36,000	EA	36,000	Year 5 only
Subtotal A				172,400	
Contingency (20% of Subtotal A)				34,500	10% scope and 10% bid
Subtotal B				206,900	
Project Mgmt (6% of Subtotal B)				12,400	From USACE and EPA Estimating Guide (July 2000)
Additional ICs Costs for Yr 5 Only				219,300	annual cost
Total Additional ICs Costs NPV for Yr 5 Only				$156,400	7% discount rate
ICs Implementation Costs Costs for Years 6 - 10 Monitoring – Market	5	$ 48,000	LS	$240,000	Includes sample collection, data management, an QA/QC oversight and data validation; based on hours in 2007 EPA work plan
Analysis Monitoring – Market	250	750	EA	187,500	10 markets, 5 white croaker at each; sample preparation, lipid content, DDT (6 isomers) and PCB congener analysis.
Monitoring – Pier	5	$ 32,300	LS	$161,500	Includes sample collection, materials, shipping/transportation, data management and QA/QC oversight and data validation; based on hours in 2007 EPA work plan
Analysis Monitoring – Pier	200	$ 750	EA	$ 150,000	4 piers, 10 white croaker at each; sample preparation, lipid content, DDT (6 isomers) and PCB congener analysis
Community Outreach	5	$750,000	LS	3,750,000	same as initial LOE
Enforcement	5	226,000	LS	1,130,000	same as initial LOE
Subtotal A				$5,619,000	
Contingency (20% of Subtotal A)				1,123,800	10% scope and 10% bid
Subtotal B				$6,742,800	
Project Mgmt (6% of Subtotal B)				404,600	From USACE and EPA Estimating Guide (July 2000)
Annual ICs Implementation Costs Subtotal for Years 6-10				$1,429,500	annual cost
Total ICs Implementation Costs				$7,147,400	

for Years 6-10					
Total ICs Implementation Costs NPV for Years 6-10				$4,180,200	7% discount rate
Year 10 Only Monitoring – Catch Ban Area	1	$ 61,400	LS	$ 61,400	Year 10 only; includes mob/demob, boat rental, labor, materials, shipping/transport, data management, and QA/QC oversight and data validation; based on hours in 2007 EPA work plan
Analysis Monitoring – Catch Ban Area	100	$ 750	EA	75,000	Year 5 only; 5 catch ban locations, 10 white croaker and 10 kelp bass each; sample preparation, lipid content, DDT (6 isomers) and PCB congener analysis
5-Yr Review Report	1	$ 36,000	EA	36,000	Year 10 only
Subtotal A				172,400	
Contingency (20% of Subtotal A)				34,500	10% scope and 10% bid
Subtotal B				206,900	
Project Mgmt (6% of Subtotal B)				12,400	From USACE and EPA estimating Guide July 2000
Additional ICs Costs for Yr 10 Only				219,300	annual cost
Total Additional ICs Costs NPV for Yr 10 Only				$111,500	7% discount rate
Total ICs Implementation Costs NPV Cost				$10,311,500	7% discount rate
Total ICs Cost				$11,948,500	

Table 12-1: Summary of Selected Remedy Costs
b) Monitored Natural Recovery Details

Description	**Quantity**	**Unit Cost**	**Unit**	**Total**	**Comment**
Year 1 Costs Natural Recovery Plans	1	400,000	EA	$400,000	Additional studies to support food web model
Fish tracking study	1	500,000	EA	500,000	Based on preliminary discussions
DDE reductive dechlorination	1	$1,100,000	EA	1,100,000	Based on reductive dechlorination workplan
Sediment and Water Sampling and Analysis					
Plans (SAP, QAP, HSP)	1	$ 50,000	LS	$ 50,000	
Mobilization/Demobilization	1	14,000	LS	14,000	Includes boat and labor for 16 days
Equipment Rental	18	6,300	DAY	100,800	
Materials	1	7,000	LS	7,000	
Shipping/Transport	1	4,000	LS	4,000	
Data Assessment Report	1	200,000	LS	200,000	

Table 12-1: Summary of Selected Remedy Costs
b) Monitored Natural Recovery Details

Description	Quantity	Unit Cost	Unit	Total	Comment
Sediment Analysis					
Sample Preparation	750	244	EA	183,000	50 cores total; 30 stations, LACSD transects 1- thru 10-B, C, D; duplicate cores at 60-m and 150-m stations; 2-cm increments
Water Content	750	5	EA	3,750	
Bulk Density	750	40	EA	30,000	
Total organic content (TOC)	750	35	EA	26,250	
Grain Size	750	75	EA	56,250	
DDTs	750	226	EA	169,500	includes 6 DDT isomers, DDMU, DDNU
PCBs	750	245	EA	183,750	specific congener list will be used
Water Column Analysis					Monitoring plan tbd during RD. will use LACSD station grid, deploy
Polyethylene Device (PED)	270	$5	EA	1,350	PEDs to measure vertical and horizontal gradients; PEDs at bed, mid-
DDTs					column, and surface
PCBs	270	400	EA	108,000	includes 6 DDT isomers, DDMU, DDNU
	270	400	EA	108,000	specific congener list will be used
Sediment and Water Sampling Subtotal				$1,245,700	
Fish Sampling					
Plans (SAP, QAP, HSP)	1	14,000	LS	$ 14,000	
Mobilization/Demobilization	1	3,400	LS	3,400	
Equipment Rental	4	4,500	DAY	45,000	Includes boat and labor for 10 days
Materials	1	1,200	LS	1,200	
Shipping/Transport	1	1,000	LS	1,000	
Data Assessment Report	1	36,000	LS	36,000	
Demersal and Pelagic Fish	60				Cost included with fish sampling: trawl paths, species identified, counted, weighed; 30 fish each of two species (1 benthic-feeding, 1 pelagic) from 2
Sample preparation	60	244	EA	14,640	locations on PV Shelf, southeast and northwest from outfalls
Lipid content	60	25	EA	1,500	Whole body lipid normalized muscle fillet tissue
DDTs	60	226	EA	13,560	Includes 6 DDT isomers and DDMU, DDNU
PCBs	60	245	EA	14,700	Specific congener list will be used
Fish Sampling Subtotal				$100,600	
Baseline Monitoring				$1,346,300	
Subtotal A				270,000	10% scope and 10% bid
Contingency (20% of Subtotal A)					
Subtotal B				$1,616,000	from USACE and EPA Estimating Guide July 2000
Project Mgmt (6% of Subtotal B)				97,000	
				1,713,000	
Total Baseline Monitoring				$1,713,000	
Total monitoring & studies				3,713,000	
Five-Yr Review (FYR) Costs					
Year 5 Monitoring					

Table 12-1: Summary of Selected Remedy Costs
b) Monitored Natural Recovery Details

Description	Quantity	Unit Cost	Unit	Total	Comment
Plans (SAP, QAP, HSP)	1	$ 0	LS	0	Use Baseline Plans
Mobilization/Demobilization	1	14,000	LS	14,000	Includes boat and labor for 10 days
Equipment Rental	18	6,300	DAY	63,000	
Materials	1	5,000	LS	5,000	
Shipping/Transport	1	4,000	LS	4,000	
Sediment Analysis					
Sample Preparation	480	244	EA	117,120	32 cores total; 16 stations, LACSD transects 2- thru 9 stations B & C;
Water Content	480	5	EA	2,400	duplicate cores; 2-cm increments
Bulk Density	480	40	EA	19,200	
Total organic content (TOC)	480	35	EA	16,800	
Grain Size	480	75	EA	36,000	
DDTs	480	226	EA	108,480	includes 6 DDT isomers, DDMU, DDNU
PCBs	480	245	EA	117,600	specific congener list will be used
Water Column Analysis					
Polyethylene Device (PED)	144	$5	EA	720	16 stations, LACSD transects 2- thru 9-B, C; 9 passive samplers per station: 3 m from bed, mid-column and 5 m below surface
DDTs	144	400	EA	$ 57,600	includes 6 DDT isomers, DDMU, DDNU
PCBs	144	400	EA	57,600	specific congener list will be used
Fish Sampling and Analysis					Cost included with fish sampling: trawl paths, species identified, counted, weighed; 30 fish each of two species (1 benthic-feeding,1 water column)
Sample preparation	60	244	EA	14,640	from 2 locations on PV Shelf southeast and northwest of the outfalls
Lipid content	60	25	EA	1,500	Whole body lipid normalized muscle fillet tissue
DDTs	60	226	EA	13,560	Includes 6 DDT isomers and DDMU, DDNU
PCBs	60	245	EA	14,700	Specific congener list will be used
Fish Sampling Subtotal				$100,600	
Five-Year Report	1	50,000		50,000	Five-Year Report
Year 5 Monitoring				$786,900	
Subtotal A				157,380	10% scope and 10% bid
Contingency (20% of Subtotal A)					
Subtotal B				$944,280	from USACE and EPA Estimating Guide July 2000
Project Mgmt (6% of Subtotal B)				56,700	
Total FYR Costs for Year 5				$1,001,000	
Total FYR Costs NPV for Year 5				$713,700	7% discount rate
Year 10 Monitoring				$786,900	
Subtotal A				157,380	10% scope and 10% bid

Table 12-1: Summary of Selected Remedy Costs b) Monitored Natural Recovery Details					
Description	**Quantity**	**Unit Cost**	**Unit**	**Total**	**Comment**
Contingency (20% of Subtotal A) Subtotal B Project Mgmt (6% of Subtotal B)				$944,280 56,700	from USACE and EPA Estimating Guide July 2000
Total FYR Costs for Year 10				$1,001,000	
Total FYR Costs NPV for Year 10				$508,800	7% discount rate
Total FYR Costs NPV Cost				$1,222,500	7% discount rate
Total MNR Cost				$3,000,000	

Table 12-1: Summary of Selected Remedy Costs c) Containment Details					
Description	**Quantity**	**Unit Cost**	**Unit**	**Total**	**Comment**
Treatability Studies				$6,700,000	Studies to define area to be capped, characterize the sediment, and test techniques. $6.7 million is a rough estimate based on 2000 pilot capping project
Construction Capital Costs					
Submerged Diffuser Placement – 1,000,000 CY scenario					
Onshore Staging Area	1	$104,125.00	LS	$ 104,125	
Crewboat (transport from shore to bargers)	704	3,748.50	DAY	2,638,904	
Material	1,000,000	5.41	CY	5,412,500	assumes 24 hr/day
Dredging of Material	1,000,000	0.66	CY	660,000	$5.00 per cy and 8.25% tax
Crew for dredging barge	9,000	62.00	HR	558,000	assumes 15-CY clamshell barge
Tugboat for Dredging Barge	384	3,795.00	DAY	1,457,280	assumes 2 crew for 24 hrs/day
Crew for Tugboat for Dredging	18,432	62.00	HR	1,142,784	assumes 24 hrs/day
Transport Materials to Site	1,000,000	2.59	CY	2,590,000	assumes 3 3000-CY hopper barges
Crew for Transport Barge	19,000	62.00	HR	1,178,000	assumes 2 crew per barge for 24 hrs/day
Placement Barge	1,000,000	1.25	CY	1,250,000	assumes placement barges for 24 hrs/day
Crew or Placement Barge	17,000	62.00	HR	1,054,000	assumes 2 crew per barge for 24 hrs/day
Tugboat for Placement Barge	704	3,795.00	DAY	2,671,715	assumes 2 tugboats for 24 hrs/day
Crew for Tugboat for Placement	33,792	62.00	HR	2,095,104	assumes 2 crew per tugboat for 24 hrs/day
Anchoring and Positioning	1	312,375.00	LS	325,250	
Survey Boat and Crew for Placement Confirmation	353	6,247.50	DAY	2,205,368	
Subtotal A Field Detail Allowance (5% of Subtotal A)				$25,343,080 1,267,154	

Table 12-1: Summary of Selected Remedy Costs c) Containment Details					
Description	**Quantity**	**Unit Cost**	**Unit**	**Total**	**Comment**
Subtotal B				26,610,234	
Overhead (12% of subtotal B)				3,193,228	
Subtotal C				29,803,462	
Profit (8% of subtotal C)				2,384,277	
Subtotal D				32,187,739	
Contingency (20% of Subtotal D)				6,437,550	10% scope and 10% bid
Total Direct Capital Cost				$38,625,290	
Non-Construction Capital Costs					
Project Management (5% of Total Direct Capital Cost)				1,931,000	USACE & EPA Estimating Guide (2000)
Remedial Design (6% of Total Direct Capital Cost)				2,318,000	USACE & EPA Estimating Guide (2000)
Construction Mgmt (6% of Total Direct Capital Cost)				2,318,000	USACE & EPA Estimating Guide (2000)
Total Non-construction Capital Cost				6,566,000	
Total Capital Costs for Submerged Placement				$45,191,000	
SUBMERGED DIFFUSER UNIT COST			CY	45	
Construction Capital Costs					
Spreading Placement – 1,000,000 CY scenario					
Onshore Staging Area	1	$104,125.00	LS	$ 104,125	
Crewboat (transport from shore to barges)	384	3,748.50	DAY	1,439,424	Assumes 24 hrs/day
Material	1,000,000	5.41	CY	5,412,500	$5.00 per CY and 8.5% tax
Dredging of Material	1,000,000	0.66	CY	660,000	assumes 2 15-CY clamshell barge
Crew for dredging barge	9,000	62.00	HR	558,000	assumes 2 crew per barge for 24 hrs/day
Tugboat for Dredging Barge	384	3,795.00	DAY	1,457,280	assumes 2 tugboats for 24 hrs/day
Crew for Tugboat for Dredging	18,432	62.00	HR	1,142,784	assumes 2 crew per tugboat for 24 hr/day
Transport and Placement of Materials	1,000,000	0.87	CY	870,000	assumes 5 1000-CY bottom dump barges, split hull
Crew for Transport/Placement Barge	14,000	62.00	HR	868,000	assumes 2 crew per barge for 24 hrs/day
Anchoring and Positioning	1	208,250.00	LS	208,250	
Survey Boat and Crew for Placement Confirmation	88	6,247.50	DAY	549,780	
Subtotal A				13,270,143	
Field Detail Allowance (5% of Subtotal A)				663,507	
Subtotal B				13,933,650	
Overhead (12% of subtotal B)				1,672,038	
Subtotal C				15,605,203	
Profit (8% of subtotal C)				1,248,416	
Subtotal D				16,853,619	
Contingency (20% of Subtotal D)				3, 370,700	10% scope and 10% bid
Total Direct Capital Cost				20,224,320	

Table 12-1: Summary of Selected Remedy Costs **c) Containment Details**					
Description	**Quantity**	**Unit Cost**	**Unit**	**Total**	**Comment**
Non-Construction Capital Costs					
Project Management (5% of Total Direct Capital Cost)				1,011,200	USACE & EPA Estimating Guide (2000)
Remedial Design (6% of Total Direct Capital Cost)				1,213,500	USACE & EPA Estimating Guide (2000)
Construction Mgmt (6% of Total Direct Capital Cost)				1,213.500	USACE & EPA Estimating Guide (2000)
Total Non-Construction Capital Cost				3,438,200	
Total Capital Costs for Spreading Placement				$23,662,500	
SPREADING UNIT COST			CY	24	
Monitoring During Cap Construction					
Resuspension and plume monitoring arrays (automated resuspension surveillance system)	6	$110,000	EA	$ 660,000	Assumes placement at 6 locations during construction
Sediment Profile Imagery (SPI)	3	$45,000	LS	$ 135,000	Assumes 50 locations for pre-, during, and post-construction monitoring
Sediment and Water Column Sampling					
Plans (SAP, QAP, HSP)	1	$ 45,000	LS	$ 45,000	
Equipment Rental	16	6,300	DAY	100,800	Includes boat and labor for 16 days
Materials	1	4,000	LS	4,000	
Shipping/Transport	1	3,000	LS	3,000	
Report	1	200,000	LS	200,000	
Sediment Analysis					
Sample Preparation	360	245	EA	88,200	Assumes 12 core locations for a depth of 60 cm with 4-cm sample increments for 180 samples for during and post-construction monitoring
Water Content	360	$5	EA	1,800	
Total organic content (TOC)	360	35	EA	12,600	
Grain size	360	75	EA	27,000	
DDTs	360	205	EA	73,800	
PCBs	360	245	EA	88,200	
Water Column Analysis					
DDTs, total	24	206	EA	4,944	
PCBs, total	24	245	EA	5,880	
DDTs, dissolved	24	206	EA	4,944	
PCBs, dissolved	24	245	EA	5,880	
Subtotal A				1,461,048	
Contingency (20% of Subtotal A)				292,210	
Subtotal B				1,753,258	

Table 12-1: Summary of Selected Remedy Costs c) Containment Details					
Description	**Quantity**	**Unit Cost**	**Unit**	**Total**	**Comment**
Project Mgmt (5% of Subtotal B)				105,195	
Technical Support (10% of Subtotal B)				210,390	
Total Construction Cap Monitoring				$2,100,000	
FYR Costs, Year 5					
Sediment Monitoring – Five-Year Review					
Sediment Profile Imagery (SPI)	1	$45,000	LS	$45,000	Assumes 50 locations for each event
Sediment and Water Column Sampling					
Plans (SAP, QAP, HSP)	0	$45,000	LS		Use same plans as for baseline monitoring
Equipment Rental	16	$6,300	DAY	$100,800	Includes boat and labor for 16 days for each sampling event
Materials	1	$4,000	LS	$ 4,000	
Shipping/Transport	1	3,000	LS	3,000	
Report	1	200,000	LS	200,000	
Sediment Analysis					
Sample Preparation	300	245	EA	73,500	Assumes 12 core locations to a depth of 100 cm with 4-cm sample increments for 300 total samples for each sampling event
Water Content	300	$5	EA	1,500	
Total organic content (TOC)	300	35	EA	10,500	
Grain Size	300	75	EA	22,500	
DDTs	300	205	EA	61,500	DDT 6 isomers &DDMU/DDNU
PCBs	300	245	EA	73,500	specific congener list wll be used
Water Column Analysis					Assumes 12 locations at depths/location
DDTs, total	24	205	EA	4,944	DDT 6 isomers &DDMU/DDNU
PCBs, total	24	245	EA	5,880	specific congener list wll be used
DDTs, dissolved	24	205	EA	4,944	DDT 6 isomers &DDMU/DDNU
PCBs, dissolved	24	245	EA	5,880	specific congener list wll be used
Subtotal A				617,448	
Contingency (20% of Subtotal A)				123,490	10% scope and 10% bid
Subtotal B				740,938	
Project Mgmt (5% of Subtotal B)				37,047	From USACE and EPA Estimating Guide (July 2000)
Technical Support (10% of Subtotal B)				74,100	
FYR Costs Sediment Monitoring for Year 5				$852,000	annual rate

Table 12-1: Summary of Selected Remedy Costs
c) Containment Details

Description	Quantity	Unit Cost	Unit	Total	Comment
Total FYR Costs NPV for Year 5				608,000	7% discount rate
FYR Costs, Year 10					
Sediment Monitoring – 2nd Five-Year Review					
Sediment Profile Imagery (SPI)	1	$45,000	LS	$45,000	Assumes 50 locations for each event
Sediment and Water Column Sampling					
Plans (SAP, QAP, HSP)	0	$45,000	LS		Use same plans as for baseline monitoring
Equipment Rental	16	$6,300	DAY	$100,800	Includes boat and labor for 16 days for each sampling event
Materials	1	$4,000	LS	$ 4,000	
Shipping/Transport	1	3,000	LS	3,000	
Report	1	200,000	LS	200,000	
Sediment Analysis					
Sample Preparation	300	245	EA	73,500	Assumes 12 core locations to a depth of 100 cm with 4-cm sample increments for 300 total samples for each sampling event
Water Content	300	$5	EA	1,500	
Total organic content (TOC)	300	35	EA	10,500	
Grain Size	300	75	EA	22,500	
DDTs	300	205	EA	61,500	DDT 6 isomers &DDMU/DDNU
PCBs	300	245	EA	73,500	specific congener list wll be used
Water Column Analysis					Assumes 12 locations at depths/location
DDTs, total	24	205	EA	4,944	DDT 6 isomers &DDMU/DDNU
PCBs, total	24	245	EA	5,880	specific congener list wll be used
DDTs, dissolved	24	205	EA	4,944	DDT 6 isomers &DDMU/DDNU
PCBs, dissolved	24	245	EA	5,880	specific congener list wll be used
Subtotal A				617,448	
Contingency (20% of Subtotal A)				123,490	10% scope and 10% bid
Subtotal B				740,938	
Project Mgmt (5% of Subtotal B)				37,047	From USACE and EPA Estimating Guide
Technical Support (10% of Subtotal B)				74,100	(July 2000)
FYR Costs Sediment Monitoring for Year 10				$852,000	annual rate
Total FYR Costs NPV for Year 10				433,000	7% discount rate
Total FYR Costs NPV Costs				1,041,000	7% discount rate

12.4 Expected Outcome for the Selected Remedy

The expected outcome from implementation of the selected remedy is that spread of COCs will be controlled and risks reduced. Surface concentrations of DDTs and PCBs will be reduced when the cap is in place and will continue to drop. Cleanup levels in sediment and water will be reached 14 years sooner with the cap than under natural recovery. The Five-Year Review process will assess whether concentrations of COCs in fish and sediment are dropping as predicted. In the interim, the ICs program will reduce risk to human health from consumption of contaminated fish.

13.0 STATUTORY DETERMINATIONS

Under CERCLA Section 121 and NCP Section 300.430(f)(5)(ii), EPA must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost-effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances, pollutants, or contaminants as a principal element, and a bias against offsite disposal of untreated wastes.

CERCLA Section 121(c) also requires the use of five-year reviews to determine if adequate protection of human health and the environment is being maintained in those instances where remedial actions result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure.

The subsections below summarize the basis for determining the interim action is protective and meets the statutory requirements under CERCLA.

13.1 Overall Protection of Human Health and the Environment

The selected remedy is an interim action that is protective of human health and the environment. Fish caught in the PV Shelf area contain concentrations of DDT and PCBs that exceed EPA acceptable risk levels for human health.

The selected remedy will apply a clean cover over the contaminated sediment in the outfall area to physically isolate and immobilize COCs where they are highest. This would reduce the median concentration of DDT in the surface sediment to approximately 47 mg/kg OC and the median concentration of PCBs in the surface sediment to approximately 5 mg/kg OC. The lower PCB sediment concentration would allow white croaker to reach the interim goal of 70 μg/kg PCBs in white croaker fish tissue within 10 years, as white croaker lose their existing body burden of PCBs. Under this alternative, median DDE concentrations in sediment across the shelf are projected to drop to 230 μg/kg in thirty years. This sediment level is correlated with the 400 μg/kg DDT in fish.

Until fish tissue concentrations meet remediation goals, the Institutional Controls program will continue. Outreach programs to keep consumers informed of which fish are safer to eat and which cooking methods reduce contaminant content would continue. Bioaccumulation of COCs in ecological receptors will continue until contaminant concentrations in fish drop to target concentrations. The monitoring program would track reductions in contaminant concentrations.

13.2 Compliance with Applicable or Relevant and Appropriate Requirements

Federal and state applicable or relevant and appropriate requirements (ARARs) are the substantive provisions of promulgated Federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate for a CERCLA site or action. *Applicable requirements* are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. *Relevant and appropriate requirements* are requirements that, while not legally "applicable" to circumstances at a particular CERCLA site, address problems or situations sufficiently similar to those encountered at the site that their use is well-suited. A list of the ARARs to be attained by the selected remedy is included in Table 13-1.

NCP Sections 300.430(f)(5)(ii)(B) and (C) require that a ROD describe the ARARs that the selected remedy will attain and any ARARs the remedy will not meet, the waiver invoked, and the justification for any waivers.

Waters overlying the shelf contain concentrations of DDTs and PCBs that exceed the EPA ambient water quality criteria (AWQC) for human health, 0.22 ng/L DDT and 0.064 ng/L PCBs (Zeng et al., 1999). DDT concentrations in water exceed the AWQC for ecological health of 1 ng/L.

As part of this interim action, EPA is waiving an ARAR: the AWQC for PCBs for human health. As noted above, PCB concentrations in water have been measured most recently at 0.56 ng/L, which exceed the AWQC for human health. EPA does not yet have sufficient data to determine whether the PCB AWQC can be achieved, and therefore cannot state with certainty that the remedy will attain this ARAR.

Under certain conditions, CERCLA and the NCP allow the selection of a remedial action that does not attain a specific ARAR. 42 U.S.C. §121(d)(4)(A); 40 CFR §300.430(f)(1)(ii)(C)(1). Pursuant to those provisions, EPA is waiving the PCB AWQC for human health on the basis that the selected remedy is an interim action that will become part of a final remedial action that will attain the ARARs. As part of the Monitored Natural Recovery element of the selected remedy, EPA will conduct further investigation of PCBs flux and background concentrations, and, in the context of selecting the final remedy, will evaluate whether and how remedial action might achieve the PCBs AWQC for human health.

13.3 Cost Effectiveness

Alternative 3, the selected remedy, is cost effective because it follows an iterative approach that assesses the effectiveness of remedial measures before undertaking additional actions. The selected remedy includes studies that will contribute to EPA's understanding of contaminant loss processes and how COCs bioaccumulate in fish. With this information, further actions can be tailored to maximize risk reduction.

13.4 Use of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

EPA has determined that the selected remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element, bias against offsite treatment and disposal, and consideration of state and community acceptance. The interim selected remedy does not include treatment; however, as discussed in section 13.5, it allows for further actions to assess the feasibility of treatment. Of the alternatives considered in the Proposed Plan, EPA has determined that the selected remedy presents the best trade-off between short-term risks and long-term protection.

Data collected over the last twenty years indicate the buried EA sediment has undergone little disturbance north of the outfalls. Even in the outfall area, most of the time near-bottom currents are too weak to move fine sand. A cover of mixed sand would provide a long-term protective layer. Periodic storms would mobilize the finer grained material; however, studies of oceanographic conditions on the Shelf indicate the remaining coarser sand would compact and form a stable layer (Sherwood et al., 2006, Ferré and Sherwood, 2008). The proposed thickness of the cover (45 cm) will contain the EA sediment even if some of the cover material is lost. Monitoring to assess whether cap integrity is being affected by erosion or bioturbation from large burrowing infauna organisms, such as ghost shrimp, would be conducted. Data that were collected during Winter 2007-2008 will provide additional information on near-bed current velocities to assist in designing a cover that will contribute clean sediment to the surrounding area but retain enough coarse material to prevent erosion of the cover.

13.5 Preference for Treatment as a Principal Element

There would be no reduction of toxicity, mobility, or volume through treatment with this interim action alternative, because no treatment will be implemented. The Feasibility Study determined in situ treatment to be infeasible because data on the reductive dechlorination processes were not available and the depth of the deposit limits action. However, the interim action includes studies of reductive dechlorination of DDE in the sediment deposit. Once the biogeochemical properties associated with reductive dechlorination are identified, EPA will be able to assess the feasibility of accelerating DDE transformation and may be able to incorporate treatment in the final remedy.

13.6 Five-Year Review Requirements

A review (in accordance with 40 CFR 300.430[f][4][ii]) is required at a minimum every five years if a remedy is selected that results in hazardous substances, pollutants or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. Because the selected remedy will not achieve levels that allow for unlimited use and unrestricted exposure within five years, EPA will conduct five-year reviews in accordance with EPA policy until cleanup levels established in this ROD are attained or a final ROD is in place. Reviews will begin five years after initiation of the remedial action to help ensure that the selected remedy is protective of human health and the environment.

14.0 DOCUMENTATION OF SIGNIFICANT CHANGES

There were no significant changes to the selected remedy based on public comments. However, in response to questions raised by the public, EPA would like to clarify that the exact size and location of the area targeted for capping will be determined during remedial design (RD). The RD includes predesign field work to define the area of highest surface concentrations of COCs. Additional studies to verify optimum cap thickness will be included under remedial design, along with selection of the cap placement technique.

Table 13-1: Identification of Federal and State Applicable or Relevant and Appropriate Requirements (ARARs)[2]

Citation	Synopsis of Requirement	Status	Rationale for Use
Chemical-Specific ARARs			
Clean Water Act, Section 304 33 USC §1314(a)	Establishes ambient water quality criteria (AWQC) for surface water to protect both aquatic life and human health. The AWQC for the protection of human health from DDT & PCBs exposures through water and consumption of DDT & PCBs residues that have bioaccumulated in fish is 0.22 ng/L and 0.064 ng/L, respectively. The chronic marine aquatic life criterion for DDT is 1 ng/L. The EPA chronic marine aquatic life criterion for PCBs of 30 ng/L. Both are fish residue-based.	Relevant and appropriate	AWQC are promulgated standards set to achieve fish tissue concentrations protective of receptors. For purposes of the interim action, EPA is waiving the PCBs AWQC for human health.
Location-Specific ARARs			
Endangered Species Act of 1973, Sections 7 and 9 16 USC §§1536 & 1538	The goal of the Endangered Species Act of 1973, 16 U.S.C. Section 1531 et seq. is the conservation and recovery of species of fish, wildlife, and plants that are threatened with extinction.	Applicable	Because of the presence of endangered/threatened species on the PV Shelf, the substantive requirements of the Endangered Species Act may be applicable.
Coastal Zone Management Act, Section 307(c)(1) 16 USC §1456	Requires that federal agencies conducting or supporting activities affecting land and water resources of the coastal zone do so in a manner consistent with approved state coastal zone management programs.	Applicable	Onsite activities are not subject to CZMA administrative review or permitting processes; however, the selected remedy must be consistent with the substantive requirements of the coastal zone management plan.

[2] For further discussion of ARARs and other identified requirements, please refer to Appendix A.

Citation	Synopsis of Requirement	Status	Rationale for Use
Clean Water Act, Section 404 33 USC §1344 Rivers and Harbors Act, Section 10 33 USC §401	These regulate the placement of fill in waters of the United States. Substantive, as opposed to permitting, requirements would be applicable with regard to placement of material on PV Shelf for cap construction.	Applicable	The criteria for determining the acceptability of placing fill into the waters of the United States would be applicable to any capping activity.
Action-Specific ARARs			
The Marine Protection, Research, and Sanctuaries Act of 1972 33 U.S.C. §§1411-1414	Regulates disposal of material in the ocean. Ocean disposal of dredged material is administered by EPA and USACE in accordance with MPRSA.	Applicable	Selected remedy involves capping, which is likely to use dredged material for the cap.
Federal ocean dumping regulations 40 CFR Parts 220-238	Dredged material must meet substantive federal testing guidelines to be approved for disposal.	Applicable	Selected remedy involves capping, which is likely to use dredged material for the cap.
Clean Water Act, Section 403 33 USC §1343	Section 403 of CWA and associated regulations at 40 CFR Part 125, Subpart M, regulate discharges into marine waters that have the potential to degrade the marine environment.	Applicable	The substantive requirements of Section 403 regulate dredging, placement or dewatering of sediment.
California Ocean Fishing regulations 14 CCR §§28.05, 28.10	Forbids by-catch of protected species	Applicable	Applies to fish sampling activities to be undertaken under monitoring
California Endangered Species Act California Fish & Game Code §2080	The goal of the California Endangered Species Act is to conserve, protect, restore, and enhance any endangered or threatened species and its habitat.	Applicable	Because of the presence of endangered/threatened species on the PV Shelf, the substantive requirements of the California Endangered Species Act, Section 2080 of the California Fish and Game Code, may be applicable.
Fully Protected Mammals California Fish & Game Code §4700	This section prohibits the take of any of the listed fully protected mammals, including the Northern elephant seal and Guadalupe fur seal.	Applicable	The population range of the Northern elephant seal and the Guadalupe fur seal include areas of the PV Shelf that will be impacted by the remedy.

PART III: RESPONSIVENESS SUMMARY

This responsiveness summary has been prepared to meet the requirements of sections 113(k)(2)(B)(iv) and 117(b) of CERCLA, which requires EPA to respond "…to each of the significant comments, criticisms, and new data submitted in written or oral presentations" on a Proposed Plan for remedial action. The responsiveness summary addresses concerns expressed by the public, community-based organizations, governmental bodies in written and oral comments received by EPA regarding the preferred alternative for the PV Shelf.

1.0 Public Comment Period

Section 3.0 details EPA's community involvement activities and efforts to solicit comments from the public. The formal comment period ran from June 15, 2009 to July 15, 2009. There were no requests for extensions. EPA held three open houses/public meetings the week of June 21st in San Pedro, Wilmington, and Rolling Hills Estates. The meetings received local media coverage and were well attended. Over 80 people attended the meetings; 12 gave oral comments, primarily to ask questions regarding implementation of the preferred remedy. EPA also received 7 letters and two emails.

2.0 Public Comments

This section contains a summary of the substantive comments EPA received and EPA's responses to those comments. Comments fell into four broad categories: comments and questions regarding the preferred alternative, comments and questions regarding fish advisories and seafood safety, comments suggesting alternative approaches to remediation, and comments related to the site, but not directly to remediation. Complete copies of the comments can be found in the administrative record.

2.1 Comments from General Public

2.1.1 Preferred Alternative

> **General Comment:** I support your selection of Alternative #3 as the Preferred Alternative. …This method should have the least impact upon the existing sediments in that area and the water quality of the surrounding water body. …I am glad to see that you have built-in institutional controls and continued monitoring to help determine the effectiveness this alternative has upon the sea life and water quality of the area. If this plan is implemented and proves to be effective I would hope that the area that is capped could be increased in the future to further eliminate the continual water contamination at this location from toxic chemicals that were discharged there in the past.

EPA Response: EPA thanks you for your words of support. Your letter succinctly summarizes what we are trying to accomplish at the site. This is an interim action that may lead to additional capping if the capping technique proves effective and additional data on fish contamination indicates more areas would benefit from capping.

> **General Comment:** More sediment monitoring is warranted; and modeling of microbiological remediation and breakdown of DDT and PCB compounds is a useful future tool to study. Also, sediment transport and deposition modeling is a good expenditure of funds.

EPA Response: Comment noted. These elements are part of the selected remedy.

> **Comments on timing:** How long will the project take? When will it start?
>
> Is it flexible so that it could have less impact on gray whale migrations?
>
> How long will the special studies take?

EPA Response: Section 12.2.3 of the interim Record of Decision (I-ROD) discusses implementation of the capping component of the selected remedy. Studies on cap placement techniques will begin in 2010 under a remedial design/remedial action (RD/RA) workplan. Cap placement is scheduled tentatively for 2012. It is anticipated that the actual capping can occur over one season. There is enough flexibility to avoid impacts to gray whale migration. Some of the special studies are underway (i.e., the reductive dechlorination study) or are in the planning phase (i.e., fish tracking study). Planning of the other studies, i.e., the fish consumption survey and pelagic forage fish monitoring, will begin this Fall and do not require coordination with the capping activities.

> **Comments on sources:** Have you identified sources of clean cap material? How much cap material would each alternative take?
>
> Wouldn't sediment from the channel projects be very contaminated, would there be testing for contamination?
>
> Did you look into different types of capping material, like activated carbon, in your review?

EPA Response: The selected remedy will require approximately 800,000 cubic yards of cap material. Alternative 4 would require 1,776,000 cubic yards. Potential sources of cap material include port projects, e.g., Port of Los Angeles deepening project, or from clean areas of PV Shelf. Material for capping would comply with the Marine Protection, Research and Sanctuaries Act of 1972, which prohibits ocean disposal of sediment that contains more than trace amounts of compounds such as DDT and PCBs. Additionally, any material used for capping PV Shelf will be tested rigorously prior to usage to assure it meets requirements for purity, organic content, grain size, etc.

During the early stages of the feasibility study preparation, EPA investigated using special capping materials, i.e., other than sand. In some capping applications, materials such as activated carbon (GAC), iron filings, etc., can be added to sand to enhance adsorption of highly mobile or soluble contaminants; however, the DDTs and PCBs at PV Shelf are relatively immobile and insoluble, and therefore not treatable by adsorption.

Section 4.3.8 of the PV Shelf Feasibility Study (May 2009) discusses EPA's evaluation of in situ treatment for contaminants, e.g., adding oxidants such as persulfate. The Feasibility Study did not carry forward in situ treatment for consideration as an alternative component because of a lack of evidence regarding its effectiveness and difficulties in implementability under the deep-sea conditions of the PV Shelf.

> **Comment on recovery**: How long would it take for benthic invertebrates to recover from capping?

EPA Response: The U.S. Army Corps of Engineers (USACE) technical report prepared for EPA, *Options for in situ Capping of Palos Verdes Shelf Contaminated Sediments* (Technical Report EL-99-2), anticipates benthic organisms would appear around the edges of the cap within several months to a year. The recolonization process in coastal environments, as relevant to capping, proceeds from an initial "stage I" colonization by benthic macroinfauna, primarily small-bodied polychaetes and bivalve mollusks, followed by "stage II" organisms, frequently amphipods, that often create dense tube mats forming a thin veneer at the sediment/water interface. Stage I and II organisms tend to have a net stabilizing effect on surficial sediment, and do not mix sediment beyond a depth of several centimeters (cm). Initial pioneering assemblages tend to persist for several months to 2 years, but are gradually replaced by deeper penetrating, larger bodied infauna. Cap performance monitoring will include tracking of benthic recovery.

> **Comments on effectiveness and cost #1:** Has this (capping) ever been tried in an ocean? If so, what were the results? Is it possible that a sand cap could cause more harm than good? Could a cap actually slow down the natural degradation of DDT? Could spreading the DDT contaminated area actually dilute the alleged negative affects of DDT?

EPA Response: In Fall 2000, EPA undertook a pilot capping project where three 45-acre cells were capped using the techniques of point placement and spreading. The results were mixed. While the pilot successfully covered the target cells, there was evidence of scouring and resuspension of the effluent-affected (EA) sediment. In 2004, EPA undertook a sediment displacement study to better gauge the effects of cap construction at depth. The report is available online at the EPA website at www.epa.gov/Region09/superfund/pvshelf. The reports on the pilot project and post-pilot monitoring are available at the site repositories.

At this point, it is not known whether capping will slow down or accelerate natural degradation. This is another reason EPA is proceeding with an interim ROD, so that the mechanisms driving DDT breakdown can be considered in design of the final remedy.

It's unlikely that a sand cap can cause harm. Cap placement, however, could be a problem because of the potential to resuspend and scour the contaminated sediment deposit. After signing the Record of Decision EPA begins the RD/RA process. During the RD phase, EPA will perform treatability studies and model low-impact capping techniques. During cap placement, EPA will monitor surge and resuspension to assure that capping does not spread EA sediment.

DDT and PCBs are persistent and bioaccumulate, so even a concentration that isn't harmful to fish, for example, could harm birds that eat fish, or birds that eat other animals that eat fish. Under the selected remedy, EPA will be refining the food web model used in the Natural Resource Damage Assessment, which considers the effects of low levels of contaminants across the Southern California Bight.

> **Comment #2:** Basically, the Palos Verdes Shelf sediment, chemistry, and biota have continued to improve…, and outfall impacts are reduced to near background conditions at the surface even in the near vicinity of the pipes. ...Given the above findings, it is difficult to see what is to be gained in carrying out an uncertain proposal to cover the vicinity of the outfalls with a blanket of unknown compatibility with existing, stabilized sediments. There is a high probability that 'explosive' resuspension would occur during application and that the resulting blanket would lack uniform thickness allowing eddy-erosion to occur along the uneven bottom. It is also not clear to me that by the time the

> deeper, more concentrated DDT sediment is re-exposed at current rates that it would not already have degraded to a less toxic form. …
>
> Depth of the water and highly variable ocean conditions will be the enemies of any such project (experiment) and the price is too high. No matter how the sediment cap is placed it will be essential to have precise navigation, real-time knowledge of winds, weather, tides, currents, upwelling and internal wave trains, thermocline depth and strength of density stratification in order to precisely place sediment from a surface barge-system or any kind of underwater chute.
>
> Whatever proposal is chosen, it would be essential to use all of our real-time capabilities of monitoring, modeling and forecasting the optimal conditions to make the 'drops' and follow the resulting plumes. The material should be injected under a strongly stratified thermocline to avoid surface effects, and ideally would be done under measured oceanographic conditions that would maximize settlement and minimize drift away from the target area.

EPA Response: EPA agrees that the PV Shelf has experienced significant recovery over the last two decades, further accelerated after implementation of full secondary treatment of effluent. Because of the reductions in contaminant concentrations in sediment and fish, EPA's selected remedy includes monitoring natural recovery as a primary component. However, concentrations of DDT and PCBs in PV Shelf sediment are much higher than those found in the rest of the Southern California Bight, and the area targeted for capping under the selected remedy has experienced increases in contaminants in surface sediment, not reductions.

EPA agrees cap placement is difficult and not without risk; however, analysis of the site indicates the sediment at the southeast edge of the deposit, between the outfalls, is susceptible to erosion. EPA's experience with the pilot capping project and more recent data regarding the EA sediment deposit, e.g., it has been compacting, especially near the surface, and is now 20 to 30 percent more dense than it was in the early 1990s, leads to the conclusion that "explosive" resuspension will not occur. Many of the issues identified regarding the importance of real-time monitoring, modeling, and identification of optimum conditions for cap placement will be assessed during the remedial design phase.

> **Comment #3:** What are the breakdown products of DDT and could they be themselves hazardous?

EPA Response: There is very little DDT in the contaminated sediment; most of it has been transformed into DDD and DDE. DDE is considered as toxic as DDT while DDD is considered less toxic. All three (DDT, DDE, and DDD) are listed in EPA's database of toxic substances, the Integrated Risk Information System (IRIS). There is very little data regarding the toxicity of the breakdown products of DDE, i.e., DDMU, DDNU, DBP, DDMS, etc.; however, they appear to be less toxic than DDTor DDE. Studies to identify the environmental conditions that allow DDT breakdown to occur are underway and will be completed in time to use the information in the final ROD.

> **Comment #4:** Is there a cost/benefit basis to this proposal?

EPA Response: Under CERCLA, EPA considers nine criteria in selecting a preferred alternative. The most important criteria are protection of human health and the environment and compliance with Federal and State requirements. Other criteria include long-term effectiveness, reduction of toxicity, mobility or volume of contaminants through treatment, short-term effectiveness, implementability, cost, state acceptance, and community acceptance. Cost is a consideration; however, as stated above, it is not the primary criterion. Under Superfund guidance, the cost estimate of the remedy is an order-of-magnitude cost estimate that is expected to be within +50/-30% of the actual project cost.

2.1.2 Comments Regarding Fish Consumption

A number of commenters asked questions about fish consumption or made recommendations regarding EPA's Institutional Controls program of outreach and education.

> **Comments on what fish are safe:** Have there been any studies of chemicals getting into crustaceans? There's a big lobster population around our coast.
>
> Yellow croaker is a very common fish in Asian markets. Is it related to the white croaker that you can't eat? Fish sold in markets years from now may have DDT in their body from before capping.
>
> The barred sand bass is one of the restricted fish. Is that from PCBs contamination or is it from a combination?

EPA Response: The selected remedy will include lobster analysis in the fish monitoring program. Lobster were last analyzed in the early 1990s and their contaminant concentrations were not of concern at that time. Like other species found on PV Shelf, it is likely that contaminant concentrations in lobster have dropped since then. Nevertheless, given the popularity of recreational lobster fishing on PV Shelf and that analytical methods have improved over the last decade, a new study of contaminant concentrations in lobster is warranted and will be included in EPA's remedial action.

Yellow croaker are not native to the Southern California coast. Yellow croaker found in markets are imported or are mislabeled. Yellowfin croaker is found off the coast and, because of PCBs and mercury, have a health advisory that recommends limiting consumption to two servings a week. The Institutional Controls program would remain in place until sampling indicates fish species of concern are safe to eat.

The June 2009 *Health Advisory and Safe Eating Guidelines* (OEHHA, 2009) discusses the basis for each advisory. In the case of barred sand bass, a combination of contaminants, driven primarily by PCBs, are responsible for the restrictions.

> **Comment on health effects of PCBs:** The PCBs are apparently the problem child here as opposed to the DDTs. Has there been any indicator or evidence that it has caused problems for people eating fish from the Shelf? Looks like the fish -- that the birds are coming back, if I understand the article right. I'm wondering if the outreach program has had the desired effect and basically negated the threat.

EPA Response: EPA's outreach program has had quantifiable success in changing the behavior of fish consumers. A new fish consumption survey, planned under the selected remedy, will add to our knowledge of program effectiveness. EPA is not aware of Los Angeles specific data regarding negative health effects from consumption of fish from the PV Shelf area. There are a number of confounding factors that make such an assessment difficult. However, evidence from studies conducted in other areas, e.g., the Great Lakes, link consumption of PCB-laden fish to negative human health effects, particularly developmental effects in children.

Women who were exposed to relatively high levels of PCBs in the workplace or ate large amounts of fish contaminated with PCBs had babies whose birth weight were slightly less than babies from women who did not have these exposures. Babies born to women who ate PCB-contaminated fish also showed abnormal responses in tests of infant behavior. Some of these behaviors, such as problems with motor skills and a decrease in short-term memory, lasted for several years. Other studies suggest that the immune system was affected in children born and nursed by mothers exposed to increased levels of PCBs (ATSDR, 2001).

> **Comments on outreach:** We need more consortium building, more environmental education and outreach in the schools using school age children.
>
> There is a population of immigrants who would be better served if you had radio spots "don't eat white croaker" or something like that.
>
> There are PV Shelf beach areas that may be too isolated for game warden patrols, but should be considered for posting fish advisory signs.
>
> It is important to focus resources on white croaker and the work being done by the Fish Contamination Education Collaborative. They should emphasize hands-on education and careful evaluation of human risk, especially catching fish off Whites Point shoreline reach, located at the base of the JWPCP outfalls, and along the Queens Gate breakwater. I suspect that offshore fishing in the vicinity of the outfall is the far riskier business. Clearly, the ban on commercial gill-nets instituted by CDF&G should be strictly enforced; and this prohibition should be extended to round-nets.
>
> Placement of an 'Internet Fish-Cam', to be located at the White Point pumping station at the top of the hill, with continuous scanning of the coastal waters in the vicinity of the outfall could provide useful area fishing surveillance…. I believe the message here is that efforts to educate that segment of the public that eats abundant fish, especially White Croaker, should be paramount in EPA remediation expenditures to assess and avoid public health risk.

EPA Response: EPA agrees that the Institutional Controls (ICs) program is an important part of the selected remedy for PV Shelf and is paramount in protecting public health. Section 12.2.1 describes the ICs component of the selected remedy in detail. The ICs program undergoes regular reviews with its members, the Fish Contamination Education Collaborative (FCEC), who provide feedback on how to improve the various programs, e.g., angler outreach, community education, etc. EPA will include these suggestions in its ongoing evaluation of the ICs program.

The FCEC is preparing new education materials based on the new OEHHA fish advisory. At the same time, the angler outreach group is inventorying popular fishing locations to identify where new signs should be placed. Shoreline fishing sites are included in the inventory. One of the FCEC members, the Cabrillo Marine Aquarium, has a strong education program that includes students of all ages. The FCEC includes community-based organizations who communicate fish advisory information to ethnic media and to at-risk populations. Public feedback is an important component of the ICs program, and EPA encourages public input on ways to improve this vital program.

2.1.3 Comments advocating other approaches, modifications or further studies

Some commenters felt EPA should seek new alternative technologies to remediate the site. These generally involved dredging as an initial step. Where specific technologies were recommended, either they had not been tried on DDT or not at sites the size and depth of PV Shelf. Two commenters suggested using a pipeline or the outfall pipes to deliver cap material. Two others advocated finding a way to neutralize the contaminants in the deposit.

> **Comment #1:** Maybe a temporary pipeline from shore would be a better option. It has always been my feeling that the only feasible solution would be to add some of the current solids back into the effluent going to the 90- and 120-inch outfalls. Even if this is not feasible because of Districts ongoing operations, there is still two other outfall pipes (60-inch and 72-inch) not currently being used that could be temporally extended to 60-meters. This would provide the most natural and exact, soft-landing placement of additional cover for the most contaminated area around the two outfalls.
>
> Another modification of this idea would be to add a 'clean' slurry at the White Point outfall access gallery into one or more of the available lines. However, this would take a lot of truckloads to do a job that could be more easily done from the plant site for free, or even at a savings to the Districts. This would certainly require an EPA/SWRCB Waiver for temporary solids disposal, but it could get the job done quickly with minimal cost and effort!

EPA Response: The potential to use the outfalls as a mechanism to distribute cap material has been raised but does not appear to be realistic for the reasons you identify. Allowing the JWPCP to increase solids disposal would not create a new layer quickly. About 90 percent of the DDT- and PCBs- contaminated solids discharged during the 1950s through 1971 did not settle on PV Shelf, indicating this would be an inefficient cap construction system. Additionally, the effluent would be unsuitable for cap material, being too fine and containing too much organic matter, etc. Bringing appropriate material to the JWPCP or outfall manifold would require trucking over 800,000 cubic yards of sand to Carson or the Palos Verdes Peninsula. Since the source of the sand would most likely be the harbor or ocean, it would have to be dewatered before being loaded and trucked.

> **Comments from vendors:** We just started the company, Nikkei. One of the technologies that we are looking at right now is a treatment plant that gets rid of PCBs, you can basically put anything in this plant, it's using plasma arc, and it turns it into hydrogen and glass and metal…
>
> I'm a vice-president of procurement for Oceans Enviro Corporation in Huntington Beach. We've had repeated success in eliminating high levels of nitrates. We also have degraded DDT, PCBs and other complex hazardous compounds in the lab. We have a couple of theories which may have some potential and are asking for a review…
>
> Project – GreenWorks is proposing an alternative method to capping that we believe could save resources and resolve the issue with minimal disturbance of the contaminated sediment. PGW is proposing the use of a vacuum to remove the sediment; implementation of Watertectonics' technology to clean the sediment; and the return of the clean sediment to the ocean.

EPA Response: Under CERCLA, EPA seeks and supports development of innovative technologies that offer permanent and cost-effective solutions to treat contaminants from Superfund sites. During development of the Feasibility Study, EPA consulted with vendors and other practitioners to hear and learn more about various proposals and technologies that were proposed to EPA as solutions. Unfortunately, the proposals submitted did not have documentation to support the claimed effectiveness. Others, like the technologies mentioned above, are still in the development phase or have been applied at sites very unlike PV Shelf. EPA will continue to review new technologies. However, EPA's first priority is protection of human health and the environment; therefore, EPA relies on technologies most likely to achieve those ends, which means technologies with a proven record of success.

> **Comment #2:** just find some ways to neutralize the contaminants
>
> The second idea was implant microbes into carbon pellets that are heavy enough to sink to the ocean floor and release a calculated amount that would cover the infected area. You wouldn't have to put 18 inches deep throughout the whole area. You just calculate how much of the penetrating carbon you need.

EPA Response: Current research has not identified a chemical additive that destroys DDTs. The delivery or injection and mixing of substrates into the sediment would be difficult in deep water. Until the processes driving degradation of DDE are identified, we will not know if the mechanisms that biologically break down the contaminants can be controlled or accelerated. Once the reductive dechlorination process occurring in the deposit is understood, EPA will evaluate the potential to accelerate the transformation. The difficulties of enhancing degradation over a large area at depth remain, however. Delivering and mixing oxidation chemicals into the sediment and achieving uniform treatment success over a large area on the ocean floor at 50 to 100 m is unlikely. Additionally, there is no evidence that PCBs are breaking down in the deposit. Section 12.1 discusses EPA's rationale for selecting an interim action of targetted capping.

2.1.4 Other Comments

> **Comment on other sources of contaminants:** The PCBs and DDTs are coming from the northern part of Los Angeles down through the channel, from the Los Angeles River. Are you doing any kind of studies on how to stop it? Have you thought of expanding your study to include the entire San Pedro Bay area?

EPA Response: EPA's actions are limited to the PV Shelf Superfund site, which is not impacted by contaminants flowing through Dominguez Channel. The Port of Los Angeles (POLA) and the Port of Long Beach (POLB) are addressing sediment quality and water quality, as reported in the draft report entitled, *Ports of Los Angeles and Long Beach Water Resources Action Plan (WRAP)* (April 2009), available on the POLB website. EPA supports the Ports' efforts in their continuing programs to monitor sediment and water as outlined in the WRAP.

> **Comment on monitoring for wildlife:** I would like some monitoring of the endangered species, the California Least Tern. I know that the white croaker is a good fish for you to study, but I would also like to see monitoring of smaller fish that the Tern feed on. I think that could give you some valuable information. I would like you to kind of widen your study parameters to include this endangered species, the California Least Tern. They're only five nesting sites in California.
>
> I am concerned that the California Least Tern and other species in the San Pedro Bay and off the Palos Verdes Peninsula are affected by the toxins and may also be harmed by

the cleanup unless done correctly. How will the release of toxins by dredging impact the Tern? How will the fish population be impacted by the Plan?

EPA Response: EPA agrees that monitoring to determine recovery of piscivorous (i.e., fish-eating) birds like the Least Tern should be undertaken. Under the selected remedy, EPA will consult the Natural Resource Trustees and other stakeholders to identify small pelagic forage fish to monitor for impacts to wildlife. Section 7.5 discusses the ecological risk assessment and the need to develop a safe cleanup level for wildlife. Section 8.2 sets as a remedial action objective support for the Natural Resource trustees' wildlife recovery efforts.

The selected remedy of placing a cap in the vicinity of the outfalls does not involve dredging contaminated sediment. Cap placement operations will be designed to minimize any resuspension of sediment or release of contaminants. Monitoring during cap placement will track any sediment plumes created by the action. The prevailing currents are northward and seaward, away from San Pedro Bay. The intent of capping is to reduce the availability of contaminants; therefore, the effects on fish populations should be beneficial. However, it is not unusual for contaminant concentrations in fish to experience a temporary increase after contaminated sediment is disturbed. The remedial design will include measures to minimize impacts to the sediment deposit during cap placement.

Comment on outfalls: You're reporting that there is a higher concentration of the DDT in the areas immediately surrounding the outfall, which obviously you're not going to plug up, and I'm wondering whether it might be worth considering relocating the outfall away from that concentration so that it would no longer disturb the higher concentrations and continuing stirring everything up.

EPA Response: The highest contaminant concentrations are near the outfalls because, during the 1950s thru early 1970s, the outfalls were the delivery mechanism for the contamination that affects the PV Shelf. The outfalls are not a cause of sediment resuspension. The outfalls contain numerous diffuser ports that discharge small quantities of wastewater mixed with saltwater. These small openings, the buoyancy and temperature of fresh water, and the rock ballast surrounding the outfalls prevent the wastewater discharge from scouring the sediment. Moving the outfalls would simplify cap placement. However, the logistics and planning involved in relocating the outfalls would take over a decade.

2.2 Comments from Organizations

2.2.1 United Anglers of Southern California

Comment: The Vice-President of United Anglers of Southern California, a 4000-member organization, expressed concern over the negative impacts to fishing. "Nobody spoke to your new paperwork regarding the DDTs and PCBs in the fish. You're coming out with a whole series of charts saying what fish and what quantities of different fish you can and cannot eat. My industry, fishing, is getting pounded by such things going on as the Marine Life Protection Act. While we can't measure the effect that's going to have on us, I can tell you that the closures at the northern Channel Islands contributed a 25 percent reduction in fishermen activity up in that area. The bulk of -- a huge percentage of people believe the fish off Southern California within the whole Bight are not edible, and they are all poisonous."

EPA Response: EPA understands these issues can negatively impact recreational and commercial fishing. EPA and the State of California Office of Environmental Health Hazard Assessment (OEHHA) include in their messages to consumers the benefits of eating fish as well as the hazards associated with consuming certain species. The new fish advisory prepared by OEHHA is quite detailed in its recommendations by species and population just so people can continue to eat fish safely. The analysis and rationale for the advisory recommendations are discussed in OEHHA's *Health Advisory and Safe Eating Guidelines for Fish from Coastal Ares of Southern California: Ventura Harbor to San Mateo Point* (June 2009). The guidelines are available online at www.oehha.ca.gov . The Marine Life Protection Act was passed by the State of California legislature and is being implemented by the CA Dept. of Fish and Game.

2.2.2 Coalition for a Safe Environment

The Wilmington-based environmental justice organization, Coalition for a Safe Environment (CFASE), spoke at a public meeting and submitted written comments. In essence, the group did not find any alternative acceptable.

> **Comment #1:** The decision to adopt Alternative 3 the Institutional Controls, Monitored Natural Recovery, & Small Cap Alternative to cap the toxic site is no final solution or adequate remediation for the site.

EPA Response: The selected remedy is an interim action. EPA will develop a final remedy after assessing the results of the interim action and new data collected from the monitoring studies, as discussed in Section 12.2. The selected alternative underwent a thorough analysis, as required by the NCP, and followed EPA regulations and guidance for remedy selection. Significant peer review was involved in the analysis and selection process.

> **Comment #2:** CFASE supports an alternative that will remove the majority of the toxic chemicals from the site. EPA's comment that underwater dredging may not be technologically feasible is not true. All Ports in the United States undertake large scale dredging operations regularly. We believe the sediment should be dredged. CFASE suggests removal options: underwater vacuum system, enclosed conveyor system, under water container/bag system, underwater dispersion control enclosure.

EPA Response: It is true ports undertake dredging operations with some regularity; however, even the deepest ports are typically just 50 to 60 ft. deep. For example, the Port of Los Angeles channel deepening project will deepen the port from 47 ft. to 53 ft. The PV Shelf deposit is 150 to 300 ft. deep. The depth and size of the PV Shelf deposit creates difficulties out of issues that would be simple to address in a smaller, shallower environment. Conversely, the depth of PV Shelf is a benefit for Alternative 3 that it promises stability once the cap is placed.

As described in the Feasibility Study (May 2009), EPA evaluated dredging as a remedial alternative for PV Shelf. Well-proven technologies for dredging fine sediments at significant ocean depths next to large outfall pipes do not exist. Dredging operations have the potential of negatively impacting the environment by resuspending the contaminated sediment, thereby increasing its mobility.

EPA chose not to pursue dredging of PV Shelf based on additional considerations, including:

- The dredge material from PV Shelf would be a Resource Conservation and Recovery Act (RCRA) federally listed waste. Land disposal requires that DDT and DDD be reduced to concentrations less than 0.087 mg/kg prior to disposal.

- The proposed unloading, dewatering, and treatment areas for PV Shelf dredged sediment would be located within the Ports of Los Angeles and Long Beach. An increase in ship traffic during dredging operations would be significant.
- There are no United States vessels (i.e., trailing suction hopper dredges) that can dredge below 100 ft.
- Location of space within ports for stockpiling dredged material would be difficult.
- Transportation of the dredged material is expected to increase truck traffic on local roads.
- Approximately 1.5 x 10^9 gallons of water contaminated from the dewatered sediments would require treatment prior to discharge.

In sum, handling more than 1.5 million cubic yards of contaminated sediment on shore for dewatering, treatment by incineration, transport, and burial in a hazardous waste facility would present enormous logistical problems, energy requirements, and negative air quality impacts.

> **Comment #3:** The LACSD is proposing to build a new 18-foot-diameter outfall pipe that would pump five to six hundred million gallons a day into the water and there're two proposed routes. One would be along side the existing one, and another one would come through Wilmington straight out to the Port of LA. What would be the impact of that new 18-foot-diameter outfall pipe with five to six million gallons coming out of it? And how would that disturb your proposed cap?

EPA Response: EPA is aware that LACSD is considering building a new outfall and has met with LACSD to discuss possible outfall alignments. It is uncertain whether or not LACSD will proceed with new construction. Because of the outfall design, which dilutes and diffuses the waste water, and the characteristics of the tidal currents and internal waves in the areas under consideration, neither of the proposed alignments poses a problem to cap stability.

> **Comment #4:** CFASE disagrees with the findings of the Health Risk Assessment which established the cancer and non-cancer risk. EPA used a computer model that was not based on any public health survey of local harbor area residents and fisherman who recreate and consume fish and shellfish. No public health baseline was established in order to establish an accurate risk assessment.

EPA Response: EPA relied on the *Santa Monica Bay Seafood Consumption Study* (SMBRC, 1994) to calculate fish consumption rates and exposure duration. The study surveyed local boat anglers who reported consuming fish in the last four weeks. This local study formed the baseline for EPA's risk calculations. Discussion of EPA's use of the survey is found in Section 7.2 of the interim ROD.

> **Comment #5:** CFASE has concluded Alternative 3 does not meet the nine criteria to be eligible for selection. CFASE requests a delay in approval and implementation of Alternative 3 to investigate a few more potential alternatives.

EPA Response: EPA has done a comparative analysis of alternatives against the nine criteria and determined that Alternative 3, as an interim action, is protective of human health and the environment. The selected remedy does not comply with AWQC for PCBs. However, the remedy is an interim action to address the apparent erosion that is occurring at the southeast edge of the deposit. This erosion may be the result of November 2002 implementation of full secondary treatment of waste water that reduced the amount of total suspended solids discharged from the outfalls to an insignificant amount. Since this is also the area of greatest contaminated sediment, EPA is concerned that delaying action further may have negative impacts on the overall recovery that is occurring on other parts of the Shelf.

2.2.3 Heal the Bay

Heal the Bay is a non-profit environmental organization that works to improve water quality along the Southern California coast. Heal the Bay was formed over 20 years ago to protect Santa Monica Bay from sewage discharge but has since expanded its activities and mission to all of Southern California's water. Heal the Bay is part of the Palos Verdes Shelf Technical Information Exchange Group (PVSTIEG) that reviews and provides technical comment on EPA's studies and reports related to cleaning up PV Shelf.

> **Comment #1:** Heal the Bay objects to the use of 10^{-4} allowable cancer risk as a human health goal for high-end consumers.

EPA Response: EPA's interim remedy will use the new, June 2009 OEHHA fish advisory that does not allow for subsistence fishing. The advisory recommends a mixed species diet and no consumption of white croaker, barred sand bass, or topsmelt from the PV Shelf area. The guidelines in the new advisory result in an estimated excess lifetime cancer risk (ELCR) in the 10^{-5} range for both general and sensitive populations. The advisory achieves a 10^{-5} ELCR by restricting consumption of many species of fish, including white croaker. Although EPA regulations use an acceptable excess lifetime cancer risk range of 10^{-4} to 10^{-6}, [40 CFR §300.430] (EPA, 1999), EPA's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1: Fish Sampling and Analysis* 3rd Edition (November 2000) recommends use of 1 x 10^{-5} ELCR. EPA will work through the FCEC to develop outreach messages using the new advisory to prevent high-end consumers from consuming white croaker and other species of concern in the PV Shelf area.

> **Comment #2:** Heal the Bay requests that the remedial action objectives for PCBs be clarified and substantiated.

EPA Response: There are remedial action objectives (RAOs) for PCBs in water and sediment. The water RAO is the ambient water quality criteria (AWQC) of 0.064 ng/L; this is a promulgated value. The RAO for sediment is the cleanup level is 7 mg/kg OC, which is correlated to white croaker fish tissue concentration of 400 µg/kg.

The I-ROD discusses the development of PCBs interim cleanup levels in sections 7.5.1.3 and 8.1. The Anchor QEA technical memorandum that explains the bioaccumulation model used in setting interim cleanup levels for PCBs in sediment can be found in the PV Shelf Feasibility Study (May 2009). The bioaccumulation model used fish tissue data from the *2002/2004 Coastal Marine Fish Contaminants Survey* (EPA/NOAA 2007) and the latest data on DDT and PCBs and TOC in surface sediment from the *JWPCP 2007/2008 Biennial Receiving Water Monitoring Report* (LACSD, 2008). Accurate sediment cleanup levels are a work in progress; however, EPA believes the remedial action objectives (RAOs) are reasonable interim goals that can be refined for the final ROD after we collect additional data. NOAA and EPA are planning a white croaker fish tracking study that will help with this effort. After collection and analysis of additional data, the food web model can be refined and the conclusions used to reassess sediment cleanup levels for PCBs and DDTs for PV Shelf. Baseline monitoring data on PCBs in sediment and water will allow EPA to assess the viability of achieving the AWQC for PCBs.

> **Comment #3:** Ecological risk assessment models need to be calibrated and validated for birds and mammals. The Proposed Plan and Feasibility Study did not set a goal based on ecological risk to cetaceans, pinnipeds or even piscivorous sea birds. Heal the Bay strongly recommends that EPA set an ecologically based target for these marine predators. If there isn't adequate data to determine the current baseline contaminant concentrations in cetaceans, that research needs to be completed. Also, EPA needs to set aquatic life health goals tied to DDT and PCB concentrations at various levels of the food chain.

EPA Response: EPA agrees that the ecological risk assessment model needs to be calibrated and validated before it can be applied to piscivorous birds and mammals. At this time, data gaps impair the use of the food web model for these receptors. Since we currently do not have sufficient data to populate the model to achieve accurate predictions at the primary level, i.e., sediment to white croaker, we plan to wait for additional data gathered as part of the interim remedial action to apply the model to pinnipeds and bald eagles.

EPA looks to the Natural Resource Trustees to take the lead on wildlife recovery and welcomes opportunities to work collaboratively to collect more data on pinnipeds, cetaceans, and birds. EPA's fish monitoring plan will include a pelagic species, e.g., sardines, squid or mackerel, that can be used to develop the food web from sediment to fish to piscivorous birds. At this time, we are not including RAOs beyond saltwater aquatic life criteria, which are promulgated standards based on relevant, sound scientific research. For example, the saltwater aquatic life criterion for DDT is directly applicable to PV Shelf since it was derived from studies of the California Brown Pelican in the Southern California Bight.

> **Comment #4:** The capping of grid cell 8C with a maximum of 45cm of material, as Alternative Three (3) proposes in the Proposed Plan, provides no margin of safety for the impacts of bioturbation, inconsistent cap placement and thickness, and erosive conditions. Heal the Bay has stated on numerous occasions that a 45 cm cap will be inadequate to fully contain the DDT and PCBs in the sediments. The norm around the country for a contaminated sediment capping project is a one meter cap. Capping projects in nearby San Pedro Bay for sediments far less contaminated than the Palos Verdes shelf have used caps of five feet or more.
>
> Previous risk evaluation and studies define the biologically active zone and the enhanced biodiffusion zone as 0-30 cm from the sediment surface. This assumption does not agree with the bioturbation discussion in Palermo, 1999[3], which states bioturbation most likely occurs to depths of 30 –50 cm. Maximum tDDT concentrations occur in sediment 20-45 cm deep (Palermo, 1999). It is common knowledge that some aquatic organisms burrow to depths of 1 meter or more in sediment. Although, there are few of these deep bioturbators on the shelf, they are definitely present. Due to the aforementioned issues, Heal the Bay strongly recommends that a one (1) meter cap be implemented as the cap thickness for grid cell 8C. One meter provides a margin of safety for bioturbation, inconsistent cap placement and thickness, and erosive conditions….
>
> Alternative Four (4) recommends adding two additional grid cells (6C and 7C) to capping alternative three. All three grid cells, 6C, 7C, and 8C, would be capped at a

[3] Palermo, M., et al (1999) Options for In-Situ Capping of Palos Verdes Shelf Contaminated Sediments.

> maximum thickness of 45cm. As Heal the Bay has stated, we are against using a thickness of 45cm. While Heal the Bay would prefer a one meter cap for the all three cells, we recognize that this might not be financially feasible for all cells. As such, based on the information provided in the Proposed Plan, Heal the Bay recommends Alternative Four, using a one meter cap for grid cell 8C, and a 60 cm cap for grid cell areas 6C and 7C. These cells contain nearly two thirds of the DDT on the shelf.

EPA Response: Heal the Bay is concerned that the 45-cm cap is not thick enough to be effective in containing the contaminated sediment because cap thickness may be uneven (i.e., less than 45 cm), the cap may erode, deep ocean disposal uses thicker caps, and bioturbating organisms may breach the cap.

The Feasibility Study Appendix E, *Options for In Situ Capping of Palos Verdes Shelf Contaminated Sediments* (Technical Report EL 99-2) (Palermo, et al. 1999) discusses issues related to capping. The report includes the erosion evaluation, seismic evaluation, bioturbation evaluation, and consolidation evaluation that were completed in support of cap design. Seismic considerations limit cap thickness to less than 60 cm. In an earthquake, the shear strength of the sediment is temporarily reduced, which could cause flow failures. Bottom slope is also a major factor in assessing potential flow failures from earthquakes and was used to define areas where capping would not be feasible. The seismic evaluation is described in Appendix B of the USACE report. The evaluation indicated that addition of a cap with thickness up to 60 cm will not render the contaminated sediments susceptible to flow failure on slopes of 5 degrees or less.

We recognize that thicker caps are used in ocean disposal in the San Pedro Bay. Oceanographic conditions in San Pedro Bay are different from oceanographic conditions at White Point. The USGS Special Investigation Report, *Connections Among the Spatial and Temporal Structures in Tidal Currents, Internal Bores, and Surficial Sediment Distributions over the Shelf of Palos Verdes, California* (Noble et al., 2008) found that the measured tidal current amplitudes are much weaker moving across PV Shelf than they are in San Pedro Bay. In spite of the weaker current field, the fine EA sediment can erode during winter storms. Heavier material, i.e., sand, found southeast of the outfalls has low erodability although the area is subject to larger current amplitudes.

Concerns regarding bioturbation were discussed in the USACE technical report, *Options for In Situ Capping*. The Palermo reference cited by Heal the Bay is found on p. 20 of *Options for In Situ Capping*. It concludes, "… a cap thickness component for bioturbation of 30 cm should accommodate most concerns related to bioturbation effects on cap integrity… However, it should be noted that potential for recolonization by deep bioturbators and their effects on the cap are unknown. Note that Stull (senior environmental scientist at LACSD) speculated that significant bioturbation could occur to depths of 50 cm. The monitoring program for the project should therefore include components to assess the potential presence and behavior of deeper bioturbators and any effects on cap integrity." (op cit. p. 22)

Because of the lack of PV Shelf-specific data on deep bioturbating infaunal organisms (BIOs), EPA undertook a bioturbation study in 2004. The document, *Study Report for the Summer 2004 Bioturbation Measurement Program on the Palos Verdes Shelf*, SAIC Rpt. #679 (2005), is available at www.epa.gov/Region09/superfund/pvshelf. The study inventoried the amount and size of large benthic organisms at various depths across the shelf and used isotopes (^{234}Thorium and ^{210}Lead) to calculate sediment mixing rates. The study found biodiffusive mixing extended to a depth of 6 cm, consistent with the principal of vertical distributions of infaunal organisms described by Wheatcroft (1994) and Stull et al. (1996) in which 40 percent to 60 percent of the infaunal organisms occurred in the upper 2-cm layer. The study concluded that low mass and abundance suggest low potential for cap disruption. The study noted that the highest mixing intensities were in the northwest portion of the study area and there was a progressive decrease toward the outfalls region. Ghost shrimp were found on the shelf in the northwest area, including the pilot capping areas, but not in deeper waters. However, given ghost shrimp preference for sandy muddy habitat, the addition of sand may attract ghost shrimp in to areas it would not otherwise inhabit. Post-construction monitoring of the cap would occur routinely to identify and repair any breaches in cap integrity.

EPA's remedial design process will refine cap design and placement techniques. During remedial design, EPA will use data collected for the RI/FS to reassess the evaluations and assumptions used in the USACE report. Remedial design development will include reviews by PVSTIEG.

> **Comment #5:** The estimated erosion rate range for this area is predicted to be 0.1 to 0.3 mm/per year, and as "over time the sediment deposit in this area will slowly erode" (Ferre and Sherwood, 2008). Was work completed to determine how the structural integrity of the cap remains over time when stressors (bioturbators and erosive conditions) are introduced? The combination of bioturbation, inconsistent cap thickness, cap material heterogeneity, and erosive conditions make it prudent to use a large margin of safety on the cap thickness.

Yes, USACE technical report (EL-99-2) *Options for In Situ Capping* (Palermo, 1999) included modeling of cap stability over time. The estimated erosion rate for the sediment deposit is different from the erosion rate of sand. The contaminated sediment is fine silts and clays. Even these very fine materials are estimated to be eroding very slowly--at one third to one tenth of a mm a year, it would take 90 to 250 years to erode one inch. The USACE technical report includes an assessment of suitable cap material. Cap modeling indicates that sand size 0.1 mm or 0.3 mm would be adequate to create a stable cap impervious to stresses from winter storms.

> **Comment #6:** The PVS/FS provides tremendous detail on the constraints to capping with regard to sheer strength, sediment characteristics, engineering possibilities, and sediment contamination levels. The fish usage of the areas proposed for capping are absent from the analysis. Without specific information about the movement patterns of white croaker (and perhaps other species) on and off the shelf, and which parts of the shelf are used as foraging habitat by the fish that represent the greatest risk, it will be impossible to evaluate the potential decrease in contamination that would result from the capping projects described in the report.

EPA Response: EPA agrees that lack of fish usage data greatly limits the ability to forecast risk reduction from capping. As discussed in section 9.3.2, the selected remedy includes a fish tracking study that will track white croaker and barred sand bass over a 2-year period. EPA is working with NOAA on the design of the study.

> **Comment #7:** USEPA must identify and state measurable objectives for the enforcement element of the ICs. For example, the Proposed Plan failed to discuss modifying the catch ban to include complete fishing blocks and San Pedro Bay as an effective means of simplifying and enhancing the enforcement program. Did USEPA ever consider a commercial and sport fishing ban off of PV shelf for non-migratory fish

species in order to meet the preferred health risk goal of 10^{-5}? Also, the Proposed Plan doesn't include any discussion on expanding the commercial fish ban to all of San Pedro Bay, as is merited based on the results of the NOAA-USEPA fish contamination study and the new OEEHA fish consumption guidelines. An effective enforcement program must be implemented.

EPA Response: Enforcement is an important component of the ICs program. However, enforcement is a complex program from an administrative stand point because it requires EPA to enter into cooperative agreements with State and other agencies that have their own mandates and jurisdictions. The California Department of Fish and Game (CDFG) under advisement of OEHHA, sets fishing bans. EPA will consult with OEHHA and CDFG regarding the adequacy of the existing commercial catch ban and any need for stricter limits to sports fishing as part of the ongoing ICs development. EPA is mindful that the ICs program will continue to be the first line of protection for the general public. As such, the program is updated and enhanced continually in response to new data. Additional studies, including a fish tracking study will be undertaken as part of the remedial design phase.

2.3 Comments from Public Agencies

2.3.1 Comments from the Santa Monica Bay Restoration Commission

The Santa Monica Bay Restoration Commission (SMBRC) is a nonregulatory, locally based state organization whose functions are to monitor, assess, coordinate and advise the activities of state programs as well as oversee funding that affects the beneficial uses, restoration and enhancement of Santa Monica Bay and its watersheds. SMBRC is a member of PVSTIEG.

Comment #1: The plan does not take into account what level of risk reduction can realistically be achieved with the new advisory in place.

At a minimum, the Proposed Plan should, but does not make it clear what is the basis for the projected level of risk reduction achieved through implementation of the preferred alternative, especially whether or not it is primarily through communication of the new advisory under the institutional controls (ICs) program. Clarification of this issue is critically important due to the fact that the advisory tissue level (ATL) used by the new OEHHA advisory is based merely on a 1 in 10,000 for cancer risk. Should communication of the OEHHA advisory be the focus of the ICs program and the ICs program be the primary mechanism for risk reduction (at least in the short-term), the overall risk reduction goal of the Proposed Plan could be severely compromised. To ensure that the Plan achieve its desired remediation goals and objectives, we want reiterate our previous comment and strongly recommend that EPA carefully evaluate or reevaluate the projected risk reduction levels through the ICs program in light of the new OEHHA advisory, and strengthen the IC program, if deemed necessary.

EPA response: The new, June 2009 fish advisory recommends a mixed species diet and no consumption of white croaker, barred sand bass, or topsmelt from the PV Shelf area. The guidelines in the new advisory result in an estimated excess lifetime cancer risk (ELCR) in the 10^{-5} range for both general and sensitive populations, as shown in the *Health Advisory and Safe Eating Guidelines* (OEHHA, 2009). OEHHA's issuance of ATLs was prior to the development of the final fish advisories which meet EPA's preferred risk range for fish consumption of 1 x 10^{-5} ELCR [EPA's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1: Fish Sampling and Analysis* 3rd Edition (November 2000)]. The advisory restricts consumption of many species of fish, including white croaker. It does not allow for subsistence fishing and warns against eating skin-on or whole fish. It is a complex advisory and we are crafting angler and community outreach messages based on it.

> **Comment #2:** We recommend that the scale of the proposed study should be expanded to include more sampling and analysis of PCBs in targeted species from these areas.
>
> As recognized in the Proposed Plan, one of the most important findings of the 2002 fish survey and consequently the new OEHHA Advisory, is the greater health threat from PCB as compared to DDT. For this reason, we support the proposed additional study on the extent of PCBs throughout PV shelf. However, given the fact that high PCB concentration was also detected in tissue samples from fish caught in areas far outside of PV Shelf, and on fish species other than white croaker, we recommend that the scale of the proposed study should be expanded to include more sampling and analysis of PCBs in targeted species from these areas.

EPA Response: EPA understands that the health concerns related to PCBs in fish is not confined to the PV Shelf site. EPA's authority under the Superfund program is limited to addressing contamination from the PV Shelf site. EPA will coordinate with other agencies to share project data. For example, the fish tracking study proposed under the selected remedy can be useful to other agencies that work in the Southern California Bight. EPA will continue to evaluate site-related risks to human health from PCBs and to provide health protectective messages through the ICs program.

> **Comment #3:** In our previous comments on the draft feasibility study report, we raised two issues, one on the need to collect new data on fish consumption, one on the need to further evaluate the tissue concentration and risk level from whole fish. We noticed, and appreciate your agreement with these needs in your responses to our comments. However, unless we missed it during our review, we have not found these studies being added as part of the remedial ICs in either the Proposed Plan document or the final feasibility study report. Our belief is stronger now that these studies should be implemented sooner than later. This is primarily due to the concern that the new OEHHA advisory is mainly based on tissue concentration data of fish filet instead of whole fish, which may result in the risk of consuming locally caught fish by some ethnic groups being greatly underestimated. Again, to ensure that these studies will indeed take place, we strongly recommend that their implementation be more clearly identified in both the Proposed Plan and the final feasibility report.

EPA Response: The selected remedy includes a fish consumption study, as discussed under the alternatives and in section 12.2.1 of the I-ROD. The study will be carried out under the ICs Program. EPA will begin planning the study after the I-ROD is signed and the cleanup enters the remedial design phase. As a member of FCEC and PVSTIEG, SMBRC will be able to review plans for the study to ensure it addresses your concerns.

2.3.2 Comments from LACSD

The Sanitation Districts of Los Angeles County (LACSD) owns and operates the Joint Water Pollution Control Plant that discharges secondary treated effluent into the Pacific Ocean pursuant to the waste discharge requirements and national pollutant discharge elimination system (NPDES) permit issued by the Los Angeles Regional Water Quality Control Board. The ocean monitoring program in the NPDES permit includes core monitoring, regional monitoring, and special studies. LACSD is a member of the PVSTIEG. The LACSD submitted written comments in a letter dated July 15, 2009.

> **Comment:** Our primary concern regarding the preferred alternative is the potential damage to the Sanitation Districts' outfall infrastructure, reduced diffuser performance, and resuspension of the buried effluent-affected sediment as a result of cap placement around grid cell 8C. The FS indicates that "low impact" techniques will be used for cap placement. However, grid cell 8C surrounds the diffuser structure of one of our active outfalls and we have significant concern that the cap placement process may damage the pipe or bury the diffusers. Further, previous attempts to cap these sediments showed that the effluent-affected deposit became resuspended in some areas, thereby increasing the exposure of biota to these contaminants.
>
> In light of these concerns, we request that EPA take the following actions:
>
> 1. Formally consult and seek consensus with Districts' engineering staff during the planning, field testing, capping method selection, and cap placement processes to ensure the Districts' outfall structures are not negatively impacted;
> 2. Unless granted written consent from the LACSD to do otherwise, the EPA should respect the existing easements of the LACSD outfalls within grid cell 8C and conduct all capping activities at least 1,000 feet away from this critical infrastructure;
> 3. Better define the exact capping area within grid cell 8C using fine spatial scale sediment contamination information and precise geo-referencing to ensure that only the most contaminated sediments are capped and minimize potential impacts to the outfalls;
> 4. Thoroughly test prospective cap placement techniques under similar conditions as found at the target cap site to ensure the placement will not do more harm than good;
> 5. Conduct comprehensive monitoring of the turbidity plume, sediment resuspension, and cap depth as part of any capping effort to ensure that the cap has been properly placed and does not degrade nearby kelp forest habitat."

EPA Response: Every precaution will be taken to protect the outfall infrastructure during capping. EPA proposes entering into a Memorandum of Understanding with LACSD to consult and seek consensus during cap design and implementation. EPA agrees with the need to test prospective cap placement techniques and closely monitor cap placement. Remedy design will include a kelp forest monitoring plan to assure capping activities do not negatively impact the kelp forest.

EPA Guidance Documents and References

40 CFR §300.430, "Remedial Investigation/Feasibility Study and Selection of Remedy" Code of Federal Regulations

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601, et seq.

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Appendix A: ARARs Overview

Section 121(d) of CERCLA states that remedial actions on CERCLA sites must attain (or justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be ARARs. Applicable requirements are those cleanup standards, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. A requirement is applicable if the specific terms, or "jurisdictional prerequisites," of the law or regulation directly address circumstances at the site.

If a requirement is not legally applicable, the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations sufficiently similar to the circumstances of the proposed response action and are well suited to the conditions of the site. The criteria for determining relevance and appropriateness are listed in Title 40, Code of Federal Regulations (CFR), Section 300.400(g)(2).

ARARs are concerned only with substantive, not administrative, requirements of a statute or regulation. The substantive portions of the regulation are those requirements that pertain directly to actions or conditions in the environment. Examples of substantive requirements include quantitative health- or risk-based restrictions upon exposure to types of hazardous substances.

Administrative requirements are the mechanisms that facilitate implementation of the substantive requirements. Administrative requirements include issuance of permits, documentation, reporting, record keeping, and enforcement. Thus, in determining the extent to which onsite CERCLA response actions must comply with environmental laws, a distinction should be made between substantive requirements, which may be ARARs, and administrative requirements, which are not. According to Section 121(e) of CERCLA, a remedial response action that takes place entirely onsite may proceed without obtaining permits. This permit exemption applies to all administrative requirements and permits.

Pursuant to EPA guidance, ARARs generally are classified into three categories: chemical-specific, location-specific, and action-specific requirements. These categories were developed to help identify ARARs, although some do not fall precisely into one group or another. The ARAR categories are defined as follows:

- **Chemical-specific ARARs** include those laws and requirements that regulate the release to the environment of materials possessing certain chemical or physical characteristics or containing specified chemical compounds. These requirements generally set health- or risk-based concentration limits or discharge limitations for specific hazardous substances. If, in a specific situation, a chemical is subject to more than one discharge or exposure limit, the more stringent of the requirements should generally be applied.

- **Location-specific ARARs** are those requirements that relate to the geographical or physical position of the site, rather than the nature of the contaminants or the proposed site remedial actions. These requirements may limit the placement of remedial action and may impose additional constraints on the cleanup action. For example, location-specific ARARs may refer to activities in the vicinity of wetlands, endangered species habitat, or areas of historical or cultural significance.

- **Action-specific ARARs** are requirements that apply to specific actions that may be associated with site remediation. Action-specific ARARs often define acceptable handling, treatment, and disposal procedures for hazardous substances. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Examples of action-specific ARARs include requirements applicable to groundwater treatment, effluent discharge, hazardous waste disposal, and emissions of air pollutants.

EPA has identified the following requirements as ARARs for this interim remedy.

A. Chemical-Specific ARARs

1. Federal Requirements

Clean Water Act Section 304, 33 USC §1314 (Ambient Water Quality Criteria)

Chemical-specific ARARs for surface water consist of EPA's ambient water quality criteria (AWQC) for DDTs and PCBs. These criteria, which have been developed for the protection of both aquatic life and human health, are summarized in Table 3-3.

Section 304 of the Clean Water Act requires EPA to publish criteria for water quality. 33 United States Code (USC) §1314(a). The EPA AWQC for DDTs and PCBs were originally published in October 1980 (USEPA, 1980a; USEPA, 1980b). The human health values have been updated since the original criteria were published in 1980 to reflect revised consumption rates and carcinogenic potency values from EPA's Integrated Risk Information System (IRIS) database. 40 CFR §131.36 and 57 Federal Register (FR) 60848, December 22, 1992.

Table A-1: EPA Ambient Water Quality Criteria

Chemical	**Saltwater Aquatic Life, 24-Hour Average (ng/L)**	**Human Health (ng/L)**
DDTs	1[a]	0.22[b]
PCBs	30	0.064

[a] The sum of the 4,4'- and 2,4'- isomers of DDT, DDD, and DDE.
[b] For DDE and DDD, the AWQC for protection of human health are 0.59 and 0.83 ng/L, respectively.
ng/L – nanograms per liter

<u>AWQC for DDTs</u>. Criteria for the protection of saltwater aquatic life are, for most contaminants and pollutants, based on toxic effects data for water-column organisms. However, for DDTs, which bioaccumulate to high levels and may cause toxicity to organisms at higher trophic levels, EPA determined that more restrictive criteria were necessary to protect fish-eating birds and birds feeding at higher trophic levels,

including birds that feed on other birds and scavenge on the carcasses of marine mammals. The chronic marine aquatic life criterion for DDT is 1 ng/L, which is equivalent to 10^{-9} grams per liter (g/L) (USEPA, 1980a). This criterion is set to achieve a fish tissue (whole-body) DDT concentration of 150 μg/kg (wet weight) in prey, and is based on a 1975 study of California brown pelicans in the Southern California Bight (Anderson et al. 1977).

The EPA AWQC for the protection of human health from DDT exposure through water and consumption of DDT residues that have bioaccumulated in fish is 0.22 ng/L, and is based on a bioconcentration factor (BCF) of 53,600. The BCF relates the concentration of a chemical in aquatic animals to the concentration in the water in which they live. The steady-state BCFs for a lipid-soluble compound, such as DDT, in the tissues of various aquatic animals seem to be proportional to the percent lipid in the tissue. The AWQC is based on a DDT concentration in fish tissue of approximately 12 μg/kg and would result in a lifetime excess cancer risk of up to 1×10^{-6}, assuming a consumption rate of approximately one meal per month. *See* 45 FR 79331, updated to reflect current IRIS potency factors. 40 CFR §131.36, 57 FR 60848.

<u>AWQC for PCBs</u>. The EPA chronic marine aquatic life criterion for PCBs of 30 ng/L is also fish residue-based. It was set at the level that would be protective of sensitive aquatic species and result in achievement of the Food and Drug Administration (FDA) tolerance level (for protection of human health) of 5,000 μg/kg in fish after bioaccumulation (USEPA, 1980b). There is no evidence that acute or chronic toxicity to aquatic life will occur at levels of PCBs less than 30 ng/L; thus, the marine aquatic life criterion has not been revised.

The EPA AWQC for the protection of human health from the bioaccumulation of PCBs in fish is 0.064 ng/L, based on achieving a concentration of 1.4 μg/kg in fish consumed, which would result in a lifetime excess cancer risk of up to 1×10^{-6}, assuming a consumption rate of one meal per month (USEPA, 1996).

<u>ARARs assessment for AWQC</u>. Section 121(d)(2)(A) of CERCLA requires that remedial actions meet federal AWQC established under Section 304 or 303 of the Clean Water Act, where such AWQC are determined by EPA to be relevant and appropriate to remedial actions at the site. 42 U.S.C. §9621(d)(2)(A) and 40 CFR §300.430(e)(2)(I)(E).

The AWQC for DDTs and PCBs are relevant and appropriate ARARs that would establish response action goals at this site since aquatic organisms, wildlife, and humans may be exposed to these contaminants either directly or through consumption of contaminated organisms.

The selected interim remedy will attain the AWQC for DDT, but will not attain the PCBs AWQC for human health. PCB concentrations in water at PV Shelf have been measured most recently at 0.56 ng/L, which exceed the AWQC for human health. EPA does not yet have sufficient data to determine whether the PCB AWQC can be achieved, and therefore cannot state with certainty that the remedy will attain this ARAR.

Under certain conditions, CERCLA and the NCP allow the selection of a remedial action that does not attain a specific ARAR. 42 U.S.C. §121(d)(4)(A); 40 CFR §300.430(f)(1)(ii)(C)(1). Pursuant to those provisions, EPA is waiving the PCB AWQC for human health on the basis that tThe selected remedy is an interim action that will become part of a final remedial action that will attain the ARARs. As part of the Monitored Natural Recovery element of the selected remedy, EPA will conduct further investigation of PCBs flux and background concentrations, and, in the context of selecting the final remedy, will evaluate whether and how remedial action might achieve the PCBs AWQC for human health.

B. Location-Specific ARARs

1. Federal Requirements

Endangered Species Act

The goal of the Endangered Species Act of 1973, 16 U.S.C. §§1531-1544, is the conservation and recovery of species of fish, wildlife, and plants that are threatened with extinction. EPA has consulted with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service to identify threatened and endangered species and ensure that any response action is not likely to jeopardize listed species or adversely modify critical habitat. Because of the presence of endangered/threatened species on the PV Shelf, the substantive requirements at Sections 7 and 9 of the Endangered Species Act apply to the selected interim remedy. 16 U.S.C. §§1536 & 1538.

Coastal Zone Management Act

Section 307(c)(1) of the Coastal Zone Management Act (CZMA) requires that federal agencies conducting or supporting activities affecting land and water resources of the coastal zone do so in a manner that is consistent with approved state coastal zone management programs. The selected remedy would affect the resources of the coastal zone. While onsite activities are not subject to CZMA administrative review or permitting processes, the selected remedy must ultimately be consistent with the substantive requirements of the coastal zone management plan that are applicable. 40 CFR §§300.5, 300.430(f)(1)(ii)(B).

The approved coastal zone management program for California coastal waters includes the California Coastal Act, and is administered by the California Coastal Commission. Generally, filling of surface waters is allowable only when public benefits exceed public detriment from the loss of water areas, the filling is for a water-oriented use, and no alternative upland location is available.

Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act

Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act regulate the placement of fill in waters of the United States. 33 U.S.C. §1344, 33 U.S.C. §401. In placing material on the Palos Verdes Shelf for the purpose of constructing a cap, EPA will comply with the substantive requirements of these Sections, and, in particular, the criteria for determining the acceptability of placing fill into the waters of the United States as promulgated in 40 CFR Part 230.

C. Action-Specific ARARs

A. Federal Requirements

Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) and Ocean Dumping Regulations

The MPRSA, commonly called the Ocean Dumping Act, 33 U.S.C. §§1411-1414, and federal ocean dumping regulations, 40 CFR Parts 220-238, regulate the dumping or disposal of material in the ocean. Ocean disposal of dredged material is administered by EPA and the United States Army Corps of Engineers (USACE) in accordance with the MPRSA. Dredged material must meet substantive federal testing guidelines to be approved for disposal. 40 CFR Part 227. Sediment containing more than trace amounts of organohalogen compounds, such as DDTs and PCBs, typically fail to meet the criteria for ocean disposal. The substantive requirements of the MPRSA and the ocean dumping regulations apply to the selected interim action.

Clean Water Act

Section 403 of the Clean Water Act, 33 U.S.C. §1343, and associated regulations at 40 CFR Part 125, Subpart M regulate discharges into marine waters that have the potential to degrade the marine environment. These provisions prohibit discharges unless limits can be established to prevent unreasonable degradation or irreparable harm to the marine environment (EPA, 1988b). The substantive requirements of Section 403 will apply to the placement of sediment on PV Shelf.

B. State Requirements

California Endangered Species Act & Fully Protected Mammals Statute

The goal of the California Endangered Species Act, Section 2050 of the California Fish and Game Code, is to conserve, protect, restore, and enhance any endangered or threatened species and its habitat. To effectuate this goal, California Fish and Game Code Section 2080 forbids the take of any state-identified endangered or threatened species. Regarding the birds likely to nest or feed in the area, most of those that are listed as endangered or threatened by the state are also listed federally. Because of the presence of endangered/threatened species on the PV Shelf, EPA has identified the substantive requirements of the California Endangered Species Act, Section 2080 of the California Fish and Game Code, as applicable requirements that the remedy will attain.

Also, California provides certain protections to a designated list of "fully protected mammals." California Fish and Game Code Section 4700 prohibits the take of any of the listed fully protected mammals, which include the Northern elephant seal and Guadalupe fur seal. The population range of these two species likely includes areas of the PV Shelf that will be impacted by the remedy. This provision is therefore designated an applicable requirement.

California Ocean Fishing Regulations

Section 28 of Title 14 of California Code of Regulations (CCR) forbids the taking of certain fish species from California ocean waters. 14 CCR Sections 28.05 and 28.10 forbid the take of garibaldi and giant (black) sea bass, respectively. Both of these species are found at the Palos Verdes Shelf, and EPA will therefore comply with the substantive requirements of these regulations.

D. Additional Requirements identified by the California Department of Fish & Game

Pursuant to CERCLA Section 121, the California Department of Fish & Game (CDFG) identified requirements that might be applicable or relevant and appropriate to the interim action. EPA has included several of those provisions as ARARs, as described above and in Table 13-1 of the ROD. The following subset of the CDFG-identified requirements, which each prohibit the take of particular species, are not ARARs because

EPA does not anticipate that the remedial action will result in any take or possession of the designated species:

- Fish and Game Code § 3511 (Fully protected birds)
- Fish and Game Code § 3503.5 (Birds of Prey)
- Fish and Game Code § 3800 (Nongame birds)
- Fish and Game Code § 4150 (Nongame mammals)

As to these provisions, EPA has notified the State that, if, in the course of remedial design, it becomes apparent that the remedy might result in mortality of the designated bird or mammal species, the Agency will work closely with the State and Federal resource managers to avoid such impact. Should EPA determine that the mitigation measures may not be sufficient to avoid the take of a species covered by one or more of the State statutory provisions listed above, then the substantive provision(s) of that portion of the California Fish and Game Code would be a relevant and appropriate ARAR.