1.0 INTRODUCTION

The United States Environmental Protection Agency (EPA), Region IX, conducted a sampling and analysis program of various environmental media at Palos Verdes Shelf (PV Shelf), Los Angeles County, California. PV Shelf is Operable Unit (OU) 5 of the Montrose Chemical Corporation (Montrose) Superfund Site, 20201 Normandie Avenue, Los Angeles, California.

Gilbane Federal (Gilbane; formerly ITSI Gilbane), Concord, California, was EPA's prime contractor for this program conducted under EPA Remedial Action Contract II (RAC) Number EP-S9-08-03, Task Order (TO) 0068. The main purpose of this program is to support monitored natural recovery (MNR) of PV Shelf. MNR is a component of the interim remedy for the site, as described in the Interim Record of Decision (IROD) for Montrose OU 5, signed by EPA in 2009.

To implement the MNR component, EPA gathers data periodically to characterize various environmental media at the site, including sediment, water, and fish; the data may also be used to support the possible remedial design (RD) of an interim isolation cap, a second component of the interim remedy. EPA will also use data from this program to develop the Final Record of Decision (ROD) for PV Shelf.

1.1 HISTORY OF MONTROSE OU 5

Since 1937, the Joint Water Pollution Control Plant (JWPCP) in Carson, California, operated by the Sanitation Districts of Los Angeles County (Sanitation Districts), has sent treated wastewater (effluent) to ocean outfalls at White Point on the Palos Verdes Peninsula. From the 1950s to 1971, the Montrose plant on Normandie Avenue discharged process wastes from the manufacture of dichlorodiphenyltrichloroethane (DDT) into the local municipal sewer system, where the wastes entered the wastewater stream. The wastewater was treated at JWPCP and subsequently discharged to the Pacific Ocean by way of the Palos Verdes Hills tunnels and the White Point outfalls. Details on the White Point outfalls, their diffusers (emitters), and the history of JWPCP emissions are available in the Sanitation Districts' references cited herein (Sanitation Districts 2006, 2012, and 2016). Until polychlorinated biphenyls (PCBs) were banned in 1976, PCBs from various other local industries were also present in the waste stream treated at JWPCP. In 1971, annual mass emissions from JWPCP were estimated at 167,000

metric tons [MT] of effluent solids, containing 21 MT of DDT and 5.2 MT of PCBs (Science Applications International Corporation [SAIC], 2004). Montrose stopped discharging DDT wastes to the sewer system in 1971, but damage to the natural environment, notably the collapse of the California brown pelican population due to DDT-related egg-shell thinning, already had occurred.

Due to DDT contamination, the State of California issued an interim health advisory in 1985 discouraging human consumption of white croaker (WC) fish. Subsequently, in 1990, the California Department of Fish and Game (CDFG; now the California Department of Fish and Wildlife [CDFW]) closed the area at PV Shelf to commercial fishing for WC.

In 1994, five state and federal Natural Resource Trustees (Trustees), issued a Natural Resource Damage Assessment (NRDA) documenting the ecological impacts caused by DDT- and PCB-contaminated sediment in the PV Shelf area. Major conclusions of the NRDA are summarized below.

- The effluent-affected (EA) sediment formed a shallow deposit varying in thickness from 5 centimeters (cm) to 1 meter (m), and covering 44 square kilometers (km^2).
- Concentrations of chemicals of concern (COCs; i.e., DDT compounds and PCBs) varied with depth in the deposit, with the highest concentrations buried under cleaner, but still contaminated, sediment.
- An estimated 110 MT of DDT compounds and 10 MT of PCBs were mixed within the EA sediment (Lee et al., 1994).

The NRDA findings were used as the basis for EPA's conceptual site model (CSM) for PV Shelf as presented in the Remedial Investigation (RI) report (EPA, 2007b) and in the IROD (EPA, 2009b).

Since the 1970s, loading rates of contaminated suspended solids emitted through the Sanitation Districts' White Point outfalls have diminished due to several factors, including: (1) industrial pre-treatment programs related to the Clean Water Act of 1972; (2) the closures of several local industrial facilities, including the 1982 closure of the Montrose Normandie Avenue plant (now the Montrose Superfund Site); and (3) the Sanitation Districts' secondary treatment of wastewater at JWPCP, which was initiated in November 1983 and fully on-line in November 2002. DDTs have not been detected in JWPCP effluent since 2002, and PCBs have not been

detected in JWPCP effluent since 1985 (Sanitation Districts, 2012). Sanitation Districts continues to operate JWPCP and the White Point outfalls, serving 2.5 million southern California residents and 2,300 industries, treating an average of 273 million gallons per day (mgd) of wastewater (Sanitation Districts, 2012).

Since 1994, organizations including the Sanitation Districts and the Southern California Coastal Water Research Project (SCCWRP), have contributed to EPA's understanding of PV Shelf through technical studies. EPA over the years has directly sponsored and funded field studies at PV Shelf, including assessing degradation of COCs, modeling sediment transport, and tracking fish movements. In 2009, as part of the MNR component of the interim remedy, EPA conducted a baseline sampling event of the sediment bed at PV Shelf (ITSI Gilbane, 2013b). The MNR study presented herein is a continuation of the MNR remedy component.

1.2 SITE DESCRIPTION

PV Shelf encompasses a bed of contaminated solids (sediment) emitted from the wastewater outfall system that has settled on the seafloor in the Pacific Ocean at water depths varying from about 40 m to 200 m or greater. The bed of contaminated sediment is situated on the western edge of the North American continental shelf off the Palos Verdes Peninsula in southern California. The distance from the shoreline to the inshore edge of the sediment bed (approximate water depth = 40 m) is about 1.5 kilometers (km). Catalina Island, one of the Channel Islands, is the closest island to PV Shelf, at a distance of about 42 km.

The sediment bed varies in width from about 1.5 to 4 kilometers, and is about 25 km in length. The continental shelf in this area slopes in the seaward direction at about 1 to 4 degrees. A shelf break (i.e., the zone of transition from the relatively flat shelf to the steeper continental slope) occurs at water depths of 70 to 100 m. The seafloor then drops sharply at a slope of about 13 degrees to a water depth of 800 m (Lee, 1994). Figure 1-1 shows the PV Shelf Study Area with bathymetry (depth) isobaths. EA sediment deposits historically have been encountered outside the Study Area on the shelf break and even the shelf slope itself, in ocean water as deep as 500 m (Sanitation Districts, 1992).

Previous researchers have surmised that materials from the Portuguese Bend Landslide (PBL) and other landslides on the Palos Verdes Peninsula have settled on the ocean floor and mixed

with the contaminated solids discharged from the Sanitation Districts' outfalls, resulting in a general enlargement of the EA deposit (Kayen et al., 2002).

The EA bed at PV Shelf generally is distinguishable from the underlying native sediment bed due to differing physical and chemical properties, e.g., higher organic carbon (OC); higher moisture content (MC); lower mean grain size; lower dry bulk density (BD_d); and higher COC concentrations (Lee et al., 2002). Previous investigators have described a three-layer characterization of the vertical sediment profile at PV Shelf, as follows (EPA, 2009b):

- Surficial sediment – Shallow sediment in the 0-20-cm bed-depth interval (though this interval can vary widely) has relatively low to moderate DDT concentrations. Characteristics of this layer conform to deposition of relatively less contaminated material and physical reworking by waves, currents, and benthic invertebrates.
- Heavily contaminated sediment – Below the shallow sediment, a layer with low values of BD_d and high DDT concentrations is encountered. The thickness of this layer varies along PV Shelf, but appears to be greatest near the diffuser sections of the Sanitation Districts' outfalls.
- Native sediment – Beneath the heavily contaminated sediment lies the native sediment bed; the bed generally is sandy and is coarser and less cohesive than the layers above. It also is further characterized by higher values of BD_d and lower concentrations of COCs and OC.

Investigations have shown that DDT at PV Shelf has undergone significant degradation through reductive dechlorination to form several breakdown products, including p,p'-DDE and 1,1-bis(4-chlorophenyl)-2-chloroethene (p,p'-DDMU), while PCBs have not exhibited biodegradation at PV Shelf (Eganhouse et al., 2008). Figure 1-2 illustrates potential microbial degradation pathways for DDT at PV Shelf, and indicates that p,p'-DDMU and 1,1-bis(4-chlorophenyl)ethene (p,p'-DDNU) have been detected historically in samples of PV Shelf sediment (Eganhouse et al., 2007).

In 2002, the following characteristics of the EA deposit were reported (Lee et al., 2002):

- The maximum thickness of the EA deposit was about 70 cm.
- The approximate volume of the EA bed was 10 million cubic meters (m^3).
- About 70 percent (%) of the volume was present in water depths less than 100 m.
- The EA bed exhibited strong spatial continuity, notably in the alongshore direction.
- The dominant direction for transport of sediment was to the northwest.

Estimates of the mass of DDTs at PV Shelf by previous researchers have varied greatly, ranging from about 60 MT to 120 MT (Lee, H.J., 1994; Murray et al., 2002; see Section 4.1.2 of this report). The mean concentration of DDTs in surface sediment (non-OC normalized) at the shelf has been reported as 12 parts per million (ppm); the mean concentration of PCBs (non-OC normalized) has been reported as 0.69 ppm (EPA, 2009b).

More details on PV Shelf and the origin and fate and transport of COCs found at the site are available in several sources, including those listed below.

- *The Distribution and Character of Contaminated Effluent-Affected Sediment, Palos Verdes Margin, Southern California, Expert Report* (Lee, H.J., 1994)
- *Final Palos Verdes Shelf Superfund Site Remedial Investigation Report* (CH2M Hill, 2007) https://www3.epa.gov/region9/superfund/pvshelf/pdf/pvs-remediation-inv.pdf
- *Feasibility Study* (FS), *May 2009, Palos Verdes Shelf, Operable Unit 5 of the Montrose Chemical Corp. Superfund Site* (EPA, 2009a) https://www3.epa.gov/region9/superfund/pvshelf/pdf/final-feas-study-may09.pdf
- *Interim Record of Decision, Palos Verdes Shelf, Operable Unit 5 of the Montrose Chemical Corporation Superfund Site, Los Angeles County, California* (EPA, 2009b) https://www3.epa.gov/region9/superfund/pvshelf/pdf/PvsIrodFinal.pdf

1.3 DESCRIPTION OF INTERIM REMEDY

The interim remedy as described in the IROD has the following components (EPA, 2009b):

- Continue the existing Institutional Controls (ICs) program.
- Monitor natural recovery to achieve specific remedial action objectives (RAOs).
- Place an in-situ isolation cap (layer of clean sand) over the most contaminated and erosive area of sediment. Features of successful cap implementation are described below.
    - The cap would reduce immediately the mean DDTs concentration in shelf surface sediment to 78 milligrams per kilogram (mg/kg) OC.
    - Natural recovery would reduce the mean DDT concentration in surface sediment to an interim cleanup level of 46 mg/kg OC (double the cleanup level of 23 mg/kg OC) by the first post-cap 5-year review (FYR).
    - The cap would reduce immediately the mean PCB concentrations in surface sediment across the shelf to the interim cleanup level of 7 mg/kg OC.

Specific RAOs promulgated in the IROD include the following (EPA, 2009b):

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

  - Achieve the goal of 400 micrograms per kilogram (ug/kg) DDTs and 70 ug/kg PCBs in WC.
  - Maintain the ICs program that aims to prevent contaminated fish from reaching markets and educates anglers on safe fish consumption practices.
  - Achieve the interim goal of mean DDT concentrations in surface sediment of 46 mg/kg OC Total DDTs in surface sediment (double the cleanup level of 23 mg/kg OC) and PCBs of 7 mg/kg OC by the first FYR.

- Reduce to acceptable levels the risks from DDTs and PCBs to the ecological community (i.e., benthic invertebrates and fish) at PV Shelf.
  - Support the Trustees' strategies to sustain wildlife recovery.
- Reduce DDTs and PCBs in water to meet EPA's Ambient Water Quality Criteria (AWQC) as cited in the IROD:
  - Achieve the human health AWQC for DDT (p,p'-DDE = 0.22 nanograms per liter [ng/L]) within 30 years of remedial action (RA).[1]
  - Collect and assess PCB data to determine the schedule to meet human health AWQC for PCBs (i.e., 0.064 ng/L) by the first FYR.
- Minimize impacts to sensitive habitats and biota during cap placement by the following:
  - Develop a monitoring program to protect kelp beds.
  - Use low-impact techniques, measure the speed of ocean currents and COCs in the water column, and monitor sediment resuspension. Stop work if site-specific standards are exceeded.

1.4 OBJECTIVES OF THE SEDIMENT SAMPLING PROGRAM

The area studied during the 2013 sediment sampling program focused on the portion of the PV Shelf Study Area from Palos Verdes Point on the northwest to Point Fermin on the southeast, i.e., the main part of the EA sediment unit. The *Final Sampling and Analysis Plan for Sediment Sampling, Part 1- Quality Assurance Project Plan* (QAPP; ITSI Gilbane, 2014) provides a detailed description of the project objectives. These are summarized below.

- Determine whether the values for the mass of COCs in the sediment bed are continuing to decrease; i.e., is the trend of recovery indicated by the 2009 sediment results evident?

[1] The AWQC (ecological) for "DDT and its metabolites" was published in 1980 using guidelines for establishing water quality criteria under Section 304 of the Clean Water Act of 1977. The AWQC (human health) for p,p'-DDE was published in 2002 using methodology for establishing AWQCs for protection of human health (referred to as the "2000 Methodology" [EPA, 2000a]), which incorporated scientific advances in cancer and non-cancer risk assessments, exposure assessments, and bioaccumulation factors in fish.

- Determine whether installation of the isolation cap will be necessary to attain the cap-related cleanup goals stipulated in the IROD.

The desired data include the following:

- Physical parameters pertinent to evaluating (modeling) sediment transport and possibly designing the interim isolation cap. Parameters include grain size (particle size); wet sediment bulk density (BD_w); specific gravity (SG); and MC. Values of BD_w and MC are also used in calculating concentrations of COCs and contaminant mass.
- Chemical parameters pertinent to evaluating the progress of MNR and selecting areas where an isolation cap will be placed. Parameters include concentrations of the prevalent DDT forms encountered at PV Shelf; individual PCB isomers; and total organic carbon (TOC).
- The list of DDTs and their breakdown products include the o,p'- and p,p'- isomers of DDT; dichlorodiphenyldichloroethene (DDE); and dichlorodiphenyldichloroethane (DDD)[2]. These chemicals have been recognized by toxicity databases, including EPA's Integrated Risk Information System (IRIS).
- Additional chemicals of interest for PV Shelf include p,p'-DDMU and p,p'-DDNU, as these have been recognized as DDT breakdown products in sediment at PV Shelf (Eganhouse et al., 2008).
- The PCB congeners of interest for PV Shelf include 46 individual congeners (see Section 2.1.6.2).

1.5 OBJECTIVES OF THE WATER SAMPLING PROGRAM

1.5.1 High Resolution Sampling Program

The *Final Quality Assurance Project Plan – Water Sampling Program* (QAPP; Gilbane Federal, 2014) presents details for the goals and objectives of the project. The objectives of the sampling program conducted in 2015 are summarized below.

- Assess water column concentrations of DDTs and PCBs at very low concentrations for the purpose of evaluating the extents of dissolved-phase contamination.
- Determine whether water column concentrations of DDTs and PCBs exceed the AWQC values presented in the IROD.

The desired data are described below.

- The IROD for PV Shelf states that AWQC for DDTs and PCBs are being considered in assessments of the progress of site cleanup (EPA, 2009). Because these criteria are less than 1 ng/L, EPA determined that high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS) methods would be used for testing water column

[2] The o,p'- and p,p'- isomers are also referred to as 2,4'- and 4,4'- isomers.

samples at PV Shelf. This sampling event would be the first time that high resolution analytical techniques were used to analyze samples of the PV Shelf water column.

- The analyte lists for DDT isomers and PCB congeners will be the same as for the current sediment program.
- The water sampling locations were to be established at sediment coring locations, and depth profiles would be based on recent deployment depths of passive sampling devices (PSDs).
- The high-resolution data would be compared to water column data acquired by previous PSD sampling programs and other programs that used filtered, high-volume pumped samples.

1.5.2 PSD Program

The *Final Quality Assurance Project Plan for Passive Sampling for Persistent Organochlorine Pollutants (POPs) in the Water Column of the Palos Verdes Shelf (2013)* (Fluen Point Environmental, 2013) presents details for the goals and objectives of the project. The objectives of the sampling program conducted in 2013 are to:

- Assess whether using performance reference compounds (PRCs) addresses the problem of offset in the 2010 results from polyethylene devices (PEDs) and devices with solid-phase microextraction fibers (SPMEs);
- Measure the dissolved concentrations of DDTs and PCBs in different horizons of the water column and along a spatial gradient away from the highly contaminated zone and at stations up-current of the most highly contaminated sediment; and
- Compare dissolved DDT and PCB concentrations to those measured using the same (i.e. PED), and similar (i.e. SPME) methods in 2010.

The desired data are described below.

- Analyte mass in the passive samplers, temperature, dissolved organic carbon (DOC) and salinity will enable the calculation of dissolved concentrations in the water column.
- Contaminants to be measured include congeners of DDT and their breakdown products (including p,p'-DDMU and p,p'-DDNU), and forty-four PCB congeners.

1.6 OBJECTIVES OF THE FISH SAMPLING PROGRAM

The *Final Quality Assurance Project Plan – Fish Sampling Program* (QAPP; Gilbane, 2016a) presents objectives and informational inputs for the project. The goals of the sampling program conducted from 2014 through 2016 are summarized below.

- Determine fish tissue concentrations of DDTs and PCBs at very low concentrations to assess contaminant trends over time.

- Determine whether installation of the isolation cap will be necessary to attain the cap-related fish cleanup goals recommended in the IROD.
- Determine whether concentrations of DDTs and PCBs in fish exceed IROD fish cleanup goals.

The proposed data inputs would include the following:

- The IROD for PV Shelf presents cleanup goals to reduce the risk to human health from the consumption of WC caught in the vicinity of PV Shelf; the values are 400 ug/kg for DDTs and 70 ug/kg for PCBs (EPA, 2009). Based on previous fish testing for the EPA ICs program at PV Shelf, the desired reporting limits (RLs) for fish testing were established at less than 1 ug/kg; this would require HRGC/HRMS methods.
- The IROD identifies monitoring for DDTs and PCBs in WC as a key element of MNR at PV Shelf. The QAPP developed for fish (Gilbane, 2016a) describes how the seven EPA fish collection areas and numbers of samples were derived by consensus during the Palos Verdes Shelf Technical Information Exchange Group (PVSTIEG) scoping meeting held in January 2014. Barred sand bass (BSB) was also added as an indicator species for this study because high concentrations of DDTs and PCBs had been found in this species during previous studies (National Oceanic and Atmospheric Administration [NOAA]/EPA, 2007). Historically there has been a high catch frequency for BSB reported by boat-based anglers near PV Shelf, and, during EPA's fish tracking study previously conducted at PV Shelf, BSB demonstrated site fidelity to PV Shelf (Lowe, 2013).
- The fish tissue data set will be compared to the IROD cleanup goals and used to calculate parameters for each fish collection area. These parameters include minimum and maximum concentrations, average concentrations, and exposure point concentrations (EPCs) of DDTs and PCBs.