Final

Source Identification Study Report United Heckathorn Superfund Site

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CH2MHILL®

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Acronyms and Abbreviations

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
ATSDR	Agency for Toxic Substances and Disease Registry
CSM	conceptual site model
CWM	Chemical Waste Management Inc.
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DTSC	Department of Toxic Substances Control
ERA	ecological risk assessment
ETS	Environmental Technical Services
ft^2/day	square feet per day
FFS	focused feasibility study
g	gram
GIS	global information system
HLA	Harding Lawson Associates
K	hydraulic conductivity
KLI	Kinnetic Laboratories, Inc.
K_{oc}	sediment-water partition coefficient
K_{ow}	octanol-water partition coefficients
LRTC	Levin Richmond Terminal Corporation
mg/kg	milligrams per kilogram
MLLW	mean lower low water
MSL	mean sea level
NAVD88	North American Vertical Datum of 1988
OBM	Older Bay Mud
PVC	polyvinyl chloride
RMP	Regional Monitoring Program
RI	remedial investigation
ROD	Record of Decision
SAP	sampling and analysis plan
SFEI	San Francisco Estuary Institute
SF USACE	United States Army Corps of Engineers San Francisco District
SVOC	semivolatile organic compound
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
YBM	Younger Bay Mud

SECTION 1

Introduction

This report presents the results of the source identification study that was performed for the United Heckathorn Superfund Site in Richmond, California, to identify and quantify if possible any ongoing source(s) of contamination to the Lauritzen Channel as part of a Focused Feasibility Study (FFS). The study focused on identifying the source(s) of the DDT[1] and Dieldrin that have been consistently measured in sediment, surface water, and biota in the Lauritzen Channel since the remedy was completed in 1997. The potential ongoing sources of contamination that were evaluated include the following:

1. Embankments (e.g., point source discharges from pipes, outfalls, and seeps and/or erosion of DDT-contaminated embankment soils)
2. Groundwater discharge from the upland portion of the site into the Lauritzen Channel
3. DDT-contaminated wood pilings
4. Stormwater outfalls
5. Sources outside of the Lauritzen Channel
6. Dredging residuals

Each potential source was evaluated using historical information, data from previous source investigations and other post-remediation studies, and new data that were collected in 2012 and 2013. The previous investigations will be summarized in more detail in the forthcoming FFS. The 2012-2013 data were collected as outlined the *Focused Feasibility Study Data Gaps Sampling and Analysis Plan Addendum #2 – Source Identification Study, United Heckathorn Superfund Site* (SAP Addendum) (CH2M HILL, 2013a). The results of the source identification study will be evaluated in conjunction with the results of the Tier 1 and Tier 2 sediment transport studies, the DDT fate and transport study, long-term monitoring data, and data from previous investigations to refine the conceptual site model (CSM) for the United Heckathorn site and identify any necessary source control measures for consideration in the FFS.

1.1 Site History

The United Heckathorn Superfund Site is located in Richmond Harbor on the east side of San Francisco Bay in Richmond, California (Figure 1-1). The site includes the former United Heckathorn facility where organochlorine pesticides were processed, packaged, and shipped and the adjacent waterways affected by releases from the former facility. A Record of Decision (ROD) that presented the selected remedial action for the site was issued in 1994 (United States Environmental Protection Agency [USEPA], 1994). Remediation activities for the upland portion of the site consisted of excavation and offsite disposal of contaminated soil (from 1982 to 1993), and placement of concrete and geotextile/gravel caps (from 1998 to 1999) over approximately 4.5 acres of Levin Richmond Terminal Corporation's (LRTC) upland soils to prevent erosion and collect surface runoff (USEPA, 2001). Remediation activities for the waterways were performed in 1996 and 1997 and consisted of (1) dredging and offsite disposal of sediment from the Lauritzen Channel and Parr Canal and (2) placement of clean sand in the channels to promote the recovery of the benthic community. However, post-dredging monitoring of surface water and sediment has indicated that the remediation levels specified in the ROD have not been maintained (USEPA, 2011).

[1] DDT is defined as the sum of 2,4'- and 4,4'-dichlorodiphenyltrichloroethane (DDT); 2,4'- and 4,4'-dichlorodiphenyldichloroethane (DDD); and 2,4'- and 4,4'-dichlorodiphenyldichloroethene (DDE)

1.2 Report Organization

This report is organized into the following sections:

Section 1, Introduction. Provides background information and an overview of the study objectives.

Section 2, Field Investigations. Summarizes the scope of the field activities performed for the source identification study, including descriptions of the sample collection and analytical methods.

Sections 3 through 8 present an evaluation of each potential source, including the objectives and approach, background, and lines of evidence and findings, as follows:

3. **Embankments**
4. **Groundwater Discharge**
5. **Wood Pilings**
6. **Stormwater Outfalls**
7. **Source Material Outside of the Lauritzen Channel**
8. **Dredging Residuals**

Section 9, Conclusions. Identifies the sources that were determined most likely to be responsible for the majority of the DDT mass currently found in Lauritzen Channel sediments, and the ongoing sources that could potentially recontaminate the channel in the future if not controlled.

Section 10, References. Provides references cited in this report.

Appendix A provides supporting detail for the groundwater discharge evaluation.

SECTION 2

Field Investigations

This section provides an overview of the field work performed for the source identification study in accordance with the SAP Addendum (CH2M HILL, 2013a). Additional details related to the field investigations are provided in the field summary reports (CH2M HILL, 2013b; 2013c; 2013d; and 2013e). The results of these field investigations are incorporated into the evaluation of each potential source in Sections 3 through 8.

2.1 Site Survey

A site survey was performed on November 29 and December 10, 2012, to document present-day site conditions on a comprehensive map of shoreline and embankment features. This survey was also used to verify the locations of selected major features to assure accuracy within the global information system (GIS) database. The eastern side of the Lauritzen Channel was inspected by boat and on foot to locate potential point sources of contamination, including outfall pipes, breaks in the sheet pile walls, and other features that potentially could act as preferential pathways for contaminant transport into the channel.

2.2 Sediment Sampling

Surface sediment grab and sediment core samples were collected in March and April 2013 to assess the present-day nature and extent of contamination and determine the thickness of the DDT-contaminated sediment layer in the Lauritzen Channel. Sediment sample locations are shown in Figure 2-1.[2]

Grab samples were collected near the head of the channel and along the eastern embankment to evaluate potential ongoing sources from the embankment (i.e., embankment soil erosion and/or discharges from pipes or seeps). Eleven of the fourteen grab samples were unbiased and were collected near the head of the channel and along the eastern embankment (between pilings and under the Levin pier). The other three grab samples were biased and were collected at locations previously identified as potential ongoing sources: one outfall (SD13-12 at T -27.5, one former seep (SD13-17 at T -8.5), and a hot spot under the Levin pier identified in the Phase I source investigation (SD13-22 at T+2.5) (Kohn and Evans, 2002).

Five grab samples also were collected along the northwest shoreline of the Lauritzen Channel in September 2013 to investigate potential shoreline sources to channel sediments in this area. Samples from locations EMB13-01 through EMB13-04 were collected near the tide line, and the sample from EMB13-05 was an upland embankment soil sample.

Vibracore samples were collected from the Lauritzen Channel and Santa Fe Channel to delineate the extent and volume of the contaminated Younger Bay Mud (YBM). A total of 24 sediment cores were collected from a sampling grid in the Lauritzen Channel and 3 cores were collected in the Santa Fe Channel. The target coring depth was 8 feet below the sediment surface, which was estimated to be sufficient to reach the contact between the YBM and the underlying Older Bay Mud (OBM). Field measurements associated with the sediment core collection, including water depth, sediment surface elevation, and thickness of the YBM layer, are provided in Table 2-1. The nature and extent of contamination based on the 2013 sample results will be discussed in the forthcoming FFS.

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2 A transect numbering system was established along the eastern shoreline by LRTC based on “bent” numbers assigned to the rows of pilings supporting the Levin pier. Each row of pilings is assigned a whole number, starting with +1 at the north end of the pier. The bent numbers range from +1 to +73 from north to south along the Levin pier, and from +1 to -45 from south to north, north of the Levin pier. Abandoned rows of pilings abut the shoreline north of the Levin pier, where the pier deck has been removed. Locations between pilings are preceded by the letter “T” for transect.

2.3 Groundwater Sampling and Hydraulic Characterization

Groundwater sampling and hydraulic testing were conducted in March 2013 to evaluate the potential for DDT transport into the Lauritzen Channel by groundwater discharge from the upland part of the site. Groundwater samples were collected from ten temporary soil borings and two monitoring well locations as shown in Figure 2-2. The borings and monitoring wells were located to provide systematic spatial coverage along the shoreline adjacent to the former plant site and to target areas where the highest DDT and Dieldrin concentrations had been measured historically in embankment soils. The borings were drilled to a depth of at least 10 feet below the water table and 10-foot screens were installed to allow sufficient borehole length to obtain the required volume of water for sampling.

Two sets of paired, flush-mounted monitoring wells were installed for hydraulic testing, as shown in Figure 2-2. The wells were constructed using 2-inch-diameter, Schedule 40 polyvinyl chloride (PVC) casing and screen. All wells had a 10-foot screen interval. Groundwater samples were collected from two of the wells (MW13-01 and MW13-03).

All groundwater samples were analyzed for total and dissolved DDT and Dieldrin, total and dissolved semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs). Field parameters are provided in Table 2-2.

Slug tests were performed on each of the four monitoring wells on March 26, 2013, to estimate hydraulic conductivity of subsurface soils and groundwater flow velocities. Two “slug in” and two “slug out” tests were performed on each well. The replicate tests from each well provided substantially similar results; therefore, only one slug in and one slug out test was evaluated for each well. In addition, a tidal fluctuation study was performed to estimate mean water levels and propagation of tidal influence through the aquifer. This study was conducted using the two sets of monitoring wells from 4:00 PM on March 26 to 4:00 PM on March 29, 2013. A stilling well was installed in the Lauritzen Channel to minimize the effect of wave action on the data logging transducer placed in the channel. Data logging pressure transducers with vented cables were placed in each monitoring well and the stilling well. The pressure transducers were synchronized and the tidal study was run for 72 hours.

2.4 Stormwater Sampling from Municipal Outfalls

Two storm drain systems discharge to the Lauritzen Channel. The City of Richmond municipal stormwater system provides drainage for the area surrounding the site and discharges to a 48-inch-diameter outfall at the head of the Lauritzen Channel. A separate stormwater management system was constructed on the LRTC property in conjunction with the construction of the upland cap. Municipal and LRTC stormwater outfall locations are shown in Figure 2-1. These systems are described further in Section 6.

The SAP Addendum includes the collection and analysis of stormwater samples from the City of Richmond municipal outfalls that discharge to the heads of the Lauritzen Channel and Parr Canal. These stormwater samples were proposed to be collected after the removal of residual sediment from the municipal storm drain system, because these sediments are known to be contaminated with DDT. To date, the municipal storm drains have not been cleaned out; therefore, the stormwater sampling will not be conducted and the cleaning of the storm drain system will be included in the evaluation of remedial alternatives in the FFS. Stormwater samples were not collected from the LRTC storm drain system because it is routinely monitored as part of a Stormwater Pollution Prevention Plan and Stormwater Monitoring Plan (Environmental Technical Services [ETS], 2013a).

2.5 Sampling from Other Pipes and Seeps

As shown in Figure 2-1, a number of other pipes and seeps are present along the shoreline of the Lauritzen Channel. The SAP Addendum included the collection of water samples from any pipe or seep that was found to be discharging to the Lauritzen Channel and was determined to not be tidal drainage based on salinity or conductivity measurements. None of the other pipes or seeps were found to be discharging during the site survey in November–December 2012, or during the subsequent site visits at low tide during the winter months in early 2013 (except one location where the water from a dripping pipe was assumed to be tidal drainage because of its intertidal location). None of the site visits coincided with wet weather conditions. If possible, the other pipes and seeps will be revisited under future wet weather conditions, such as when the municipal storm drains are sampled, and a sample will be collected from any feature that is found to be flowing continuously.[3]

An active seep was identified under the Levin pier at bent +37 in April 2013. A sample was collected from this seep during low tide on July 24, 2013. The sample was analyzed for total and dissolved DDT and Dieldrin and total suspended solids; results are provided in Section 3.

[3] The “continuous flow” criterion was incorporated into the SAP to exclude sampling features that were dripping. Sampling discontinuous low-rate flows was determined to be impractical because of the large sample volume required for analysis. In many cases, pipes that are submerged at high tide drip at low tide as seawater drains from the pipe.

SECTION 3

Embankments

The embankments along the shoreline of the Lauritzen Channel have been identified as a potential ongoing source of DDT contamination to channel sediments. The following contaminant transport pathways were evaluated:

- Discharges from features along the embankment that could act as preferential pathways for the transport of DDT from the former plant site to the Lauritzen Channel, including seeps and outfalls that are not related to the municipal or LRTC stormwater systems
- Erosion of contaminated embankment soils above the tide line into the Lauritzen Channel (erosion and transport of undredged sediments below the tide line are addressed in Section 8)

3.1 Objectives and Approach

The objectives of the source identification study relative to the embankments were as follows:

- Identify and document pipes, outfalls, or point sources along the embankment that may act as conduits or preferential pathways for the transport of DDT from the former plant site to the Lauritzen Channel.
- Estimate the magnitude of ongoing contributions from other pipe outfalls or features acting as preferential pathways if possible.
- Determine whether contaminated soils in the embankment above the tide line are eroding into the Lauritzen Channel.
- Estimate the magnitude of ongoing contributions from embankment soil erosion if possible.

The first two objectives were investigated by documenting shoreline features (including pipes, outfalls, and seeps) and collecting water and sediment grab samples from or near features that were identified as potential ongoing sources of contamination. The sampling results were evaluated in conjunction with previous data collected in the Phase I source investigation (Kohn and Evans, 2002). The observed pipes, outfalls, and seeps are illustrated in Figure 3-1. This figure also illustrates what types of materials comprise the shoreline along the embankment, including the shotcrete that was applied between bent -4 and bent +9 during July 2013.

Embankment soil erosion was evaluated by reviewing historical data and information related to embankment soils, visually inspecting the embankments for signs of soil erosion, and reviewing sediment grab sample data collected along the base of the embankment.

3.2 Background

The Phase 1 and Phase 2 source investigations (Kohn and Evans, 2002 and 2004) evaluated pipes, outfalls, and embankment soils and sediments along the eastern bank of the Lauritzen Channel.

3.2.1 Pipes, Outfalls and Seeps

During the Phase 1 source investigation (Kohn and Evans, 2002), sediment and water samples were collected from selected outfalls and passive samplers were deployed to determine whether water flowing from pipe outfalls carried significant quantities of pesticides. The Phase 1 investigation concluded that most of the identified outfalls were not likely to be significant sources of the DDT to the Lauritzen Channel. Two outfalls were identified for further investigation:

- Concrete outfall at T-8.5 – a concrete outfall on the eastern bank of the channel was found to be discharging a small volume of water during the Phase 1 sampling event. The water contained part-per-million levels of total DDT and Dieldrin. This feature is referred to as P1-4 on Figure 3-1.

- 8-inch outfall at T-27.5 – this outfall was recommended for further investigation because the data collected during the Phase 1 investigation were inconclusive and the outfall could not be ruled out as a potential source. No further investigation of this feature was performed in the Phase 2 source investigation. This feature is referred to as P1-1 on Figure 3-1.

During the Phase 2 source investigation field sampling, water was observed discharging from the broken concrete outfall on the embankment below the high tide line at T-8.5. This feature was referred to as the "seep."[4] The highest concentrations of total DDT were measured in water, sediment, and mussels sampled from the seep pipe. High total DDT in water samples collected approximately 1 year apart suggested that the seep was an ongoing source of DDT contamination to the channel. The seep was sealed with grout by USEPA on July 18, 2003.

3.2.2 Embankment Soil Erosion

The remedial investigation (RI) for the upland portion of the United Heckathorn site (Levine-Fricke, 1990) delineated the length of embankment along the eastern side of the Lauritzen Channel that was contaminated by chlorinated pesticides. Embankment soils with DDT concentrations greater than 1 milligram per kilogram (mg/kg) were determined to extend from the northern end of the channel southward for a distance of approximately 1,200 feet. The highest concentrations (up to 27 percent DDT) were detected over a localized area of the embankment adjacent to the former facility. DDT concentrations in embankment soils tended to decrease with depth and distance away from the former facility.

Between 1990 and 1993, contaminated soil and visible pesticide residue were removed from the upland part of the site and embankment in a series of interim removal actions (Levine Fricke, 1991a; 1991b; and 1993; Weston, 1993). The embankment excavation areas were located adjacent to the former plant site and former train scale area, as shown in Figure 3-1. The visible pesticide residue extended from approximately bent +3 to bent -3, at the north end of the Levin pier. The cleanup goal for the interim removal actions was 100 mg/kg total DDT. The removal actions did not include the removal of sediments below about 0 feet mean lower low water (MLLW); pre-construction sampling results indicated that the subtidal sediments adjacent to the visible pesticide residue had total DDT concentrations exceeding 100 mg/kg in a relatively localized area (i.e., a hot spot). The western extent of this hot spot was not delineated because of the presence of a ferry at the Levin pier.

Most of the soil excavated under the removal actions was transported to an offsite landfill for disposal; however, some of the soil was temporarily stored in stockpiles at the north end of the Lauritzen Channel and in the former train scale area (Figure 3-1). A portion of these soils were removed and disposed in a hazardous waste landfill in 1992 and the remaining soils were disposed in a hazardous waste landfill in April 1993 (Levine Fricke, 1993).

The Phase 1 and Phase 2 source investigations included collection and analysis of embankment soil and sediment samples (Kohn and Evans, 2002 and 2004). The sediment sampling results are shown in Figures 3-2a and 3-2b. The embankment sediment samples collected near the north end of the Levin pier indicated the presence of a DDT hot spot. The location of this hot spot corresponds to the hot spot that was identified in preconstruction sampling performed for the interim removal actions and appears to be embankment sediment below 0 feet MLLW that was not removed in either the upland or marine remedies.

Additional embankment soil samples were collected in the Phase 2 source investigation to characterize the depth of contamination in the embankment. The results varied by sampling location, with the highest concentrations at the surface at some locations and in the subsurface at others. Under the north end of Levin pier, embankment soils were substantially more contaminated at depth than at the surface. The Phase 2 investigation concluded that the hot spot under the north end of the Levin pier and the seep at T-8.5 were the sources that were most likely contributing to high DDT concentrations detected in mussels collected from nearby pilings.

[4] The Phase 2 source investigation report mistakenly refers to this feature as being located at T(-12.5).

3.3 Lines of Evidence and Findings

A comprehensive site features map was compiled based on previous reports and field observations documented during the 2012 site survey. This map is provided in Figure 3-1. The eastern shoreline of the Lauritzen Channel is constructed of sheet pile (steel plates supported by railroad ties), concrete, rip rap, and/or shotcrete. Evidence of soil erosion was observed during the site surveys performed in 2012. Erosion under the sheet pile wall, observed as approximately 1- to 2-foot voids, was noted at the north end of the eastern bank of the channel. These features were noted between bent -37 and the head of the channel. Sink holes and exposed cap material were also observed on the Levin property in the vicinity of bent -24 and T-8.5 (embankment soils were not exposed in these locations). Additional information including photo documentation of the features described above is provided in the site survey field summary report (CH2M HILL, 2013b).

3.3.1 Pipes, Outfalls, and Seeps

Table 3-1 summarizes the embankment features identified during all phases of the investigation, including associated analytical data. The table includes the City of Richmond municipal outfalls at the heads of the Lauritzen Channel and Parr Canal, the five stormwater outfalls associated with LRTC's upland cap stormwater management system, and other pipes and outfalls on the west, north, and eastern shores of the Lauritzen Channel. All pipe and outfall locations are shown on Figure 3-1. New features that were identified in 2012 include four pipes along the western side of the channel (P4-4 through P4-7) and eight new pipes (P4-8 through P4-15) along the eastern side of the channel underneath the Levin pier. In addition, two electrical conduits were observed on the eastern side of the channel beneath the Levin pier. As noted in Section 2.5, none of the features were observed to be flowing continuously during the site surveys or any of the subsequent site visits in early 2013.

The SAP Addendum (CH2M HILL, 2013a) specified the collection of water samples from any feature found to be flowing continuously, particularly the following two locations:

- P1-1, the 8-inch pipe at T-27.5 that was previously sampled
- P1-4, the area around the former seep pipe at T-8.5 that was sealed by USEPA in 2003

The former seep at P1-4 was not observed during the field surveys and therefore was not sampled. The 8-inch pipe at P1-1 was located and observed to be dripping.[5] This pipe was not sampled because it was not flowing continuously. However, two sediment grab samples were collected adjacent to these features. The sediment sample locations are shown in Figure 2-1 and grab sample results are provided in Table 3-2. The grab sample collected near P1-1 (SD13-12) had a total DDT concentration of 75 mg/kg, which is substantially higher than the concentrations measured at the adjacent grab samples collected along the shoreline. The high concentration at SD13-12 could be attributable to discharges from outfall P1-1, and/or to historical soil contamination in the vicinity of the former train scale area that was not removed in the interim removal actions. The total DDT concentration measured in the grab sample collected near the former seep pipe (SD13-17) was 92 mg/kg, indicating that high DDT concentrations persist in this area even though the seep has been sealed. The high DDT concentrations could also be attributed to historical soil contamination that was not removed in the interim removal actions.

The seep that was observed at bent +37 under the Levin pier in April 2013 was sampled in July 2013. The analytical results are provided in Table 3-3. The total DDT concentrations in filtered and whole water samples were 0.024 and 0.034 micrograms per liter (µg/L), respectively, indicating that the majority of the total DDT contamination is in the dissolved phase. The dissolved and whole water Dieldrin concentrations were nearly the same (0.071 and 0.068 µg/L, respectively). The flow from the seep was estimated to be about 10 to 15 liters per minute at the time of sample collection. If the flow rate from this seep is constant, then the annual load of total DDT and Dieldrin to the Lauritzen Channel from this seep would be less than 1 gram (g).

Based on the 2012 site survey and the 2013 sampling results, the pipes, outfalls, and seeps do not appear to be ongoing sources of DDT contamination to the Lauritzen Channel under dry weather conditions. The pipes and

[5] The 8-inch pipe at P1-1 is located in the intertidal zone, so the dripping observed at low tide was assumed to be tidal drainage.

outfalls that were identified do not convey dry weather flow, and the one continuously-flowing seep contained only low levels of pesticides. The pipes and outfalls have not been inspected or sampled during wet weather conditions. If possible, the outfalls will be inspected again during wet weather conditions and any features that are found to be flowing continuously under wet weather conditions will be sampled.

3.3.2 Embankment Soil

No soil samples were collected from the embankment along the eastern side of the Lauritzen Channel in 2013. However, sediment grab samples below the tide line were collected adjacent to the embankment. Twelve of these samples were collected from unbiased locations on a systematic grid, and three were collected from biased locations as shown in Figure 2-1. Sample results are provided in Table 3-2.

The 2013 sediment grab sample results are consistent with the historical data for embankment soils. Total DDT concentrations between 15 and 92 mg/kg were found in samples adjacent to the former train scale area and the former plant site (including the hot spot under the north end of the Levin pier), where the interim soil removal actions were performed. As noted in Section 3.2.2, the cleanup level for the interim removal actions was 100 mg/kg, and sediments below about 0 feet MLLW were not included. Therefore, these shoreline sediments were not removed as part of the upland removal actions. They were also apparently not dredged during the Lauritzen Channel remedy in 1996-1997. The completion report indicates that dredging was to be completed to within 10 feet of the shoreline, plus or minus 2 feet of the toe of the slope (Chemical Waste Management Inc. [CWM], 1997). The 2013 shoreline grab samples were collected at the top of the slope. Therefore, these highly contaminated shoreline sediments adjacent to the former plant site and former train scale area most likely represent historical contamination that was never removed.

The 2012 site survey identified evidence of embankment soil erosion at the base of the sheetpile wall from bent 37 to the head of the channel. The total DDT concentrations in the sediment grab sample from this area (SD13-07) was 2.9 mg/kg, which is lower than the concentrations near the former plant site and former train scale area, but well above the sediment remediation goal of 590 µg/kg.

The highest total DDT concentration in a sediment grab sample was found at SD13-01 in the northwest corner of the Lauritzen Channel. The total DDT concentration was 299 mg/kg, and contained over 90 percent 4,4’-DDT, indicating that the DDT mixture is less degraded compared to samples from adjacent locations. Total DDT concentrations in adjacent surface sediment samples were an order of magnitude lower and contained a larger proportion of 4,4’-DDD (i.e., were more degraded).

Five additional embankment soil and sediment samples were collected along the northwestern edge of the channel to investigate the potential source of contamination to SD13-01. The sample locations are shown in Figure 2-1 and the results are reported in Table 3-2. The highest total DDT concentration (14 mg/kg; 78 percent 4,4’-DDT) was found at EMB13-01, which is located between the former soil stockpile location (Figure 3-1) and SD13-01. The other embankment soil and sediment samples contained between 0.5 and 11 mg/kg total DDT (with 18 to 49 percent 4,4’-DDT), indicating widespread contamination along the shoreline.

The former soil stockpile at the northwest corner of the site was placed partially on an asphalt concrete pad, on top of a visquine liner (Levine Fricke, 1993). The stockpile was removed in April 1993. A composite confirmation soil sample collected from the area beneath the liner contained 23,480 mg/kg total DDT (72 percent 4,4’-DDT). Additional cleanup was performed in the area beneath the former stockpile, including pressure washing (the wash water was contained by a sorbent dike around the perimeter). A second confirmation sample collected after the additional cleanup was completed contained 226 mg/kg total DDT (71 percent 4,4’-DDT). These results indicate that the soil in the stockpile was not effectively contained, and runoff from the stockpile to the northwest corner of the channel may have occurred. The sediments along the northern edge of the Lauritzen Channel were not completely dredged in 1997, and the localized hot spot at SD13-01 is most likely undredged residual contamination.

The 2013 sediment grab sample data in conjunction with historical embankment soil and sediment data indicate that erosion of contaminated embankment soils on the northern and eastern sides of the channel is an ongoing source of contamination to the Lauritzen Channel. However, the magnitude of the source is difficult to quantify because most of the embankment is lined with sheetpile, rip rap, and/or concrete, with only localized areas of exposed soil subject to erosion.

SECTION 4
Groundwater Discharge

4.1 Objectives and Approach

Groundwater data were collected at the United Heckathorn Site in the mid-1980s as part of the upland investigation (Harding Lawson Associates [HLA], 1986). However, because site conditions have changed since that time, total DDT mass flux into the Lauritzen Channel from the eastern shoreline was evaluated as part of the source identification study.

The approach used for the 2013 groundwater characterization was as follows:

- Characterize contaminant concentrations in groundwater along the eastern shoreline of the Lauritzen Channel.
- Estimate the hydraulic conductivity of shallow water-bearing soils.
- Characterize hydraulic gradients and tidal influence in the shallow water-bearing soils.
- Calculate the volumetric discharge rate from the eastern shoreline into the Lauritzen Channel.
- Calculate the flux of dissolved DDT into the Lauritzen Channel from the eastern shoreline.

The results of this evaluation are presented in Section 4.3.

4.2 Background

During the upland investigation in the mid-1980s, groundwater elevations varied from 0 to 4.7 feet mean sea level (MSL) across the site and the groundwater flow was reported to be very complex, with an overall westward flow direction toward the Lauritzen Channel. The saturated thickness of the artificial fill unit was less than 18 inches and in some cases no groundwater was found in the fill. Table 4-1 lists the estimated groundwater discharge rates into Lauritzen Canal from the historical investigation (HLA, 1986; Levine Fricke, 1990) and Figure 2-2 depicts the locations of the monitoring wells listed in Table 4-1.

Groundwater samples collected from the upland part of the site between 1983 and 1986 had total DDT concentrations ranging from below the detection limit to 178 µg/L (HLA, 1986). The solvents chlorobenzene and trans-1,2-dichloroethene were sporadically detected at low part per billion levels. The 1990 RI Report for the upland area concluded that chemicals in groundwater were not a significant concern compared to the contamination documented in upland soils and the embankment sediments (Levine Fricke, 1990).

4.3 Lines of Evidence and Findings

The following sections summarize the groundwater chemistry data, slug testing findings, and tidal evaluation study results and evaluate potential groundwater discharge and associated total DDT transport into the Lauritzen Channel from the eastern upland area.

4.3.1 Groundwater Analytical Results

Filtered and unfiltered groundwater samples were analyzed for total and dissolved organochlorine pesticides and SVOCs, as well as total VOCs. The analytical data are provided in Table 4-2 and a statistical summary of the results is presented in Table 4-3. DDT was detected in the filtered and unfiltered samples from all 12 sampling locations. The total DDT in the filtered samples ranged from 0.03 to 14.6 µg/L, with an average concentration of 1.62 µg/L. Total DDT in the unfiltered samples ranged from 0.27 to 69.6 µg/L, with an average concentration of 12.8 µg/L. The maximum total DDT concentrations in the filtered and unfiltered samples were detected at location GW13-11, which is within the footprint of the former main building (Figure 2-2). The highest total DDT concentrations are on the same order of magnitude as the solubility limits for the DDT and DDD isomers, which range from 25 to 100 µg/L (Agency for Toxic Substances and Disease Registry [ATSDR], 2002).

Three SVOC compounds were detected in groundwater: bis(2-ethylhexyl-phthalate), Caprolactam, and diethyl phthalate. The two phthalate compounds were detected in two filtered and in two unfiltered samples. Caprolactam was detected in nine of the twelve filtered samples and was not detected in the unfiltered samples. Caprolactam concentrations ranged from 6.7 to 83 µg/L.

VOCs were sporadically detected and the compounds with the highest observed concentrations included 1,3-dichlorobenzene (41 µg/L), cis-1,2,-dichloroethene (7,500 µg/L), trans-1,2-dichloroethene (29 µg/L), tetrachloroethene (84 µg/L), trichloroethene (1,300 µg/L), and vinyl chloride (370 µg/L). These compounds were detected in as many as four wells and the maximum concentrations were observed at GW13-08, which is located in the northern portion of the site, near the former train scale area (Figure 2-2).

4.3.2 Slug Testing Results

Slug testing was conducted at each of the four newly-constructed monitoring wells to estimate the hydraulic conductivity (K) of the water-bearing shallow soils. The groundwater sampling field summary report (CH2M HILL, 2013e) contains the soil boring logs and well completion diagrams for these four new monitoring wells. The new monitoring wells include MW13-01 and MW13-02 near the north end of the Former Main Building and MW13-03 and MW13-04 near the south end of Former Building #3 (Figure 2-2). Two slug-in and two slug-out tests were conducted at each monitoring well.

The slug-in test was accomplished by rapidly lowering a 1.5-inch-diameter, 5-foot-long displacement device into each well until the top of the device was below the static water level and recording the response of groundwater levels in the well. The test was allowed to run until the water level reached static (pre-test) levels. After completing the slug-in test, a slug-out test was conducted by rapidly removing the slug device and recording water levels until the water levels again returned to static levels. Although water level changes due to tidal influence occurred in all wells, the water level fluctuations during the test (typically several minutes) were not significant enough to impact the slug test analysis.

The time-series water-level data that resulted from slug testing were input to AQTESOLV for Windows[6] Version 4.x to estimate the K needed to fit these time-series water levels. The Bouwer and Rice (1976) method was used in AQTESOLV to estimate the K values. Table 4-4 presents the estimated K values for the four wells tested in 2013, as well as those published in HLA (1986). The geometric mean of the K values listed in Table 4-4 is 2.96×10^{-4} centimeters per second (0.84 feet per day).

The K values estimated for the new monitoring wells are associated with an upper portion of the Bay Mud that underlies the fill because little to no water was encountered in the fill material during the drilling of the four new monitoring wells. The K values estimated by HLA (1986) are representative of an upper portion of the Bay Mud and overlying saturated fill and this is likely why the HLA (1986) K values are higher than those estimated using the 2013 slug testing data.

4.3.3 Tidal Study Results

A study of tidal fluctuation in the Lauritzen Channel and four new monitoring wells was conducted in March 2013 to estimate mean water levels and propagation of tidal influence through the shallow water-bearing soils. A data logging pressure transducer with vented cables was instrumented within each of the four available monitoring wells and within a stilling well. The stilling well was temporarily secured to a piling in the Lauritzen Channel to minimize the influence of wave actions on the water level inside the stilling well. Data logging pressure transducers were vented to compensate for barometric pressure changes during the tidal study.

The tidal study was conducted over a 72-hour period. Data were downloaded from the transducers and processed to remove anomalous readings associated with placement and removal of the transducers and to reference the

[6] http://www.aqtesolv.com/ (Accessed August 5, 2013)

water levels to a common vertical datum (i.e., North American Vertical Datum of 1988 [NAVD88]). Appendix A lists the processed water levels for the first 71 hours of the test; these water levels were further processed using the filtering method described by Serfes (1991) to compute mean groundwater levels. Table 4-5 lists summary statistics associated with the 2013 tidal study data.

4.3.4 Groundwater Discharge Evaluation

The objective of the groundwater discharge evaluation was to estimate the total DDT mass flux from the shallow water-bearing soils of the upland area immediately east of the Lauritzen Channel to assess whether groundwater discharge may be contributing to the high concentrations of DDT detected in the Lauritzen Channel sediments. Data and information sources that were used to achieve the evaluation objective are as follows:

- Estimates of the K values resulting from slug testing conducted by CH2M HILL in March 2013 and those resulting from prior aquifer tests conducted by HLA (Table 4-4) – the geometric mean of these K estimates was used in conjunction with the hydraulic gradients estimated using the 2013 tidal study data and an assumed saturated thickness of shallow water bearing soils to compute volumetric groundwater discharge rates into Lauritzen Channel from the upland area east of the channel.
- Soil boring logs associated with MW13-01, MW13-02, MW13-03, and MW13-04 (Appendix A) – these logs were reviewed and used in conjunction with the K estimates and assumed saturated thickness of shallow water bearing sediments to inform the groundwater discharge estimates.
- Tidal study data (Table 4-5) – groundwater level data from the tidal study monitoring wells provided the basis for estimating ranges of horizontal hydraulic gradients in the upland area immediately east of the Lauritzen Channel. The horizontal hydraulic gradients were used in conjunction with the geometric mean of the K estimates and assumed saturated thickness to compute groundwater discharge rates via Darcy's Law over an assumed width of the groundwater flow field.
- March 2013 unfiltered total DDT concentration data (Table 4-2) – these data were used in conjunction with the volumetric groundwater discharge rates to compute the potential annual mass flux of total DDT into Lauritzen Channel from the upland area east of the channel. Annual mass flux estimates were computed using unfiltered total DDT concentrations to account for the potential presence of contaminated colloids in the groundwater.

The annual mass flux of total DDT to Lauritzen Channel from the eastern upland area was computed using two methods, as follows:

- Method 1. This method uses a single hydraulic gradient value (i.e., 4.80×10^{-3} foot per foot) computed with the mean groundwater levels at MW13-03 and MW13-04 (see Table 4-5 for mean water levels) from the 2013 tidal study and the separation distance of 105.4 feet between these monitoring wells. These particular monitoring wells were selected because the mean groundwater levels at MW13-01 and MW13-02 indicated net landward groundwater flow rather than net groundwater flow toward Lauritzen Channel. The annual total DDT mass flux estimates were computed using the following equations:

$$Q = 0.019661 \cdot Tiw$$

$$AMF = 0.52596 \cdot QC$$

where

T = transmissivity [square feet per day or ft²/day]; a value of 27 ft²/day was used.

i = hydraulic gradient [foot per foot]; a value of 4.80×10^{-3} foot per foot was used.

w = cross-sectional width perpendicular to groundwater flow [feet]; a value of 1,500 feet was used.

Q = annual volumetric groundwater discharge to Lauritzen Channel [liters per minute]; this value was rounded to the nearest whole number.

C = unfiltered total DDT concentration in groundwater [µg/L]; a value of 69.6 µg/L was used.

AMF = annual mass flux of total DDT from the eastern upland aquifer to Lauritzen Channel [grams per year]

- Method 2. This method uses time-varying hydraulic gradients between MW13-03 and MW13-04 computed at 5-minute intervals over the 2013 tidal study. Time-varying landward hydraulic gradient values were replaced with a value of zero, given that DDT would not discharge to the channel during periods of landward gradients. The mass flux of total DDT was computed for each 5-minute interval during the 2013 tidal study, summed over the 3-day tidal study, and then multiplied by a factor of 365.25 ÷ 3. This method essentially integrates the mass flux of total DDT for periods of groundwater discharge to Lauritzen Channel during the 3-day 2013 tidal study and then, assuming this mass flux is representative for periods during the rest of the year, sums the mass that would occur over one calendar year.

Table 4-6 summarizes the parameters used and results of the groundwater discharge and total DDT mass flux evaluation. The results indicate that the annual total DDT flux using Method 1 is 146 g, whereas this flux using Method 2 is 167 g. There was no need to adjust these estimates for total DDT that would enter the Lauritzen Channel with groundwater that upwells into the bottom of the channel because sampling has confirmed that the Older Bay Mud beneath the channel is not contaminated; therefore, groundwater upwelling through the Older Bay Mud beneath the channel is not a DDT transport pathway.

Discharge of groundwater to Lauritzen Channel with the unfiltered maximum total DDT concentrations measured in the 2013 groundwater samples could lead to contamination of sediments to levels above the remediation goal of 590 µg/kg.[7] The potential effects of groundwater discharge on surface water quality in Lauritzen Channel will be further evaluated in the DDT fate and transport study.

The groundwater discharge and total DDT mass flux evaluation presented in Table 4-6 is based on the following assumptions:

- Groundwater level conditions during the March 2013 tidal study are representative of the longer-term range of groundwater levels that have occurred and will occur within the upland area east of Lauritzen Channel.
- Errors introduced by not accounting for potential preferential contaminant transport pathways, such as those created by backfill around subsurface pipes, are negligible.
- Errors introduced by not accounting for groundwater density variations across the upland area east of Lauritzen Channel are negligible.

[7] Assuming equilibrium partitioning from groundwater to sediment containing 2 percent total organic carbon and a Log K_{oc} of 5.18 (partition coefficient for 4,4'DDT and 4,4'-DDD; ASTDR, 2002).

SECTION 5

Wood Pilings

5.1 Objectives and Approach

One of the objectives of the source identification study was to determine whether the abandoned wood pilings along the northeastern shoreline of the Lauritzen Channel act as an ongoing source of DDT to the Lauritzen Channel sediments and surface water. The analysis previously completed for the Sediment Recontamination Study (Kohn and Gilmore, 2001) was used for this assessment.

5.2 Background

Wood chip samples were collected from six creosote-treated wood pilings evenly spaced along the eastern side of the Lauritzen Channel during a sediment recontamination study conducted in 1999 (Kohn and Gilmore, 2001). The wood samples were collected during a low tide as close as possible to the 0 foot MLLW elevation on the pilings. Scrapings of selected pilings were collected to a depth of approximately 3 millimeters. All six samples were screened for DDT using EnviroGard commercial test kits, and five samples were submitted for confirmation analyses for DDT and Dieldrin. The sampling locations are illustrated in Figure 5-1 and the confirmation analysis results from the wood chip analyses are provided in Table 5-1. Samples CR-35 and CR-33 exhibited similar total DDT concentrations from the test kit results (82 and 94 µg/kg, respectively), and sample CR-35 was not submitted for further confirmatory analysis.

5.3 Findings and Lines of Evidence

The analytical results for the wood chips are provided in Table 5-1. The total DDT concentrations ranged from 1,700 to 200,000 µg/kg, with DDD comprising 88 to 100 percent of the total. Four of the six samples contained greater than 50,000 µg/kg DDT. Dieldrin was detected in four of the five samples and the detected concentrations ranged from 3,000 to 14,000 µg/kg.

Kohn and Gilmore (2001) presented an analysis of this potential source and found that although very high DDT and Dieldrin concentrations are associated with the creosote-treated pilings sampled, the pilings are unlikely to be a significant source of DDT to surface water or sediment. DDT isomers have both very high octanol-water partition coefficients (K_{ow}) and sediment-water partition coefficients (K_{oc}), indicating that these pesticides are much more likely to bind with an organic solvent, such as the creosote constituents, or the organic carbon present in sediment, wood, or petroleum. The log K_{ow} and log K_{oc} values utilized for the 2001 evaluation for DDT were 6.19 and 5.39, respectively, indicating that, at equilibrium, the concentration associated with organic solvents or organic carbon is expected to be approximately a million times greater than the concentration in water. More recently published log K_{ow} and log K_{oc} values for the six DDT isomers range from 5.87 to 6.91 and from 4.70 to 5.35, respectively (ATSDR, 2002). Using the more recent log K_{ow} and log K_{oc} would not change the conclusions of the 2001 evaluation.

Kohn and Gilmore (2001) also noted that the pilings could contribute to sediment contamination through mechanical weathering, which includes a range of ablative effects from anthropogenic activity, resulting in particle deposition to the sediment. If the pilings are not removed or cut off, the DDT-contaminated wood particles will continue to accumulate in sediments, increasing sediment DDT concentrations and potentially being incorporated into the food web.

SECTION 6

Stormwater Outfalls

6.1 Objectives and Approach

One of the objectives of the source identification study was to determine whether discharges from the City of Richmond municipal storm drain system or LRTC upland cap stormwater management system are ongoing sources of contamination to the Lauritzen Channel and if so, to estimate the magnitude of ongoing contributions from stormwater outfalls. The storm drain systems were evaluated as follows:

- Stormwater discharges from the municipal storm drain at the head of the Lauritzen Channel were to be sampled as part of this source identification study after the residual sediments in the storm drain system had been removed. However, these sediments have not yet been removed, so the potential for the municipal storm drain system to act as an ongoing DDT transport pathway in the future cannot be evaluated. If the residual sediments are removed prior to completion of the FFS, then stormwater sampling may be performed to verify whether or not discharges from the municipal storm drain system are an ongoing source of contamination to the Lauritzen Channel. Otherwise, development of the remedial alternatives should address this potential ongoing source.
- Monitoring data collected for the LRTC stormwater management system for the upland part of the site were reviewed and evaluated to determine whether the system is functioning as intended.

6.2 Background

The storm drain systems at and around the site are shown in Figure 6-1. There are two components to the storm drain system described below: the City of Richmond municipal storm drain system and the storm water management system within the LRTC property.

6.2.1 City of Richmond Municipal Storm Drains

The City of Richmond municipal stormwater system provides drainage for the area surrounding the United Heckathorn site. There are no municipal drains on the LRTC property; the municipal drain inlets are located on the public roads adjacent to the property (ETS, 2013a; 2013b). These inlets are shown on Figure 6-1. Stormwater from areas to the north, east, and west of the site is carried into the municipal stormwater sewer and enters the Lauritzen Channel through the 48-inch concrete outfall at the north end of the channel.

A storm drain investigation was performed in 2008 and 2009 to determine whether the City of Richmond municipal storm drain system was a source of DDT and Dieldrin to the Lauritzen Channel (USEPA, 2011). Field studies were performed to determine the hydraulic connectivity of the storm drain structures to the outfalls at the head of the Lauritzen Channel and Parr Canal, and to characterize the residual sediments in the storm drain system. Additionally, a video survey was performed to assess the integrity of the storm drains that extend under the upland cap. The survey confirmed that seawater intruded into some of the drains at high tide, but the structural integrity, invert elevations, and hydraulic connections could not be determined for all drains because of the large amount of residual sediment in the system.

The sampling results are presented in Table 6-1 and on Figure 6-2. Storm drain sediment samples collected from 2008 to 2012 contained total DDT concentrations ranging from below the detection limit to 52,000 µg/kg. Dieldrin concentrations ranged from below the detection limit to 680 µg/kg. The highest total DDT and Dieldrin concentrations were observed at location SSWL03, which was sampled in July and again during September 2008. These samples were collected from a manhole near the northeast end of the Lauritzen Channel. The SSWL03 structure was cleaned out in December 2008, and was determined to be a catch basin that was not part of the municipal storm drain system and was not connected to the Lauritzen Channel. The inlet to the catch basin was not identified.

The portion of the municipal storm drain system shown in Figure 6-1 has not been cleaned out by the City of Richmond in many years. The DDT-contaminated sediments in the drains may be a remnant of historical operations at the United Heckathorn site and/or may be from tidal intrusion.

Storm drain sediment sampling was also performed by USEPA's START contractor in 2012 to support a potential emergency removal action. Due to cost implications, the removal action was placed on hold and the sampling report was not finalized; therefore, the data are not included in this evaluation.

A flap gate valve was installed in the Parr Canal storm drain outfall in January 2011. A flap gate valve was installed on the Lauritzen Channel municipal outfall by the EPA START contractor in October 2012 to prevent sediment in the channel from washing back into the storm drain system.

LRTC Stormwater Management System

The selected remedy for the upland part of the United Heckathorn site included implementing a stormwater monitoring program as a component of the operation and maintenance activities. Stormwater is sampled from the interceptors at the LRTC terminal and because the facility is operating under a State Water Resources Control Board Industrial Activities – Storm Water General Permit. The stormwater monitoring schedule and analytical program are incorporated into the LRTC's existing facility-wide Stormwater Pollution Prevention Plan and Stormwater Monitoring Plan (ETS, 2013a).

Stormwater within the Main Terminal Complex of LRTC is managed using two storm drain systems. Both systems include interceptors constructed with compartments and steel baffles to trap and collect oil and suspended solids before water is discharged. One system includes interceptors SW-1 and SW-2, which collect runoff from the dock and main storage/loading areas, and portions of the paved area to the east and north of the equipment repair building and warehouse. Water collected into these interceptors is released to the Santa Fe Channel after removal of oil and suspended solids.

The second storm drain system in the upland area is a storm drain system that was installed in 1998 to collect runoff from the 5-acre upland cap. Runoff from the cap area is directed into five stormwater interceptors, SW-3 through SW-7, which have been designed to have sufficient capacity to hold most stormwater runoff generated during the rainy season (October through May) to minimize direct discharge into the Lauritzen Channel. Runoff captured by the interceptors is sampled and until 2013 was discharged under permit to the City of Richmond municipal stormwater sewer and directed to the publically owned treatment works. As of the 2013 to 2014 stormwater season, these stormwater discharges to the municipal sewer will no longer be allowed. In 2009, SW-3 was modified to allow for discharge of water to a 20,000 gallon tank for additional sediment removal. LRTC added a second 20,000 gallon stormwater holding and sedimentation tank at interceptor SW-3 for the 2013-2014 stormwater season. Interceptors SW-3 through SW-7 have outfalls to the Lauritzen Channel and all five interceptors now include gate valves, which are normally closed, but can be opened to allow discharge to the Lauritzen Channel (Weiss Associates, 2013).

Should very heavy rainfall occur generating discharge to the Lauritzen Channel, a stormwater outflow sample is collected during a minimum of two discharge events per stormwater season. No discharges occurred in the 2004-2005 or in 2008-2009 reporting periods (ETS, 2006 and 2009), but an unusually heavy rain event on January 27, 2010, resulted in outflow from interceptors SW-3 through SW-6 to the Lauritzen Channel. The annual O&M report indicated that the annual sampling was performed during this event, but no associated analytical results were provided (ETS, 2010). As part of the routine maintenance, the five interceptors are drained, emptied of all sediment, and pressure-washed, as necessary, to prevent outflow of sediments into the Lauritzen Channel (ETS, 2013a).

Inspections of the stormwater drop inlets and interceptors are conducted monthly and are documented in the Annual Report for Stormwater Discharges Associated with Industrial Activities (ETS 2006; 2008; 2009; 2010; and 2013b). According to the annual reports, the stormwater system, in general, has been maintained in good condition, with occasional minor sedimentation observed within the storm drains. Staining and odors have not been observed or detected. The annual reports also indicate that no pesticides (including DDT and Dieldrin) were detected in the composite samples taken from the five stormwater interceptors surrounding the cap from 2008 to

2010; DDT was not tested in storm drain sediment prior to 2007. The discharge and annual monitoring sampling performed in October 2011 and March and May 2012 indicated very low concentrations, less than one part per billion, of DDT isomers and Dieldrin in four samples collected from interceptors SW-6 and SW-7 (ETS, 2013b).

During the October 2011 sampling, ETS field staff observed water flowing into the SW-7 interceptor through its outflow pipe (i.e., the pipe from the interceptor to the channel) while the shutoff valve to the channel was in the closed position. A sample of this inflowing water contained 0.085 µg/L total DDT and 0.15 µg/L Dieldrin; a sample collected from the baffle area of the interceptor at the same time contained 0.044 µg/L Dieldrin. As described below, a subsequent inspection determined that the outflow pipe was cracked, and the water that had entered the interceptor was infiltration from surrounding soils.

A sample collected from interceptor SW-6 on March 14, 2012 contained 0.024 µg/L total DDT. Additional samples were collected from interceptors SW-6 and SW-7 on May 9, 2012. The sample collected from SW-6 contained 0.102 µg/L total DDT and 0.013 µg/L Dieldrin. Water collected from SW-7 contained 0.267 µg/L total DDT. Further inspection of these interceptors revealed a crack in the outflow pipe of SW-7 and a crack in the SW-6 interceptor where the above- and below-ground interceptor walls meet. Interceptor SW-7 was repaired by LRTC by placing a clean segment of 8-inch-diameter PVC pipe inside the existing cracked outflow pipe and sealing the entire length of annular space with concrete. The crack in the SW-6 interceptor was repaired by ETS using an anchoring system and environmentally safe epoxy; the repairs are documented in the 2011-2012 Operations Maintenance Plan, which also indicated that both repairs were successful (ETS, 2013b).

Interceptors SW-3 through SW-7 were sampled more frequently than the required minimum of two storm events per wet season during the 2012-2013 reporting year (Weiss Associates, 2013). Between two and eight samples were collected from each interceptor. Some of these samples represent additional sampling performed during the same multi-day event. Total DDT was detected in samples collected on October 22, 2012, from interceptors SW-3, SW-4, and SW-5 at concentrations of 0.028 µg/L, 0.023 µg/L, and 0.056 µg/L, respectively. The sample from SW-5 also contained 0.19 µg/L Dieldrin. A sample collected from SW-6 on November 30, 2012 contained 0.024 µg/L total DDT. The 2012-2013 annual report noted that the pesticide concentrations detected in storm water discharges were consistent with observations from previous years, except at SW-4, where pesticides were detected after being undetected in the three previous reporting years. The report recommended continued monitoring of stormwater discharges, along with evaluation of the spatial and temporal distribution of pesticide concentrations. Future inspections will be expanded to focus on potential pesticide transport mechanisms that could be introducing pesticides to the stormwater interceptors, particularly in the vicinity of SW-6 (Weiss Associates, 2013).

SECTION 7

Source Material Outside of the Lauritzen Channel

7.1 Objectives and Approach

As part of the source identification study, the previous conclusion that there were no significant sources of DDT contamination from outside of the Lauritzen Channel was revisited. The specific objective of this evaluation was to determine whether a source of DDT or Dieldrin external to the Lauritzen Channel could be acting as an ongoing of source of contamination to sediments within the channel and, if so, to estimate the magnitude of this source.

The evaluation of potential DDT sources outside of the Lauritzen Channel focused on the following lines of evidence:

- A review of nearby hazardous waste sites
- Sediment sampling results for areas outside of the Lauritzen Channel and ambient concentrations of total DDT for San Francisco Bay sediments.

7.2 Background

No non-site related sources of DDT and Dieldrin to the Lauritzen Channel or the rest of Inner Richmond Harbor have been identified. The RI report for the marine portion of the site concluded that the main source of total DDT and Dieldrin to the Lauritzen Channel was waste discharges during pesticide processing activities at the United Heckathorn site (White et al., 1994). The total DDT concentration gradients measured during the RI strongly suggested that the Lauritzen Channel was the source of pesticides to the rest of Inner Richmond Harbor. Total DDT concentrations in sediment decreased by two orders of magnitude from the Lauritzen Channel to the Santa Fe Channel, and by another order of magnitude from the Santa Fe Channel to the Inner Harbor Channel. In addition, the analysis of water-sediment ratios in the ecological risk assessment (ERA) indicated that the Lauritzen Channel was the source of contamination to the other channels (Lee et al., 1994).

7.3 Lines of Evidence and Findings

7.3.1 Nearby Hazardous Waste Sites

Nearby hazardous waste sites were evaluated by reviewing the following national and state hazardous waste site databases:

- The California Department of Toxic Substances Control (DTSC) Hazardous Waste and Substances Site (Cortese) List[8]
- Toxics Release Inventory Facilities Database (National Institute of Health – United States National Library of Medicine)[9]

Three sites in Richmond besides United Heckathorn are listed as having DDT and Dieldrin as contaminants of concern: FMC Corporation (855 Parr Boulevard); the University of California, Berkeley Richmond Field Station (1301 South 46th Street); and Zeneca Richmond Ag Products (1415 South 47th Street). The FMC Corporation site is in North Richmond, approximately 3 miles north of the United Heckathorn site. The Richmond Field Station and Zeneca Ag Products are located approximately 2 miles east-southeast from the site. These sites are all unlikely to be potential sources to the Lauritzen Channel due to the distance and the lack of any apparent transport pathways from any of these sites to the United Heckathorn site.

[8] http://www.dtsc.ca.gov/SiteCleanup/Cortese_List.cfm accessed July 16, 2013. Filtered by city to include Richmond and Berkley.

[9] http://toxmap.nlm.nih.gov/toxmap/main/index.jsp accessed July 16. 2013. Search parameters were “Richmond, California”

7.3.2 Sediment Chemistry Data

Sediment chemistry data from the Regional Monitoring Program (RMP), the 1994 RI, the 2013 Source Identification Study, and from sampling performed by the United States Corps of Engineers (USACE) were used to evaluate whether sediment being transported into the Lauritzen Channel from San Francisco Bay could be considered a contaminant source.

7.3.2.1 Regional Monitoring Program Data and Ambient Sediment Concentrations

The RMP began in 1993 to evaluate the cumulative effects of multiple contaminant contributions on ambient bay conditions. Initially, most of the RMP sampling locations were located as far as possible from the "influence of major contaminant sources and to be as representative as possible of 'background' contaminant concentrations." During later sampling events, locations near tributaries to the Bay have been included in the monitoring program. Surface sediment is collected biennially from a set of historic, fixed locations (to allow for temporal trend analysis) as well as new, randomly selected stations (for more accurate assessment of overall ambient conditions) (San Francisco Estuary Institute [SFEI], 1999).

The RMP data were obtained through the RMP Web Query (http://www.sfei.org/rmp/rmp_data_access.html) on February 12, 2013.[10] A subset of the RMP data set for locations sampled within the central San Francisco Bay region were used and included 199 records, collected between 1993 and 2010, from 57 sampling locations to calculate a regional average background concentration. Total DDT was detected in 187 samples, with concentrations ranging from 0.2 to 30.2 µg/kg. The average and median concentration are 3.67 µg/kg and 2.88 µg/kg, respectively. Dieldrin was detected in 102 samples, with concentrations ranging from 0.01 to 0.51 µg/kg. The average and median detected Dieldrin concentrations were 0.12 and 0.11 µg/kg, respectively.

In addition, ambient threshold values for the San Francisco Bay sediments have been developed by the Regional Water Quality Control Board San Francisco Region (Gandesbery and Hetzel, 1998). The ambient threshold values are based on a statistical evaluation of chemical concentrations in surface sediments collected from the bay (Gandesbery and Hetzel, 1998).[11] The ambient stations were located away from point and non-point pollution sources. The ambient threshold values for total DDT and Dieldrin are as follows:

- Total DDT – 2.8 µg/kg for sediments with less than 40 percent fines and 7 µg/kg for sediments dominated by fines
- Dieldrin – 0.18 µg/kg for sediments with less than 40 percent fines and 0.44 µg/kg for sediments dominated by fines

7.3.2.2 Remedial Investigation and 2013 Source Identification Sampling outside of Lauritzen Channel

The 1994 RI report for the marine portion of the United Heckathorn site documented that total DDT concentrations in sediment markedly decreased with distance from the Lauritzen Channel and the median total DDT concentration in the lower Inner Harbor Channel was 19 µg/kg (White et al., 1994). A sediment sample collected at biomonitoring station 303.1 in Richmond Inner Harbor in 2008 had a total DDT concentration of about 7 µg/kg (average of field duplicates) (CH2M HILL, 2008), which is consistent with the ambient threshold value for fine-grained sediments in San Francisco Bay. Dieldrin was not detected, although the detection limit was higher than the ambient threshold value.

Total DDT concentrations in the surface intervals of the three locations in the Santa Fe Channel sampled in 2013 were between 23 and 49 µg/kg. Dieldrin was detected in the surface interval at one of the 2013 Santa Fe Channel

[10] The user interface downloading data had changed between the time of the data query and when this report was drafted. The current web data query tool is located at http://www.sfei.org/tools/wqt

[11] The ASC values were derived using data from the 1991 Pilot and ongoing RMP activities and the Bay Protection and Toxic Cleanup Program's 1995 Reference Study. The data set included 81 records with data for polycyclic aromatic hydrocarbons, polychlorinated biphenyls, metals and metalloids, and selected chlorinated pesticides.

locations, at a concentration of 1.7 µg/kg; the detection limit in the other two surface samples was higher than the ambient threshold value.

7.3.2.3 Richmond Inner Harbor

USACE San Francisco District (SF USACE) conducted sediment sampling in Richmond Inner Harbor in February and July 2012 to determine whether sediment was suitable for ocean disposal. The Inner Harbor dredge area was divided into eleven areas from which two cores were collected and composited. The sediment coring locations were on opposite sides of the channel and at each location sediment was collected from the mudline to an elevation of -40 feet MLLW. The results indicated that total DDT concentrations were greater than the project-specific screening values and the San Francisco Bay ambient concentrations in several samples. The highest concentrations were observed in the composites collected from the reach identified as RIH-6, which is shown in Figure 7-1. The two composite samples from RIH-6, designated as RIH-6A (southern sample) and RIH-6B (northern sample, nearest the site), had total DDT concentrations of 23.8 and 58.1 µg/kg, respectively. Dieldrin was detected in both composites at concentrations of 0.96 and 1.7 µg/kg, respectively (Kinnetic Laboratories, Inc. [KLI], 2012). A summary of the analytical results for parameters relevant to this evaluation is provided in Table 7-1.

SF USACE also collected three discrete samples from each coring locations in RIH-6 in order to evaluate the characteristics of the post-removal surface under different dredging scenarios. The analytical results for the parameters of interest for this evaluation are provided in Table 7-1. Total DDT concentrations in these samples ranged from 0.45 µg/kg to 6,690 µg/kg. The samples from coring location at RIH-6A-1 (Figure 7-1) exhibited the highest total DDT concentrations, with the maximum concentration of 6,690 µg/kg found in the -39.5 to -40.0 feet MLLW sample. Concentrations in the samples above and below this interval were an order of magnitude lower, and concentrations in the samples from the other coring locations were one to two orders of magnitude lower. Dieldrin concentrations in these samples exhibited a similar pattern, with concentrations ranging from below the detection limit to 14 µg/kg (KLI, 2012).

Location RIH-6A-1, which contained the highest total DDT and Dieldrin concentrations, is approximately 800 meters from the mouth of the Lauritzen Channel and is located on a shoal on the eastern side of the channel near the northern end of Terminal 3 of the Port of Richmond, and just to the south of Terminal 2. Terminal 3 is used for the handling, storage, and distribution of break bulk, project cargo, and containers. Terminal 2 is used for the storage and distribution of bulk liquid.[12] The relatively higher DDT and Dieldrin concentrations measured in this area are surrounded by samples with lower concentrations, suggesting that the source is local and limited in extent. Although sediment potentially could be transported away from this area through tidal action, it is unlikely that the magnitude of that transport would be sufficient to result in total DDT concentrations above the remediation goal in the Lauritzen Channel.

[12] Port of Richmond information collected from City of Richmond website: http://www.ci.richmond.ca.us/index.aspx?NID=324 Accessed July 17, 2013.

SECTION 8
Dredging Residuals

8.1 Objectives and Approach

The source identification study objectives related to the evaluation of dredging residuals remaining in the Lauritzen Channel after the 1996-1997 remedial action were as follows:

- Determine whether sediments in undredged or partially dredged areas (i.e., undisturbed residuals) were subsequently redistributed throughout the Lauritzen Channel after the remedy was completed, thereby re-contaminating the channel and acting as an ongoing secondary source of contamination.
- Determine whether contaminated sediments that were re-suspended during dredging or sloughed from the sides of the channel (i.e., generated residuals) were deposited throughout the channel after the remedy was completed.

Sediment core and grab sample data collected from 1998 to 2013 were compared to the remediation goal to infer whether dredging residuals are primarily responsible for the high levels contamination seen in the Lauritzen Channel sediments.

8.2 Background

Information and data provided in the completion report (CWM, 1997), EPA remediation oversight report (Kohn, 1998), and other documents indicate that both undisturbed and generated residuals remained in the Lauritzen Channel after the remedy was completed in 1997. Two types of dredging residuals were present:

- Undisturbed residuals – sediments that were not dredged either because of obstructions (e.g., abandoned pilings or sediments beneath the Levin pier) or because they were impractical to remove (e.g., sediments along the embankment or rip-rapped areas); in addition, some patches of undredged sediment remained within the removal footprint but were not detected during verification or confirmation sampling.
- Generated residuals – fine-grained material that was re-suspended during dredging, escaped from the dredge bucket, or ran out of the scow. In addition, sediment underneath the Levin pier continually sloughed into the dredged portions of the channel during remedy implementation (Kohn, 1998).

Areas that were dredged in 1996-1997 are shown in Figure 8-1**.** The target dredging depths in each 50-foot-by-50-foot dredge cell were verified through lead-line soundings and hydrographic surveys. If the removal plan bathymetric contours were achieved, then the dredging was determined to be complete. Completion was verified by either penetrating 6 inches into the OBM with the dredge bucket or by collecting vibracore samples in each grid cell. EPA deemed the grid cell complete if at least three of five cores contained no dredgeable YBM. After completion, confirmatory samples for chemical analysis were collected from a total of 18 locations throughout the Lauritzen Channel (USEPA 1997a and 1997b). The average total DDT concentration was below the remediation goal of 590 µg/kg.

Sand was placed throughout the channel after the confirmatory sampling to facilitate the recovery of the benthic community (the sand layer was not intended to isolate and contain dredging residuals). The sand layer was nominally 6 inches thick, with more sand reportedly placed at the head of the canal and in inaccessible areas that could not be dredged. No sand was placed beneath the Levin pier where the slope was too steep to hold it in place, or in the Levin berths on the southeast side of the channel. The sand layer was most likely variable in thickness because of the uneven bottom (Kohn, 1998). Rock and sand were also placed on the embankments (CWM, 1997). The thickness and extent of the benthic sand layer was not verified after placement.

The sand layer was found in only a subset of sediment cores collected in the Lauritzen Channel in 1999, 2003, and 2007 (Kohn and Gilmore, 2001; Kohn and Evans, 2004; CH2M HILL, 2008). The distribution of the sand layer in

2013 is shown in Figure 8-2. In some instances, the sand was observed immediately above the OBM; in other cases, a sand layer was observed separating two intervals of YBM. The presence of YBM beneath the sand layer in some locations indicates that it was incompletely dredged in 1996-1997.

8.3 Lines of Evidence and Findings

The analyses in the previous sections concluded that none of the other potential sources that were identified appear to be contributing sufficient masses of DDT to the Lauritzen Channel to account for the concentrations currently seen in the sediments (although the magnitude of discharges from the municipal stormwater system still needs to be verified). Therefore, the most likely explanation for the consistently high levels of DDT detected in sediments throughout the Lauritzen Channel is the presence of dredging residuals. The pesticide data for YBM sediment and soil samples collected from 1998 to 2007 are provided in Table 8-1, and the 2013 sediment grab and core data are provided in Tables 3-2 and 8-2, respectively. Figure 8-3 shows the total DDT concentrations measured in all of the channel and embankment samples collected since 1997 compared to the remediation goal. These data indicate that sediments and soils with DDT concentrations above the remediation goal of 590 µg/kg have been present in and adjacent to the Lauritzen Channel since the time the remedy was completed. It should be noted that the results from one year to another are not directly comparable because samples were not collected from the same locations in every sample event.

Figures 8-4 and 8-5 show the areal distribution of surface and core maximum DDT concentration at the 2013 sampling locations. The surface data clearly indicate that the highest concentrations are found in samples collected in the undredged and partially dredged areas on the eastern embankment, and in the northern two-thirds of the channel. A comparison of the surface and core maximum results indicates that the surface sediment concentrations are lower than the subsurface sediment concentrations in the dredged parts of the channel, suggesting deposition of less contaminated sediment over time. The nature and extent of contamination in the Lauritzen Channel sediments based on the 2013 sample data will be more fully discussed in the forthcoming FFS report.

Erosion and transport of the contaminated embankment sediment under the Levin pier and along the eastern shoreline do not appear to be responsible for the DDT contamination seen in the rest of the Lauritzen Channel sediments. The Tier 2 sediment transport study indicates that wakes from transiting vessels could remobilize under-pier and shoreline sediments, but that the mass of sediment suspended would be low compared to the sediment suspended behind an operating stationary vessel (Sea Engineering Inc. [SEI], 2014).

SECTION 9
Conclusions

The source identification study did not identify any ongoing sources of contamination to the Lauritzen Channel that are of sufficient magnitude to account for the high DDT concentrations seen throughout the channel sediments. Dredging residuals, including contaminated embankment sediments that were not removed in either the upland or marine remedial actions, appear to be responsible for the majority of the DDT mass currently found in the channel. However, many of the other sources of contamination that were investigated are still active and may lead to the recontamination of channel sediments, surface water, and biota in the future if not controlled. The general conclusions for each potential source are listed in Table 9-1 and the specific findings are as follows:

- The other pipes, outfalls and seeps that were identified in the 2012 site survey do not appear to be ongoing sources of DDT contamination to the Lauritzen Channel under dry weather conditions. The pipes and outfalls that were identified do not convey dry weather flow, and the one continuously-flowing seep that was sampled contained only low levels of pesticides. However, other pipes and conveyances that are not visible may exist (i.e., features that terminate behind rip rap or sheetpile, or are subtidal). Any of the identified or unidentified pipes and conveyances could have and may still act as preferential pathways for the transport of DDT from the upland area to the Lauritzen Channel, particularly adjacent to the former plant site and former train scale area where highly contaminated soils and groundwater still exist. Additionally, the pipes and outfalls have not been inspected or sampled during wet weather conditions.
- The embankment soil and sediment data indicate that DDT contamination is widespread along the eastern, northern, and northwestern shorelines of the Lauritzen Channel. Only two of the 19 shoreline locations sampled in 2013 had total DDT concentrations below the remediation goal of 590 μg/kg. Although the shoreline is largely armored with rip rap and sheetpile, fine-grained sediments are present in pockets in the rip rap and soils are eroding from under the sheetpile in some areas.
- The highest DDT concentrations measured in sediment grab samples collected along the embankment correspond to the areas where interim removal actions along the embankment were previously completed. These interim soil removal actions did not address sediments below about 0 feet MLLW or embankment soils with DDT concentrations below 100 mg/kg. The dredging remedy extended only to the toe of the slope, and the area around the abandoned pilings was only partially dredged. The high DDT concentrations that persist in this area appear to be attributable to historical contamination that was not addressed in either the upland or the marine remedies.
- The shallow aquifer of the upland area east of the Lauritzen Channel contributes total DDT mass to the Lauritzen Channel sediments. The estimated contribution of total DDT from groundwater (approximately 167 g/year) is not of sufficient magnitude to account for the high levels of DDT in channel sediments. This conclusion is consistent with the previous findings in the 1990 upland RI report (Levine Fricke, 1990). However, groundwater discharge will continue to contribute DDT to sediments, surface water and biota in the Lauritzen Channel if not controlled.
- The abandoned wood pilings along the northeastern shoreline are contaminated with DDT. Mechanical weathering of the pilings is an ongoing source of DDT-contaminated particles to the sediment bed and potentially to biota. DDT is not likely to desorb from the pilings into the sediment and water of the channel.
- The City of Richmond municipal outfall at the head of the Lauritzen Channel cannot be fully evaluated as an ongoing source of contamination to the Lauritzen Channel until the DDT-contaminated residual sediments within the storm drain system are removed. These sediments will be removed a part of the remedy, and monitoring will be performed to verify that the municipal drains are no longer acting as a DDT transport pathway to the Lauritzen Channel.
- The stormwater monitoring data collected for the storm drain system that serves the upland cap on the LRTC property indicates that the system is functioning as designed, with only infrequent direct discharges to the

Lauritzen Channel. Low levels of pesticides are periodically detected in stormwater samples from the interceptors.

- The distance and lack of transport pathways between the three other DDT-contaminated sites in Richmond and the United Heckathorn site suggest that none of these three sites are potential sources to the Lauritzen Channel. The available sediment chemistry data for areas outside of the Lauritzen Channel do not suggest that sediments from the San Francisco Bay would be a source of DDT or Dieldrin to the channel. The San Francisco Bay ambient threshold values, RMP concentrations for Central Bay samples, and samples collected in the Santa Fe Channel as part of the 1994 RI and 2013 source identification study are much lower than the pesticide concentrations observed within the Lauritzen Channel.
- The SF USACE sampling results did include some samples with elevated pesticide concentrations at depth in the upper reaches of Richmond Inner Harbor. The lack of concentration gradient between these locations and the Lauritzen Channel, which are approximately 800 meters apart, the position of the sampling location on a small shoal, and the observation that the highest concentrations were at depth all indicate that the sediments in Richmond Inner Harbor would not act as an additional source of contamination to the Lauritzen Channel.
- Dredging residuals appear to be the primary source of the DDT mass currently found in the Lauritzen Channel. The channel and embankment sample data collected since 1997 indicate that sediments and soils with DDT concentrations above the remediation goal of 590 µg/kg have been present in and near the Lauritzen Channel since the time the remedy was completed.

SECTION 10
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Tables

TABLE 2-1

Summary of Vibracore Observations - 2013 Source Identification Investigation

United Heckathorn Superfund Site, Richmond, California

Location	Field Longitude (X)	Field Latitude (Y)	Measured Water Depth (ft)	Observed/Verified Tide (ft MLLW)[1]	Penetration (ft)	Recovery (ft)	Refusal (Y/N)	Core Barrel Advanced to Full Length (Y/N)	OBM in core (Y/N)	Thickness of YBM (Corrected) (ft)[2]	Elevation of YBM Surface (ft MLLW)	Elevation of OBM[3] (ft MLLW)	Evidence of 1997 Benthic Sand Layer (Y/N)	Additional Comments
SD13-4	6023234.68	2164441.03	14.6	0.74	7.17	1.50	Y	N	N	7.17	-13.86	*-21.0*	N	Rocks and riprap were observed along the seafloor on west side of channel. Three attempts at this location all resulted sufficient penetration but minimal recovery. The vibracore head continued to slip downslope due to unfavorable bottom conditions. Attempt 3, located approximately 9.8' east of the target location was retained for sampling. Core was black silt and sand over gravel; petroleum hydrocarbon odor noted, stronger in gravel. The core catcher contained OBM.
SD13-5	6023274.05	2164435.49	17.7	0.36	5.50	4.10	Y	N	N	4.75	-17.34	*-22.1*	N	Fine interval core. Entire core dominantly sticky black clay/silt with trace to minor sand. Increased sand and gravel at bottom of core. Strong hydrocarbon-type odor at 3.3' below TOC.
SD13-6	6023328.85	2164430.36	13.5	2.41	5.33	5.00	Y	N	N	5.33	-11.09	*-16.4*	Y	The first attempt at this location hit a rocky bottom. The boat was moved into deeper water slightly to the west of the proposed location. When the core liner was removed from the core barrel, it was noted that the core catcher contained rocks, not OBM. Since no OBM was observed a third attempt was made to collect a core including the YBM/OBM interface. The third attempt had approximately 4' penetration which was stopped by rock. The senior field staff confirmed that 2 attempts at the offset location were sufficient and the third attempt was discarded. Below 2 feet, core is dominantly sand, increasing gravel and decreasing silt/clay content with depth to 4.2 feet. Below 4.2 feet to BOC no gravel and less clay/silt.
SD13-8	6023181.39	2164245.71	19.6	-0.21	7.17	5.60	N	Y	Y	5.57	-19.81	-25.4	N	Transition zone to OBM from 4 to 4.3 feet from TOC.
SD13-9	6023248.50	2164238.21	20.7	-0.37	6.00	5.50	N	N	Y	3.75	-21.07	-24.8	Y	This location was identified as the fine interval sample. The first core retrieved was allowed to rest horizontally for a brief period of time, during barge movement. Since this location is designated as a fine interval sample, a second core was collected. Nose cone was cut off during processing and not included in processed length. Sand layer observed above 0.6 feet of consolidated, black, clay/silt YBM. Due to OBM observation in first core, second core was stopped once a depth of 6 feet had been reached to minimize consolidation of YBM.
SD13-10	6023307.69	2164238.02	12.4	-0.12	6.67	6.60	Y	N	Y	1.87	-12.52	-14.4	N	Minor sand was observed from 0.9 to 1.8 feet below TOC.
SD13-13	6023160.53	2164049.90	14.1	1.06	7.00	2.50	Y	N	Y	5.60	-13.04	-18.6	N	Sandy silt/clay observed in top 0.6 feet. Penetration was 7' and the operator felt the vibracore tilt when OBM was encountered. OBM was encountered, so despite a low recovery, no additional attempts were required. Since vibracore head tipped over the penetration is overestimated.
SD13-14	6023212.77	2164041.92	20.2	0.63	6.67	6.40	Y	N	Y	1.17	-19.57	-20.7	N	Top 0.4 feet of core included coarse, dark gray to black sand with clay and silt, approximately 80% sand.
SD13-15	6023278.51	2164034.84	14.3	0.1	6.25	4.90	Y	N	Y	3.35	-14.20	-17.6	Y	Dark gray to black medium sand (drier than interval above) observed from 1.6 to 2 feet from TOC.
SD13-18	6023087.22	2163850.25	21.6	2.05	6.42	6.50	Y	N	Y	1.00	-19.55	-20.6	Y	Observed approximately 1 inch of dark gray, medium sand right above OBM.
SD13-19	6023185.28	2163842.50	31.5	2.26	6.00	6.10	Y	N	Y	4.00	-29.24	-33.2	Y	From 1.8 to 2.7 feet below TOC transition from black clay/silt to medium, dark gray firm, slightly moist sand - decreasing fines with depth noted. From 2.7 to 4 feet below TOC observed dark gray, fine to medium sand, dry and hard. Minor shell hash from 2.7 to 3 feet. Transition to OBM at 4 feet below TOC.
SD13-20	6023255.11	2163837.51	25.1	1.7	7.25	5.17	N	Y	N	7.25	-23.40	NA	N	YBM included black silt/clay with pockets of gravel or gravel with fine sand throughout.
SD13-23	6023066.85	2163651.19	21.4	1.21	4.33	3.70	Y	N	Y	4.33	-20.19	-24.5	Y	Sand observed from 0.9 to 1.5 feet from TOC - medium, dark gray, trace to minor fines and trace shell hash. Below 1.5 feet black silt/clay was observed interspersed with hard, fat gray-brown clay. No clear transition observed and there appeared to be fingers of silt/clay that comprises YBM into the firmer, drier OBM. From 3 to 3.7 feet, there was less of the black silt/clay. Slight petroleum hydrocarbon odor (observed as diesel-like odor) was noted at bottom of core.
SD13-24	6023139.40	2163642.13	32.5	0.78	6.92	6.00	Y	N	Y	6.92	-31.72	*-38.6*	N	Top 0.7 feet of core was soft, black clay/silt (clearly YBM) and from 0.7 to 4.1 feet below TOC, sediment appeared to be OBM; however from 4.1 to 5.2 feet below the TOC, material became wet again and gravel observed at bottom of this interval. From 5.2 to 6.0 the sediment was soft clay/silt with gravel and pockets of black silt/clay (presumed to be YBM sediment). Based on DDT results entire core is going to be considered YBM for FFS purposes.
SD13-25	6023211.18	2163646.43	33.9	1.59	6.83	5.90	Y	N	N	6.83	-32.31	*-39.1*	Y	Sand observed in bottom interval of core (5.3 to BOC at 5.9 feet). Transition from YBM to sand was abrupt, material below sand interval not observed.
SD13-27	6022989.83	2163456.36	13.2	-0.2	5.00	3.10	Y	N	N	5.00	-13.40	*-18.4*	N	Core appeared to be highly disturbed and contained multiple, relatively thin, layers of sediment ranging from black clay/silt and poorly sorted sand and coarse gravel to very hard, dry clay with gravel.
SD13-28	6023091.65	2163452.79	34.3	0.22	6.50	6.00	Y	N	N	6.50	-34.08	*-40.6*	N	At 3 feet from TOC, an abrupt transition in moisture content and firmness observed. Pockets of dark olive-brown to dark gray silt/clay were observed between 4 and 6 feet.
SD13-29	6023189.47	2163438.66	34.2	0.06	6.67	6.20	Y	N	N	6.67	-34.14	*-40.8*	N	Entire core silt/clay with trace fine sand (YBM). PHC odor noted throughout, but was notably stronger near bottom of core. At 5.7 feet from TOC, increased gravel and sand content observed, but there was not a distinct "sand" layer.
SD13-31	6022972.31	2163263.24	14.6	-0.27	4.83	5.00	Y	N	Y	0.00	N/A	-15.5	N	Entire core was OBM; the top 2 feet contained areas of mottled dark gray clay/silt and appeared disturbed compared to the sediment below 2 feet.
SD13-32	6023070.70	2163251.79	33.5	-0.3	6.75	6.10	Y	N	N	6.75	-33.79	*-40.5*	N	Entire core silt/clay with trace fine sand (YBM). PHC odor noted throughout. Notable transition at 3 feet; sediment above is very cohesive, wet, and sticky; below material is still silt/clay but less wet. At 4.4 feet from TOC observed a clast of black, organic rich material.
SD13-33	6023168.50	2163239.19	33.7	-0.2	6.92	6.20	Y	N	N	6.92	-33.90	*-40.8*	N	Entire core is black silt/clay (YBM) with pockets of firmer gray-brown clay observed below 2 feet.
SD13-35	6022947.27	2163061.12	30.7	0.62	6.58	5.80	Y	N	Y	6.58	-30.08	-36.7	Y	Medium, dark gray sand observed from 2.6 to 2.9 feet from TOC and from 3.4 to 4.6 feet from TOC; trace shell hash observed in lower interval. From 4.6 feet to BOC soft, wet, black silt clay. Plug of OBM observed at very bottom of core.

TABLE 2-1

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United Heckathorn Superfund Site, Richmond, California

Location	Field Longitude (X)	Field Latitude (Y)	Measured Water Depth (ft)	Observed/Verified Tide (ft MLLW)[1]	Penetration (ft)	Recovery (ft)	Refusal (Y/N)	Core Barrel Advanced to Full Length (Y/N)	OBM in core (Y/N)	Thickness of YBM (Corrected) (ft)[2]	Elevation of YBM Surface (ft MLLW)	Elevation of OBM[3] (ft MLLW)	Evidence of 1997 Benthic Sand Layer (Y/N)	Additional Comments
SD13-36	6023044.53	2163055.96	36.5	1.71	6.58	6.50	Y	N	N	6.58	-34.79	*-41.4*	Y	Sand layer observed from 4.3 to 4.5 feet and 5.2 to 5.4 feet below TOC. Remainder of core clay/silt with varying degrees of firmness and moisture (all YBM).
SD13-37	6023145.91	2163043.31	35.3	-0.19	6.58	6.00	Y	N	N	6.58	-35.49	*-42.1*	N	Gravel and rocks noted at bottom of core during processing.
SD13-39	6022756.43	2162979.33	40	4.06	5.58	4.90	Y	N	Y	4.08	-35.94	-40.0	N	From 4.8 to 5.2 feet below TOC a layer of coarse, angular gravel with sand and silt observed; YBM present below this layer. At 5.6 feet below TOC there is a layer of black, organic rich material, approximately 3/8" thick that had a strong, chemical-type odor.
SD13-40	6022921.50	2162662.19	41.5	3.07	4.92	4.00	Y	N	Y	2.92	-38.43	-41.4	N	Penetration likely overestimated due to the very soft nature of the surface sediment. From 3 to 3.4 feet the OBM contained what appeared to be black inclusions of YBM.
SD13-41	6023057.92	2162400.50	39.1	2.25	6.42	6.50	Y	N	Y	3.92	-36.85	-40.8	N	Transition from YBM to OBM observed at 4 feet below TOC. From 4 to 5 feet the clay was broken into angular, gravel-sized clumps, from 4.9 to 5 feet this transitioned into a hard, dark gray clay.

Notes:

1. Verified tide data from National Oceanographic and Atmospheric Adminstration Station 9414863, Richmond, California. Accessed May 6, 2013.
2. Thickness of the YBM has been corrected to account for less than 100 percent core recovery.
3. Where OBM was not directly observed in cores that met refusal, the inferred elevation of the OBM surface was calculated by subtracting the corrected thickness of YBM from the YBM surface elevation. The inferred values are italicized.

BOC - bottom of core
ft - feet
MLLW - mean lower low water
N/A - not applicable
OBM - Old Bay Mud
TOC - top of core
YBM - Young Bay Mud

TABLE 2-2

Groundwater Sampling - Field Water Quality Measurements and Elevations - March 2013

United Heckathorn Superfund Site, Richmond, California

			Well Constructionand Elevation Data							Field Water Quality Parameters				
Well ID	Groundwater Sample Collection Date & Time		Well Depth (ft)	X	Y	Screen Interval (ft below surface)	Depth to Water (ft)	Tubing Intake Depth (ft)	Temperature (°C)	Field pH	Specific Conductivity (mS)	Conductivity (mS)	Comment
MW13-01	3/25/2013	9:50	30	6023329.05	2163993.83	20-30	10.5	29	14.9	6.61	37.02	35.69	Tan and cloudy
MW13-02	NA	NA	25	6023536.06	2163403.65	14.5-24.5	NA	NA	NA	NA	NA	NA	
MW13-03	3/25/2013	15:30	33	6023282.26	2163398.94	18-33	11.5	32	15.1	6.65	34.96	34.62	Tan and cloudy
MW13-04	NA	NA	30.0	6023392.09	2163360.93	20-30	NA	NA	NA	NA	NA	NA	
GW13-05	3/21/2013	12:35	20	6023311.18	2164535.44	10-20	9.8	NR	21.6	6.66	43.50	43.5	
GW13-06	3/21/2013	13:34	20	6023376.60	2164512.24	9-19	10.8	NR	26.2	6.61	27.67	24.07	
GW13-07	3/22/2013	7:45	20	6023406.38	2164296.89	9-19	10.2	NR	15.06	6.54	21.54	17.67	
GW13-08	3/22/2013	10:30	30	6023373.35	2164162.65	20-30	10.3	NR	19.7	6.36	28.96	26.01	
GW13-09	3/22/2013	9:45	30	6023356.70	2164090.13	20-30	9.5	NR	17.2	6.45	35.32	30.07	
GW13-10	3/22/2013	12:10	30	6023327.88	2163914.65	20-30	10.4	29	18.3	6.73	28.09	27.20	Tan and cloudy
GW13-11	3/22/2013	12:45	30	6023340.97	2163840.06	20-30	7.5	29	17.9	6.71	32.23	31.61	Tan and cloudy
GW13-12	3/22/2013	13:30	30	6023309.89	2163760.18	20-30	10.1	29	17.6	6.67	23.95	22.06	Tan and very slightly cloudy
GW13-13	3/22/2013	11:15	30	6023310.98	2163700.38	20-30	9.6	29	17.9	6.72	27.09	24.62	Tan and slightly cloudy
GW13-14	3/22/2013	10:30	30	6023250.84	2163063.34	20-30	8.0	29	16.9	6.51	32.61	30.02	Tan and slightly cloudy

Notes:

°C - degrees Celsius

ft - feet

mg/L - milligram per liter

mS - milliSiemens

mV - millivolts

NR - not recorded

NTU - nephelometric turbidity unit

TABLE 3-1
Potential Point Sources of Contamination to the Lauritzen Channel
United Heckathorn Superfund Site, Richmond, California

Point Source Identifier[a]	Description [b]	Phase 1 Identifier Transect [c]	Phase 1 and 2 Comments and Analytical Results	Bent Number[d]	2012 Site Survey Comments
Pipes Documented Prior to the Phase I Source Investigation					
LCI-1	Concrete municipal outfall at north end of Lauritzen Channel Flap gate installed on outfall in October 2012	-47	Some water flow observed. Sediment samples from outfall pipe contained 1,060 and 300 µg/kg total DDT. Passive sampler placed in outfall pipe for 4 weeks had 3,779 µg/kg polyethylene total DDT	Head of channel	Lauritzen Outfall was located and flap gate observed.
PCI-1	Concrete municipal outfall at north end of Parr Canal. Flap gate installed on outfall prior to site visit on January 25, 2011.	N/A	N/A		Pipe was not verified because Parr Canal was not inspected as part of the site survey.
P1-1	8-in. metal outfall through retaining wall about 2 ft above sediment	-27.5	Some water dripping observed (pipe is submerged at high tide). Sediment samples collected from outfall pipe had 8,700 µg/kg dry weight and 500 µg/kg wet weight total DDT. Passive sampler placed in outfall pipe for 4 weeks had 123,972 µg/kg polyethylene total DDT. Resident mussels collected from pilings near this outfall in Phase 2 had 929 µg/kg total DDT (wet weight); about 2.5 times higher than the concentration in mussels collected from the mid-channel biomonitoring station (303.3). These were the second highest concentrations detected after mussels collected at the seep (P1-4).		Pipe was located. Tidal drainage was observed dripping from pipe. Biased surface sediment sample collected adjacent to this outfall in 2013 (location SD13-12) had 75,220 µg/kg total DDT.
P1-2	5.5-in. metal pipe through retaining wall about 5 ft above present sediment surface, same location as 8-in. pipe above	-27.5	No sediment in pipe, no water flow, not sampled.		Pipe was located.
P1-3	L-shaped pipe	-24.5	Valve closed; not sampled.		Angled metal pipe was located. Appears to be an abandoned fire main.
P4-3	Described in Phase I as a screened pipe end in riprap near north end of sheetpile wall		Not found during Phase I field survey		Pipe was not located.
P4-1	Pipe discharging to west side of channel, identified on City of Richmond drainage map.		Not found during Phase I field survey		Pipe was not verified because this portion of the Lauritzen Channel was inaccessible by boat due to barge stationed in the channel.
P4-2	21-inch pipe discharging beneath Levin Pier, identified on City of Richmond drainage map.		Pipe this size not found at expected location during Phase I field survey, but several smaller previously undocumented pipes were found beneath pier.	+9.5	2-inch diameter corroded metal pipe was located.
Pipes identified in Phase I Source Investigation					
P1-4	Concrete pipe at bottom of riprap. Described as the "seep" in Phase 2. Grouted on July 18, 2003 by EPA, after the Phase 2 investigation was completed.	-8.5	Some flow observed in 2002. Pipe is difficult to see as it blends in with cobbles and rip rap. Channel sediment samples collected 18 m south had 1,280 and 150 µg/kg total DDT. Seep water sample had 4.455 µg/L total DDT, which was more than 100 times higher than surface water samples from the Lauritzen Channel. Three seep[1] water samples collected in Phase 2 had an average of 8.99 µg/L total DDT and 2.74 µg/L dissolved DDT, compared to average concentrations of 0.396 µg/L total DDT and 0.022 µg/L		Former pipe/seep was not located. Biased surface sediment sample collected adjacent to the former seep in 2013 (location SD13-17) had 91,620 µg/kg total DDT.

[1] This feature was named the "seep" in Phase 2. The Phase 2 report incorrectly described the seep as being located at T-12.5.

TABLE 3-1
Potential Point Sources of Contamination to the Lauritzen Channel
United Heckathorn Superfund Site, Richmond, California

Point Source Identifier[a]	Description [b]	Phase 1 Identifier Transect [c]	Phase 1 and 2 Comments and Analytical Results	Bent Number[d]	2012 Site Survey Comments
			dissolved DDT in channel surface water at the mid-channel biomonitoring station (303.3). Resident mussels collected near the seep in Phase 2 contained 135,700 µg/kg wet weight total DDT, the highest measured on the site.		
P1-5	Corroded metal pipe identified during February 6, 2002 deployment, under Levin Pier.	+20	Appears valved off, end very corroded. Sediment sample collected from nearby channel in Phase 1 had 750 µg/kg total DDT.	+20.5	10-inch diameter corroded metal pipe located.
P1-6	6-inch diameter pipe, under Levin Pier.	+31.5	Appears to discharge occasionally. Nearby channel sediment sampled (T+31.5B) during Phase 1 contained 2,820 µg/kg total DDT.	+31.5	Corroded metal pipe was located.
P1-7	8-inch diameter pipe, under Levin Pier.	+59.5	Appears valved off, old, unused; not sampled or photographed.	+59.5	12-inch diameter pipe located. Appears to be an abandoned fire main.
Pipes identified in Phase 4 Source Investigation					
SW-3	NA	NA	NA	+27	18-inch diameter HDPE storm water interceptor pipe. Filter cloth is loosely hanging from pipe.
SW-4	NA	NA	NA	0	18-inch diameter HDPE storm water interceptor pipe. Contains 8 inch diameter valve and filter cloth intact. Water was flowing from pipe.
SW-5	NA	NA	NA	-17	18-inch diameter HDPE storm water interceptor pipe. Contains 8 inch diameter valve and filter cloth intact.
SW-6	NA	NA	NA	Head of channel, east of LC1-1	18-inch diameter HDPE storm water interceptor pipe. Contains 8 inch diameter valve and filter cloth intact.
SW-7	NA	NA	NA	Head of channel, west of LC1-1	15-inch diameter HDPE storm water interceptor pipe. Appears to be valved closed.
P4-4	NA	NA	NA	Head of channel, west of SW-7	10-inch diameter metal pipe. Surface sediment sample collected near outfalls SW-7 and P4-4 in 2013 (location SD13-01) had 298,920 µg/kg total DDT, the highest concentration measured in 2013
P4-5	NA	NA	NA	Western side channel across from -33	4-inch diameter metal pipe.
P4-6	NA	NA	NA	Western side channel across from -26	2 to4-inch diameter metal pipe.
P4-7	NA	NA	NA	Western side channel across from -24	4-inch diameter metal pipe.
P4-8	NA	NA	NA	0	8-inch diameter corroded metal pipe located at bottom of rip rap.
P4-9	NA	NA	NA	+20.5	9-inch diameter corroded metal U-shaped pipe. Appears to be abandoned fire main.
P4-10	NA	NA	NA	+26.5	4-inch diameter corroded metal pipe. See Photograph 7 in Attachment 1.

TABLE 3-1
Potential Point Sources of Contamination to the Lauritzen Channel
United Heckathorn Superfund Site, Richmond, California

Point Source Identifier[a]	Description [b]	Phase 1 Identifier Transect [c]	Phase 1 and 2 Comments and Analytical Results	Bent Number[d]	2012 Site Survey Comments
P4-11	NA	NA	NA	+70.5	18-inch diameter metal pipe cemented shut.
P4-12	NA	NA	NA	+72	6-inch diameter metal pipe.
P4-13	NA	NA	NA	-14	2-inch diameter corroded metal pipe.
P4-14	NA	NA	NA	-11.5	2-inch diameter corroded metal pipe.
P4-15	NA	NA	NA	-10.5	2-inch diameter long metal pipe.
P4-16	NA	NA	NA	T+37	Seep identified beneath the Levin pier on April 29, 2013 Seep water sampled on July 24, 2013
Conduits 1 and 2	NA	NA	NA	+30.5	2 metal conduits.

NOTES:

NA=Not applicable

[a] Point source identifiers have been assigned for this study. Labels containing a prefix of P1 refer to pipes that were identified in the field during the Phase I Source Investigation (Kohn and Evans, 2002). The prefix P4 refers to pipes that were identified on a storm drain figure from the City of Richmond obtained after the Phase I Source Investigation, one structure P4-3 that was discussed in the Phase I Source Investigation but was not located in the field, and all new structures identified during field activities on 11/29/12 and 12/10/12.

[b] Descriptions from Table 3.1 of the Phase I Source Investigation (Kohn and Evans, 2002).

[c] A transect naming system and navigational baseline were established using the numbers assigned to rows of pier pilings (also known as bent numbers) supporting the Levin pier. Each row of pilings was assigned a whole number starting with +1 at the north end of the pier. The transect numbering system for the rows of pier pilings is presented as Attachment B of the SAP (CH2M HILL, 2012). Transect numbers fall between whole number pier pilings (e.g., +17.5 falls between +17 and +18).

[d] Positive bent numbers are associated with existing rows of pier pilings. Negative bent numbers are associated with historical pier pilings. Bent numbers are spaced approximately 15 feet apart.

TABLE 3-2

Summary of Pesticide and Organic Carbon Results - 2013 Sediment and Embankment Soil Grab Sample Data

United Heckathorn Superfund Site, Richmond, California

						Pesticide results are µg/kg dry weight								
Location ID	**Location Description**	**Sample ID**	**Sample Type**	**Top Depth (ft)**	**Bottom Depth (ft)**	**Dieldrin**	**2,4-DDD**	**2,4-DDE**	**2,4-DDT**	**4,4-DDD**	**4,4-DDE**	**4,4-DDT**	**Total DDT**	**Total Organic Carbon (mg/kg)**
SD13-01	unbiased	SD13-01-0005	N	0.0	0.5	**140**	**1500**	3.2 UJ	**9700**	**17000**	**720**	**270000**	**298920**	**21100**
SD13-02	unbiased	SD13-02-0005	N	0.0	0.5	**78**	**700**	3.3 UJ	**190**	**4400**	**330**	**8500**	**14120**	**38000 >**
SD13-03	unbiased	SD13-03-0005	N	0.0	0.5	**130**	**430**	**160**	**230**	**790**	**390**	**290**	**2290**	**38000 >**
SD13-07	unbiased	SD13-07-0005	N	0.0	0.5	**68 J**	**310**	3.2 UJ	**150**	**1600**	**290**	**580**	**2930**	**31200**
SD13-11	unbiased	SD13-11-0005	N	0.0	0.5	**34 J**	**150 J**	3.2 UJ	**81 J**	**630**	**98 J**	**490**	**1449**	**9700**
SD13-12	Outfall P1-1 at T(-27.5)	SD13-12-0005	N	0.0	0.5	**270**	**3900**	**530**	**390**	**61000**	**1600**	**7800**	**75220**	**18700**
SD13-16	unbiased	SD13-16-0005	N	0.0	0.5	**180**	**430**	**97**	**670**	**1300**	**860**	**4200**	**7557**	**11300**
SD13-17	Former seep at T(-8.5)	SD13-17-0005	N	0.0	0.5	**450**	**3800**	**220 J**	**8900**	**6300**	**3400**	**69000**	**91620**	**10900**
SD13-21	Unbiased	SD13-21-0005	N	0.0	0.5	**310 J**	**2300**	**74 J**	**2400**	**7000**	**420**	**28000**	**40194**	**8250**
SD13-21	Unbiased	SD13-79-0005	FD	0.0	0.5	**270 J**	**2300**	**120 J**	**3400**	**21000**	**670**	**50000**	**77490**	--
SD13-22	Hot spot at north end of Levin pier	SD13-22-0005	N	0.0	0.5	**170**	**890**	**22 J**	**3100**	**1900**	**200**	**8800**	**14912**	**7150**
SD13-26	Unbiased	SD13-26-0005	N	0.0	0.5	**0.98 J**	**12 J**	**1.9 J**	**72 J**	**38 J**	**30 J**	**280**	**433.9**	**18300**
SD13-30	Unbiased	SD13-30-0005	N	0.0	0.5	**21 J**	**53 J**	**13 J**	**250**	**220**	**360**	**1500**	**2396**	**10700**
SD13-34	Unbiased	SD13-34-0005	N	0.0	0.5	**51**	**86**	**26 J**	**140 J**	**250**	**180**	**610**	**1292**	**17500**
SD13-38	Unbiased	SD13-38-0005	N	0.0	0.5	**68**	**63**	**19 J**	**420**	**140**	**320**	**1400**	**2362**	**12200**
EMB13-01	embankment soil	EMB13-01	N	--	--	**220 J**	**520**	27 U	**110**	**2100 J**	**370 J**	**11000 J**	**14100**	--
EMB13-02	embankment soil	EMB13-02	N	--	--	**170**	**430**	22 U	**650**	**1300**	**500**	**2000**	**4880**	--
EMB13-03	embankment soil	EMB13-03	N	--	--	**350**	**830**	16 U	**820**	**2600**	**1100**	**2700**	**8050**	--
EMB13-04	embankment soil	EMB13-04	N	--	--	**380 J**	**560**	**63**	**1400**	**1600**	**1800**	**5300**	**10723**	--
EMB13-05	embankment soil	EMB13-05	N	--	--	**27**	**74**	13 U	**15 J**	**260**	**88**	**93**	**530**	--

Notes:

Bold values indicate detected result.

Embankment soils collected opportunistically from areas where thin layers of sediment were observed between pieces of rip-rap and shoreline armoring. Sediment depth was not recorded.

Total DDT is the sum of the detected isomers.

FD - field duplicate

N - normal sample

ft - feet

g/g - grams per gram

mg/kg - milligrams per kilogram

µg/kg - micrograms per kilogram

J - estimated value

U - not detected above reporting limit shown

> actual value is greater than result shown

TABLE 3-3

Summary of Pesticide and Total Suspended Solids Results - 2013 Seep Sample

United Heckathorn Superfund Site, Richmond, California

Location ID	Sample Type	Sample ID	Sample Type	Pesticides (µg/L) Dieldrin	2,4-DDD	2,4-DDE	2,4-DDT	4,4-DDD	4,4-DDE	4,4-DDT	Total DDT	Total Suspended Solids (mg/L)
P4-16	Filtered	SD13-P4-16F	N	**0.071 J**	**0.00212**	**0.00026**	**0.0030**	**0.0044**	**0.00436**	**0.00948**	**0.024**	NA
P4-16	Whole water	SD13-P4-16	N	**0.068 J**	**0.00266**	**0.00035 J**	**0.00414**	**0.00586**	**0.00714**	**0.014**	**0.034**	10 U

Notes:

Bold values indicate detected result.

Total DDT is the sum of the detected isomers.

FD - field duplicate

J - estimated value

N - normal sample

ug/L - micrograms per liter

U - not detected above reporting limit shown

TABLE 4-1

1986 Estimates of Groundwater Discharge into the Lauritzen Channel from the Eastern Upland Fill

United Heckathorn Superfund Site, Richmond, California

Sector/Well Pairs	Sector Width (ft)	Saturated Fill Thickness (ft)	Hydraulic Conductivity (cm/sec)	Horizontal Hydraulic Gradient (ft/ft)	Cross Sectional Area of Saturated Fill (ft^2)	Groundwater Seepage Through Saturated Fill (gpd)
Low Tide						
1. B33 to B34	220	0.7	8.3×10^{-4}	0.0550	154	150
2. B29 to B30	330	0.0 [a]	7.3×10^{-4}	Negative [b]	0	0
3. B5A to B11	385	0.7	8.3×10^{-4}	0.0092	270	43
4. B25 to B26	290	0.1	7.3×10^{-4}	0.0065	29	3
5. B24 to B23	130	3.4	7.3×10^{-4}	0.0380	442	260
					Low Tide Total	**456**
High Tide						
1. B33 to B34	220	0.7	8.3×10^{-4}	0.0470	154	130
2. B29 to B30	330	0.0 [a]	7.3×10^{-4}	Negative [b]	0	0
3. B5A to B11	385	0.7	8.3×10^{-4}	0.0092	270	43
4. B25 to B26	290	0.1	7.3×10^{-4}	0.0065	29	3
5. B24 to B23	130	5.1	7.3×10^{-4}	0.0150	663	150
					High Tide Total	**326**

[a] Groundwater within this sector was not present in the fill.

[b] Water-level measurements in wells B29 and B30 indicated groundwater flow away from the channel. This was due to the presence of a sheetpile wall along the embankment.

N**ote:**

Source: HLA (1986)

TABLE 4-2
Groundwater Sample Analytical Data March 2013
United Heckathorn Superfund Site, Richmond, California

Location:		GW13-05	GW13-05	GW13-06	GW13-06	GW13-07	GW13-07	GW13-07	GW13-07	GW13-08	GW13-08	GW13-09	GW13-09	GW13-10	GW13-10	GW13-11	GW13-11
Date:		3/21/2013	3/21/2013	3/21/2013	3/21/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013
Sample Type:		N	N	N	N	N	FD	N	FD	N	N	N	N	N	N	N	N
Basis:		Filtered	Total	Filtered	Total	Filtered	Filtered	Total	Total	Filtered	Total	Filtered	Total	Filtered	Total	Filtered	Total
Parameter	**Units**																
Pesticides																	
2,4-DDD	µg/L	**0.0326**	**1.15 J**	**0.0339**	**1.67 J**	**0.00161 J-**	**0.169 J**	**3.85 J+**	**1.24 J**	**0.00837**	**0.0223 J**	**0.44 J**	**2.06 J**	**0.0691 J**	**0.0944**	**3.6 J**	**8.05 J**
2,4-DDE	µg/L	**0.00326**	**0.231**	**0.00878**	**0.915**	**0.0000763 J**	**0.00264**	**0.149 J**	**0.0422 J**	**0.0000721 J**	**0.000362 J**	**0.00132 J**	**0.0123 J**	**0.00255**	**0.00401 J**	**0.0296 J**	**0.221 J**
2,4-DDT	µg/L	**0.0102**	**1.02 J**	**0.0513**	**6.66 J**	0.0000372 U	**0.000248 J+**	**0.0257 J**	**0.00737 J**	**0.00507**	**0.0254 J**	**0.0146**	**0.171**	**0.324 J**	**0.528 J**	**3.1**	**26.8 J**
4,4-DDD	µg/L	**0.0514**	**2.07 J**	**0.0311**	**1.77 J**	**0.00281 J-**	**0.342 J**	**6.86 J+**	**2.44 J**	**0.0133**	**0.0536**	**1.45 J**	**5.93 J**	**0.111 J**	**0.149**	**4.2 J**	**13.4 J**
4,4-DDE	µg/L	**0.0443**	**3.18 J**	**0.133 J**	**13.4 J**	**0.000958 J-**	**0.0227**	**1.79 J+**	**0.544**	**0.000826**	**0.00593 J**	**0.0132**	**0.151**	**0.0339**	**0.055 J**	**0.24**	**2.87 J**
4,4-DDT	µg/L	**0.0302**	**2.87 J**	**0.168 J**	**19.7 J**	0.0000194 U	**0.000693 J+**	**0.104 J**	**0.0276 J**	**0.006 J+**	**0.172**	**0.053**	**0.835 J**	**0.5 J**	**1.69 J**	**3.44**	**18.3 J**
Dieldrin	µg/L	**0.078 J**	**0.577 J**	**0.206 J**	**1.42 J**	**0.00156 J-**	**0.848 J**	**2.83 J+**	**1.23 J+**	**0.0207**	**0.0305 J**	**0.106**	**0.165**	**1.21 J**	**1.31 J**	**5.75 J**	**0.435 J**
Total DDT	µg/L	**0.172**	**10.5**	**0.426**	**44.1**	**0.00545**	**0.537**	**12.8**	**4.3**	**0.0336**	**0.28**	**1.97**	**9.16**	**1.04**	**2.52**	**14.6**	**69.6**
Volatile Organic Compounds																	
1,1,1-Trichloroethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
1,1,2,2-Tetrachloroethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
1,1,2-Trichloroethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
1,1-Dichloroethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
1,1-Dichloroethene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 UJ	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
1,2,3-Trichlorobenzene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
1,2,4-Trichlorobenzene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
1,2-Dibromo-3-chloropropane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
1,2-Dibromoethane (EDB)	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
1,2-Dichlorobenzene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
1,2-Dichloroethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	**0.58**	---	**8.9 J**	---	**0.18 J**	---	0.5 U	---	0.5 U
1,2-Dichloropropane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
1,3-Dichlorobenzene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	**41 J**	---	0.5 U	---	0.5 U	---	0.5 U
1,4-Dichlorobenzene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	**1.3**
2-Butanone (MEK)	µg/L	---	5 U	---	5 U	---	---	5 U	5 U	---	500 U	---	5 U	---	5 U	---	5 U
2-Hexanone	µg/L	---	5 U	---	5 U	---	---	5 U	5 U	---	500 U	---	5 U	---	5 U	---	5 U
4-Methyl-2-pentanone (MIBK)	µg/L	---	5 U	---	5 U	---	---	5 U	5 U	---	500 U	---	5 U	---	5 U	---	5 U
Acetone	µg/L	---	5 U	---	5 U	---	---	5 U	5 U	---	500 U	---	5 U	---	5 U	---	5 U
Benzene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 UJ	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	**3.4**
Bromochloromethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Bromodichloromethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Bromoform	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Bromomethane	µg/L	---	0.5 U	---	**0.12 J**	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Carbon disulfide	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Carbon tetrachloride	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Chlorobenzene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 UJ	0.5 U	---	**6.3 J**	---	0.5 U	---	0.5 U	---	**3.1**
Chlorodibromomethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Chloroethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Chloroform	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Chloromethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
cis-1,2-Dichloroethene	µg/L	---	**0.11 J**	---	0.5 U	---	---	0.5 U	**1.8**	---	**7,500**	---	**0.61**	---	0.5 U	---	0.5 U
cis-1,3-Dichloropropene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U

TABLE 4-2

Groundwater Sample Analytical Data March 2013

United Heckathorn Superfund Site, Richmond, California

	Location:	GW13-05	GW13-05	GW13-06	GW13-06	GW13-07	GW13-07	GW13-07	GW13-07	GW13-08	GW13-08	GW13-09	GW13-09	GW13-10	GW13-10	GW13-11	GW13-11
	Date:	3/21/2013	3/21/2013	3/21/2013	3/21/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013
	Sample Type:	N	N	N	N	N	FD	N	FD	N	N	N	N	N	N	N	N
	Basis:	Filtered	Total	Filtered	Total	Filtered	Filtered	Total	Total	Filtered	Total	Filtered	Total	Filtered	Total	Filtered	Total
Parameter	**Units**																
Volatile Organic Compounds																	
Cyclohexane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Dichlorodifluoromethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Dichloromethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Ethylbenzene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Isopropylbenzene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
m&p-Xylene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Methyl acetate	µg/L	---	**0.48 J**	---	**0.48 J**	---	---	**0.54**	**0.48 J**	---	50 U	---	**0.5 J**	---	**0.6**	---	**0.48 J**
Methylcyclohexane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
o-Xylene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Styrene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
tert-Butyl methyl ether (MTBE)	µg/L	---	**0.2 J**	---	**0.27 J**	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Tetrachloroethene	µg/L	---	0.5 U	---	**0.12 J**	---	---	0.5 U	**6.7**	---	**84**	---	**0.15 J**	---	0.5 U	---	0.5 U
Toluene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 UJ	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
trans-1,2-Dichloroethene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	**29 J**	---	0.5 U	---	0.5 U	---	0.5 U
trans-1,3-Dichloropropene	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Trichloroethene	µg/L	---	0.5 U	---	**0.19 J**	---	---	0.5 UJ	**9.4**	---	**1,300**	---	**0.16 J**	---	0.5 U	---	0.5 U
Trichlorofluoromethane	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	50 U	---	0.5 U	---	0.5 U	---	0.5 U
Vinyl chloride	µg/L	---	0.5 U	---	0.5 U	---	---	0.5 U	0.5 U	---	**370**	---	0.5 U	---	0.5 U	---	0.5 U
Semivolatile Organic Compounds																	
1,1'-Biphenyl	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2,4,5-Tetrachlorobenzene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,2'-Oxybis(1-chloropropane)	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,3,4,6-Tetrachlorophenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,4,5-Trichlorophenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,4,6-Trichlorophenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,4-Dichlorophenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,4-Dimethylphenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,4-Dinitrophenol	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrotoluene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,6-Dinitrotoluene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2-Chloronaphthalene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2-Chlorophenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2-Methylnaphthalene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2-Methylphenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2-Nitroaniline	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
3,3'-Dichlorobenzidine	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
3-Nitroaniline	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4,6-Dinitro-2-methylphenol	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Bromophenyl phenyl ether	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Chloro-3-methylphenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Chloroaniline	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

TABLE 4-2

Groundwater Sample Analytical Data March 2013

United Heckathorn Superfund Site, Richmond, California

Location:		GW13-05	GW13-05	GW13-06	GW13-06	GW13-07	GW13-07	GW13-07	GW13-07	GW13-08	GW13-08	GW13-09	GW13-09	GW13-10	GW13-10	GW13-11	GW13-11
Date:		3/21/2013	3/21/2013	3/21/2013	3/21/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013
Sample Type:		N	N	N	N	N	FD	N	FD	N	N	N	N	N	N	N	N
Basis:		Filtered	Total	Filtered	Total	Filtered	Filtered	Total	Total	Filtered	Total	Filtered	Total	Filtered	Total	Filtered	Total
Parameter	**Units**																
Semivolatile Organic Compounds																	
4-Chlorophenyl phenyl ether	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Methylphenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Nitroaniline	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Nitrophenol	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Acenaphthalene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acenaphthene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acetophenone	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Anthracene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Atrazine	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzaldehyde	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
benzo(a) anthracene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
benzo(a) pyrene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
benzo(b) fluoranthene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
benzo(g,h,i) perylene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
benzo(k) fluoranthene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bis(2-chloroethoxy)methane	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bis(2-chloroethyl)ether	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
bis(2-ethylhexyl)phthalate	µg/L	5 U	5 U	5 U	**4 J**	**3.1 J**	5 U	**4.1 J**	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Butyl benzyl phthalate	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Caprolactam	µg/L	5 U	5 U	**6.7**	5 U	5 U	**41**	5 U	5 U	**60**	5 U	**72**	5 U	**79**	5 U	**83**	5 U
Carbazole	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chrysene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
dibenzo(a,h) anthracene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibenzofuran	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Diethyl phthalate	µg/L	**5 J**	**4.9 J**	5 U	5 U	**8.8**	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dimethyl phthalate	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Di-n-butyl phthalate	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Di-n-octyl phthalate	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Fluoranthene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Fluorene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Hexachlorobenzene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Hexachlorobutadiene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Hexachlorocyclopentadiene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Hexachloroethane	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
indeno(1,2,3-cd) pyrene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Isophorone	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Naphthalene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Nitrobenzene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
N-Nitroso-di-n-propylamine	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
N-Nitrosodiphenylamine	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Pentachlorophenol	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Phenanthrene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

TABLE 4-2
Groundwater Sample Analytical Data March 2013
United Heckathorn Superfund Site, Richmond, California

	Location:	GW13-05	GW13-05	GW13-06	GW13-06	GW13-07	GW13-07	GW13-07	GW13-07	GW13-08	GW13-08	GW13-09	GW13-09	GW13-10	GW13-10	GW13-11	GW13-11
	Date:	3/21/2013	3/21/2013	3/21/2013	3/21/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013
	Sample Type:	N	N	N	N	N	FD	N	FD	N	N	N	N	N	N	N	N
	Basis:	Filtered	Total	Filtered	Total	Filtered	Filtered	Total	Total	Filtered	Total	Filtered	Total	Filtered	Total	Filtered	Total
Parameter	**Units**																
Semivolatile Organic Compounds																	
Phenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	**8.6**	5 U	5 U	5 U	5 U	5 U	**10**	5 U
Pyrene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

TABLE 4-2

Groundwater Sample Analytical Data March 2013

United Heckathorn Superfund Site, Richmond, California

Location:		GW13-12	GW13-12	GW13-13	GW13-13	GW13-14	GW13-14	MW13-01	MW13-01	MW13-03	MW13-03
Date:		3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/25/2013	3/25/2013	3/25/2013	3/25/2013
Sample Type:		N	N	N	N	N	N	N	N	N	N
Basis:		Filtered	Total	Filtered	Total	Filtered	Total	Filtered	Total	Filtered	Total
Parameter	**Units**										
Pesticides											
2,4-DDD	µg/L	**0.0142**	**0.0284 J**	**0.0173**	**0.113**	**0.0033**	**0.00529 J**	**0.0541 J**	**0.075 J**	**0.0163**	**0.0202**
2,4-DDE	µg/L	**0.0000878 J**	**0.00036 J**	**0.000122 J**	**0.00215 J**	**0.000138 J**	**0.000239 J**	**0.000213 J**	**0.000447 J**	**0.000121 J**	**0.000326 J**
2,4-DDT	µg/L	**0.00773**	**0.03 J**	**0.0119**	**0.322**	**0.0306**	**0.127**	**0.00299 J**	**0.00737 J**	**0.00884 J**	**0.024**
4,4-DDD	µg/L	**0.0348 J**	**0.0695 J**	**0.0435 J**	**0.366 J**	**0.00984**	**0.0173 J**	**0.118**	**0.171**	**0.0244**	**0.0503 J**
4,4-DDE	µg/L	**0.000698**	**0.00394**	**0.00113**	**0.0358 J**	**0.00221**	**0.00426 J**	**0.00156 J**	**0.00431 J**	**0.00136 J**	**0.00499 J**
4,4-DDT	µg/L	**0.0331**	**0.143 J**	**0.0484**	**2.47 J**	**0.107 J**	**0.441**	**0.00715 J+**	**0.0379**	**0.0194**	**0.165 J**
Dieldrin	µg/L	**0.0876 J**	**0.0765 J**	**0.00876**	**0.0684**	**0.00165**	**0.00124 J**	**0.165**	**0.163**	**0.0656 J**	**0.0612 J**
Total DDT	µg/L	**0.0906**	**0.275**	**0.122**	**3.31**	**0.153**	**0.595**	**0.184013**	**0.296027**	**0.070421**	**0.264816**
Volatile Organic Compounds											
1,1,1-Trichloroethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,1,2,2-Tetrachloroethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,1,2-Trichloroethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,1-Dichloroethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,1-Dichloroethene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,2,3-Trichlorobenzene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,2,4-Trichlorobenzene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,2-Dibromo-3-chloropropane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,2-Dibromoethane (EDB)	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,2-Dichlorobenzene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,2-Dichloroethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,2-Dichloropropane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,3-Dichlorobenzene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
1,4-Dichlorobenzene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
2-Butanone (MEK)	µg/L	---	5 U	---	5 U	---	5 U	---	5 U	---	5 U
2-Hexanone	µg/L	---	5 U	---	5 U	---	5 U	---	5 U	---	5 U
4-Methyl-2-pentanone (MIBK)	µg/L	---	5 U	---	5 U	---	5 U	---	5 U	---	5 U
Acetone	µg/L	---	5 U	---	5 U	---	5 U	---	5 U	---	5 U
Benzene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Bromochloromethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Bromodichloromethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Bromoform	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	**0.15 J**	---	0.5 U
Bromomethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Carbon disulfide	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Carbon tetrachloride	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Chlorobenzene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Chlorodibromomethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	**0.16 J**	---	**0.07 J**
Chloroethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Chloroform	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Chloromethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
cis-1,2-Dichloroethene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
cis-1,3-Dichloropropene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U

TABLE 4-2

Groundwater Sample Analytical Data March 2013

United Heckathorn Superfund Site, Richmond, California

	Location:	GW13-12	GW13-12	GW13-13	GW13-13	GW13-14	GW13-14	MW13-01	MW13-01	MW13-03	MW13-03
	Date:	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/25/2013	3/25/2013	3/25/2013	3/25/2013
	Sample Type:	N	N	N	N	N	N	N	N	N	N
	Basis:	Filtered	Total	Filtered	Total	Filtered	Total	Filtered	Total	Filtered	Total
Parameter	**Units**										
Volatile Organic Compounds											
Cyclohexane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Dichlorodifluoromethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Dichloromethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Ethylbenzene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Isopropylbenzene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
m&p-Xylene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Methyl acetate	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	**0.86**	---	**0.84**
Methylcyclohexane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
o-Xylene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Styrene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
tert-Butyl methyl ether (MTBE)	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	**0.08 J**	---	0.5 U
Tetrachloroethene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Toluene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
trans-1,2-Dichloroethene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
trans-1,3-Dichloropropene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Trichloroethene	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Trichlorofluoromethane	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Vinyl chloride	µg/L	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U	---	0.5 U
Semivolatile Organic Compounds											
1,1'-Biphenyl	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2,4,5-Tetrachlorobenzene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,2'-Oxybis(1-chloropropane)	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,3,4,6-Tetrachlorophenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,4,5-Trichlorophenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,4,6-Trichlorophenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,4-Dichlorophenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,4-Dimethylphenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,4-Dinitrophenol	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,4-Dinitrotoluene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,6-Dinitrotoluene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2-Chloronaphthalene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2-Chlorophenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ
2-Methylnaphthalene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2-Methylphenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2-Nitroaniline	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Nitrophenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
3,3'-Dichlorobenzidine	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
3-Nitroaniline	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4,6-Dinitro-2-methylphenol	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Bromophenyl phenyl ether	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Chloro-3-methylphenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Chloroaniline	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

TABLE 4-2
Groundwater Sample Analytical Data March 2013
United Heckathorn Superfund Site, Richmond, California

Location:		GW13-12	GW13-12	GW13-13	GW13-13	GW13-14	GW13-14	MW13-01	MW13-01	MW13-03	MW13-03
Date:		3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/25/2013	3/25/2013	3/25/2013	3/25/2013
Sample Type:		N	N	N	N	N	N	N	N	N	N
Basis:		Filtered	Total	Filtered	Total	Filtered	Total	Filtered	Total	Filtered	Total
Parameter	**Units**										
Semivolatile Organic Compounds											
4-Chlorophenyl phenyl ether	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Methylphenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Nitroaniline	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Nitrophenol	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Acenaphthalene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acenaphthene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acetophenone	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Anthracene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Atrazine	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzaldehyde	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
benzo(a) anthracene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
benzo(a) pyrene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
benzo(b) fluoranthene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
benzo(g,h,i) perylene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
benzo(k) fluoranthene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bis(2-chloroethoxy)methane	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bis(2-chloroethyl)ether	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
bis(2-ethylhexyl)phthalate	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	**3.2 J**	5 U	5 U	5 U
Butyl benzyl phthalate	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Caprolactam	µg/L	**65**	5 U	**74**	5 U	**33**	5 U	5 U	5 U	5 U	5 U
Carbazole	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chrysene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
dibenzo(a,h) anthracene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibenzofuran	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Diethyl phthalate	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dimethyl phthalate	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Di-n-butyl phthalate	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Di-n-octyl phthalate	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Fluoranthene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Fluorene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Hexachlorobenzene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Hexachlorobutadiene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Hexachlorocyclopentadiene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Hexachloroethane	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
indeno(1,2,3-cd) pyrene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Isophorone	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Naphthalene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Nitrobenzene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
N-Nitroso-di-n-propylamine	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
N-Nitrosodiphenylamine	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Pentachlorophenol	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Phenanthrene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

TABLE 4-2
Groundwater Sample Analytical Data March 2013
United Heckathorn Superfund Site, Richmond, California

	Location:	GW13-12	GW13-12	GW13-13	GW13-13	GW13-14	GW13-14	MW13-01	MW13-01	MW13-03	MW13-03
	Date:	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/22/2013	3/25/2013	3/25/2013	3/25/2013	3/25/2013
	Sample Type:	N	N	N	N	N	N	N	N	N	N
	Basis:	Filtered	Total	Filtered	Total	Filtered	Total	Filtered	Total	Filtered	Total
Parameter	**Units**										
Semivolatile Organic Compounds											
Phenol	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Pyrene	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

Notes:

Detected results are bolded
--= not analyzed
FD = field duplicate
J = Concentration or reporting limit estimated by laboratory or data validation.
J- = Concentration or reporting limit estimated by laboratory or data validation, biased low
J+ =Concentration or reporting limit estimated by laboratory or data validation, biased high
mg/L = milligrams per liter
N = primary sample
U = Not detected at listed reporting limit
µg/L = micrograms per liter

TABLE 4-3

Statistical Summary of Analytical Results for Groundwater Samples, March 2013

United Heckathorn Superfund Site, Richmond, California

Analyte	Units	Range of NonDetect RLs	Minimum Detect	Maximum Detect	Average Result	Number of Detects	Number of Samples	Location of Maximum Detect
Dissolved Pesticides								
2,4-DDD	µg/L	--	0.0033	3.6 J	0.372	12	12	GW13-11
2,4-DDE	µg/L	--	0.0000721 J	0.0296 J	0.00408	12	12	GW13-11
2,4-DDT	µg/L	--	0.000248 J+	3.1	0.297	12	12	GW13-11
4,4-DDD	µg/L	--	0.00984	4.2 J	0.536	12	12	GW13-11
4,4-DDE	µg/L	--	0.000698	0.24	0.0412	12	12	GW13-11
4,4-DDT	µg/L	--	0.000693 J+	3.44	0.368	12	12	GW13-11
Dieldrin	µg/L	--	0.00165	5.75 J	0.712	12	12	GW13-11
Total DDT	µg/L	--	0.0336	14.6	1.62	12	12	GW13-11
Total Pesticides								
2,4-DDD	µg/L	--	0.00529 J	8.05 J	1.43	12	12	GW13-11
2,4-DDE	µg/L	--	0.000239 J	0.915	0.128	12	12	GW13-06
2,4-DDT	µg/L	--	0.00737 J	26.8 J	2.98	12	12	GW13-11
4,4-DDD	µg/L	--	0.0173 J	13.4 J	2.58	12	12	GW13-11
4,4-DDE	µg/L	--	0.00394	13.4 J	1.79	12	12	GW13-06
4,4-DDT	µg/L	--	0.0379	19.7 J	3.91	12	12	GW13-06
Dieldrin	µg/L	--	0.00124 J	2.83 J+	0.595	12	12	GW13-07
Total DDT	µg/L	--	0.264816	69.6	12.8	12	12	GW13-11
Total Volatile Organic Compounds								
1,1,1-Trichloroethane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
1,1,2,2-Tetrachloroethane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
1,1,2-Trichloro-1,2,2-trifluoroethane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
1,1,2-Trichloroethane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
1,1-Dichloroethane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
1,1-Dichloroethene	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
1,2,3-Trichlorobenzene	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
1,2,4-Trichlorobenzene	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
1,2-Dibromo-3-chloropropane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
1,2-Dibromoethane (EDB)	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
1,2-Dichlorobenzene	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
1,2-Dichloroethane	µg/L	0.5 U	0.18 J	8.9 J	0.805	3	12	GW13-08
1,2-Dichloropropane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
1,3-Dichlorobenzene	µg/L	0.5 U	41 J	41 J	3.42	1	12	GW13-08
1,4-Dichlorobenzene	µg/L	0.5 U - 50 U	1.3	1.3	0.108	1	12	GW13-11
2-Butanone (MEK)	µg/L	5 U - 500 U	--	--	--	0	12	NA

TABLE 4-3

Statistical Summary of Analytical Results for Groundwater Samples, March 2013

United Heckathorn Superfund Site, Richmond, California

Analyte	Units	Range of NonDetect RLs	Minimum Detect	Maximum Detect	Average Result	Number of Detects	Number of Samples	Location of Maximum Detect
Total Volatile Organic Compounds								
2-Hexanone	µg/L	5 U - 500 U	--	--	--	0	12	NA
4-Methyl-2-pentanone (MIBK)	µg/L	5 U - 500 U	--	--	--	0	12	NA
Acetone	µg/L	5 U - 500 U	--	--	--	0	12	NA
Benzene	µg/L	0.5 U - 50 U	3.4	3.4	0.283	1	12	GW13-11
Bromochloromethane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Bromodichloromethane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Bromoform	µg/L	0.5 U - 50 U	0.15 J	0.15 J	0.0125	1	12	MW13-01
Bromomethane	µg/L	0.5 U - 50 U	0.12 J	0.12 J	0.01	1	12	GW13-06
Carbon disulfide	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Carbon tetrachloride	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Chlorobenzene	µg/L	0.5 U	3.1	6.3 J	0.783	2	12	GW13-08
Chlorodibromomethane	µg/L	0.5 U - 50 U	0.07 J	0.16 J	0.0192	2	12	MW13-01
Chloroethane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Chloroform	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Chloromethane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
cis-1,2-Dichloroethene	µg/L	0.5 U	0.11 J	7,500	625	4	12	GW13-08
cis-1,3-Dichloropropene	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Cyclohexane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Dichlorodifluoromethane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Dichloromethane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Ethylbenzene	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Isopropylbenzene	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
m&p-Xylene	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Methyl acetate	µg/L	0.5 U - 50 U	0.48 J	0.86	0.398	8	12	MW13-01
Methylcyclohexane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
o-Xylene	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Styrene	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
tert-Butyl methyl ether (MTBE)	µg/L	0.5 U - 50 U	0.08 J	0.27 J	0.0458	3	12	GW13-06
Tetrachloroethene	µg/L	0.5 U	0.12 J	84	7.58	4	12	GW13-08
Toluene	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
trans-1,2-Dichloroethene	µg/L	0.5 U	29 J	29 J	2.42	1	12	GW13-08
trans-1,3-Dichloropropene	µg/L	0.5 U - 50 U	--	--	--	0	12	NA
Trichloroethene	µg/L	0.5 U	0.16 J	1,300	109	4	12	GW13-08
Trichlorofluoromethane	µg/L	0.5 U - 50 U	--	--	--	0	12	NA

TABLE 4-3

Statistical Summary of Analytical Results for Groundwater Samples, March 2013

United Heckathorn Superfund Site, Richmond, California

Analyte	Units	Range of NonDetect RLs	Minimum Detect	Maximum Detect	Average Result	Number of Detects	Number of Samples	Location of Maximum Detect
Total Volatile Organic Compounds								
Vinyl chloride	µg/L	0.5 U	370	370	30.8	1	12	GW13-08
Dissolved Semivolatile Organic Compounds								
1,1'-Biphenyl	µg/L	5 U	--	--	--	0	12	NA
1,2,4,5-Tetrachlorobenzene	µg/L	5 U	--	--	--	0	12	NA
2,2'-Oxybis(1-chloropropane)	µg/L	5 U	--	--	--	0	12	NA
2,3,4,6-Tetrachlorophenol	µg/L	5 U	--	--	--	0	12	NA
2,4,5-Trichlorophenol	µg/L	5 U	--	--	--	0	12	NA
2,4,6-Trichlorophenol	µg/L	5 U	--	--	--	0	12	NA
2,4-Dichlorophenol	µg/L	5 U	--	--	--	0	12	NA
2,4-Dimethylphenol	µg/L	5 U	--	--	--	0	12	NA
2,4-Dinitrophenol	µg/L	10 U	--	--	--	0	12	NA
2,4-Dinitrotoluene	µg/L	5 U	--	--	--	0	12	NA
2,6-Dinitrotoluene	µg/L	5 U	--	--	--	0	12	NA
2-Chloronaphthalene	µg/L	5 U	--	--	--	0	12	NA
2-Chlorophenol	µg/L	5 U	--	--	--	0	12	NA
2-Methylnaphthalene	µg/L	5 U	--	--	--	0	12	NA
2-Methylphenol	µg/L	5 U	--	--	--	0	12	NA
2-Nitroaniline	µg/L	10 U	--	--	--	0	12	NA
2-Nitrophenol	µg/L	5 U	--	--	--	0	12	NA
3,3'-Dichlorobenzidine	µg/L	5 U	--	--	--	0	12	NA
3-Nitroaniline	µg/L	10 U	--	--	--	0	12	NA
4,6-Dinitro-2-methylphenol	µg/L	10 U	--	--	--	0	12	NA
4-Bromophenyl phenyl ether	µg/L	5 U	--	--	--	0	12	NA
4-Chloro-3-methylphenol	µg/L	5 U	--	--	--	0	12	NA
4-Chloroaniline	µg/L	5 U	--	--	--	0	12	NA
4-Chlorophenyl phenyl ether	µg/L	5 U	--	--	--	0	12	NA
4-Methylphenol	µg/L	5 U	--	--	--	0	12	NA
4-Nitroaniline	µg/L	10 U	--	--	--	0	12	NA
4-Nitrophenol	µg/L	10 U	--	--	--	0	12	NA
Acenaphthalene	µg/L	5 U	--	--	--	0	12	NA
Acenaphthene	µg/L	5 U	--	--	--	0	12	NA
Acetophenone	µg/L	5 U	--	--	--	0	12	NA
Anthracene	µg/L	5 U	--	--	--	0	12	NA
Atrazine	µg/L	5 U	--	--	--	0	12	NA

TABLE 4-3

Statistical Summary of Analytical Results for Groundwater Samples, March 2013

United Heckathorn Superfund Site, Richmond, California

Analyte	Units	Range of NonDetect RLs	Minimum Detect	Maximum Detect	Average Result	Number of Detects	Number of Samples	Location of Maximum Detect
Dissolved Semivolatile Organic Compounds								
Benzaldehyde	µg/L	5 U	--	--	--	0	12	NA
benzo(a) anthracene	µg/L	5 U	--	--	--	0	12	NA
benzo(a) pyrene	µg/L	5 U	--	--	--	0	12	NA
benzo(b) fluoranthene	µg/L	5 U	--	--	--	0	12	NA
benzo(g,h,i) perylene	µg/L	5 U	--	--	--	0	12	NA
benzo(k) fluoranthene	µg/L	5 U	--	--	--	0	12	NA
Bis(2-chloroethoxy)methane	µg/L	5 U	--	--	--	0	12	NA
Bis(2-chloroethyl)ether	µg/L	5 U	--	--	--	0	12	NA
bis(2-ethylhexyl)phthalate	µg/L	5 U	3.1 J	3.2 J	0.525	2	12	MW13-01
Butyl benzyl phthalate	µg/L	5 U	--	--	--	0	12	NA
Caprolactam	µg/L	5 U	6.7	83	42.8	9	12	GW13-11
Carbazole	µg/L	5 U	--	--	--	0	12	NA
Chrysene	µg/L	5 U	--	--	--	0	12	NA
dibenzo(a,h) anthracene	µg/L	5 U	--	--	--	0	12	NA
Dibenzofuran	µg/L	5 U	--	--	--	0	12	NA
Diethyl phthalate	µg/L	5 U	5 J	8.8	1.15	2	12	GW13-07
Dimethyl phthalate	µg/L	5 U	--	--	--	0	12	NA
Di-n-butyl phthalate	µg/L	5 U	--	--	--	0	12	NA
Di-n-octyl phthalate	µg/L	5 U	--	--	--	0	12	NA
Fluoranthene	µg/L	5 U	--	--	--	0	12	NA
Fluorene	µg/L	5 U	--	--	--	0	12	NA
Hexachlorobenzene	µg/L	5 U	--	--	--	0	12	NA
Hexachlorobutadiene	µg/L	5 U	--	--	--	0	12	NA
Hexachlorocyclopentadiene	µg/L	5 U	--	--	--	0	12	NA
Hexachloroethane	µg/L	5 U	--	--	--	0	12	NA
indeno(1,2,3-cd) pyrene	µg/L	5 U	--	--	--	0	12	NA
Isophorone	µg/L	5 U	--	--	--	0	12	NA
Naphthalene	µg/L	5 U	--	--	--	0	12	NA
Nitrobenzene	µg/L	5 U	--	--	--	0	12	NA
N-Nitroso-di-n-propylamine	µg/L	5 U	--	--	--	0	12	NA
N-Nitrosodiphenylamine	µg/L	5 U	--	--	--	0	12	NA
Pentachlorophenol	µg/L	10 U	--	--	--	0	12	NA
Phenanthrene	µg/L	5 U	--	--	--	0	12	NA
Phenol	µg/L	5 U	8.6	10	1.55	2	12	GW13-11

TABLE 4-3

Statistical Summary of Analytical Results for Groundwater Samples, March 2013

United Heckathorn Superfund Site, Richmond, California

Analyte	Units	Range of NonDetect RLs	Minimum Detect	Maximum Detect	Average Result	Number of Detects	Number of Samples	Location of Maximum Detect
Dissolved Semivolatile Organic Compounds								
Pyrene	µg/L	5 U	--	--	--	0	12	NA
Total Semivolatile Organic Compounds								
1,1'-Biphenyl	µg/L	5 U	--	--	--	0	12	NA
1,2,4,5-Tetrachlorobenzene	µg/L	5 U	--	--	--	0	12	NA
2,2'-Oxybis(1-chloropropane)	µg/L	5 U	--	--	--	0	12	NA
2,3,4,6-Tetrachlorophenol	µg/L	5 U	--	--	--	0	12	NA
2,4,5-Trichlorophenol	µg/L	5 U	--	--	--	0	12	NA
2,4,6-Trichlorophenol	µg/L	5 U	--	--	--	0	12	NA
2,4-Dichlorophenol	µg/L	5 U	--	--	--	0	12	NA
2,4-Dimethylphenol	µg/L	5 U	--	--	--	0	12	NA
2,4-Dinitrophenol	µg/L	10 U	--	--	--	0	12	NA
2,4-Dinitrotoluene	µg/L	5 U	--	--	--	0	12	NA
2,6-Dinitrotoluene	µg/L	5 U	--	--	--	0	12	NA
2-Chloronaphthalene	µg/L	5 U	--	--	--	0	12	NA
2-Chlorophenol	µg/L	5 U	--	--	--	0	12	NA
2-Methylnaphthalene	µg/L	5 U	--	--	--	0	12	NA
2-Methylphenol	µg/L	5 U	--	--	--	0	12	NA
2-Nitroaniline	µg/L	10 U	--	--	--	0	12	NA
2-Nitrophenol	µg/L	5 U	--	--	--	0	12	NA
3,3'-Dichlorobenzidine	µg/L	5 U	--	--	--	0	12	NA
3-Nitroaniline	µg/L	10 U	--	--	--	0	12	NA
4,6-Dinitro-2-methylphenol	µg/L	10 U	--	--	--	0	12	NA
4-Bromophenyl phenyl ether	µg/L	5 U	--	--	--	0	12	NA
4-Chloro-3-methylphenol	µg/L	5 U	--	--	--	0	12	NA
4-Chloroaniline	µg/L	5 U	--	--	--	0	12	NA
4-Chlorophenyl phenyl ether	µg/L	5 U	--	--	--	0	12	NA
4-Methylphenol	µg/L	5 U	--	--	--	0	12	NA
4-Nitroaniline	µg/L	10 U	--	--	--	0	12	NA
4-Nitrophenol	µg/L	10 U	--	--	--	0	12	NA
Acenaphthalene	µg/L	5 U	--	--	--	0	12	NA
Acenaphthene	µg/L	5 U	--	--	--	0	12	NA
Acetophenone	µg/L	5 U	--	--	--	0	12	NA
Anthracene	µg/L	5 U	--	--	--	0	12	NA
Atrazine	µg/L	5 U	--	--	--	0	12	NA

TABLE 4-3

Statistical Summary of Analytical Results for Groundwater Samples, March 2013

United Heckathorn Superfund Site, Richmond, California

Analyte	Units	Range of NonDetect RLs	Minimum Detect	Maximum Detect	Average Result	Number of Detects	Number of Samples	Location of Maximum Detect
Total Semivolatile Organic Compounds								
Benzaldehyde	µg/L	5 U	--	--	--	0	12	NA
benzo(a) anthracene	µg/L	5 U	--	--	--	0	12	NA
benzo(a) pyrene	µg/L	5 U	--	--	--	0	12	NA
benzo(b) fluoranthene	µg/L	5 U	--	--	--	0	12	NA
benzo(g,h,i) perylene	µg/L	5 U	--	--	--	0	12	NA
benzo(k) fluoranthene	µg/L	5 U	--	--	--	0	12	NA
Bis(2-chloroethoxy)methane	µg/L	5 U	--	--	--	0	12	NA
Bis(2-chloroethyl)ether	µg/L	5 U	--	--	--	0	12	NA
bis(2-ethylhexyl)phthalate	µg/L	5 U	4 J	4.1 J	0.675	2	12	GW13-07
Butyl benzyl phthalate	µg/L	5 U	--	--	--	0	12	NA
Caprolactam	µg/L	5 U	--	--	--	0	12	NA
Carbazole	µg/L	5 U	--	--	--	0	12	NA
Chrysene	µg/L	5 U	--	--	--	0	12	NA
dibenzo(a,h) anthracene	µg/L	5 U	--	--	--	0	12	NA
Dibenzofuran	µg/L	5 U	--	--	--	0	12	NA
Diethyl phthalate	µg/L	5 U	4.9 J	4.9 J	0.408	1	12	GW13-05
Dimethyl phthalate	µg/L	5 U	--	--	--	0	12	NA
Di-n-butyl phthalate	µg/L	5 U	--	--	--	0	12	NA
Di-n-octyl phthalate	µg/L	5 U	--	--	--	0	12	NA
Fluoranthene	µg/L	5 U	--	--	--	0	12	NA
Fluorene	µg/L	5 U	--	--	--	0	12	NA
Hexachlorobenzene	µg/L	5 U	--	--	--	0	12	NA
Hexachlorobutadiene	µg/L	5 U	--	--	--	0	12	NA
Hexachlorocyclopentadiene	µg/L	5 U	--	--	--	0	12	NA
Hexachloroethane	µg/L	5 U	--	--	--	0	12	NA
indeno(1,2,3-cd) pyrene	µg/L	5 U	--	--	--	0	12	NA
Isophorone	µg/L	5 U	--	--	--	0	12	NA
Naphthalene	µg/L	5 U	--	--	--	0	12	NA
Nitrobenzene	µg/L	5 U	--	--	--	0	12	NA
N-Nitroso-di-n-propylamine	µg/L	5 U	--	--	--	0	12	NA
N-Nitrosodiphenylamine	µg/L	5 U	--	--	--	0	12	NA
Pentachlorophenol	µg/L	10 U	--	--	--	0	12	NA
Phenanthrene	µg/L	5 U	--	--	--	0	12	NA
Phenol	µg/L	5 U	--	--	--	0	12	NA

TABLE 4-3
Statistical Summary of Analytical Results for Groundwater Samples, March 2013
United Heckathorn Superfund Site, Richmond, California

Analyte	Units	Range of NonDetect RLs	Minimum Detect	Maximum Detect	Average Result	Number of Detects	Number of Samples	Location of Maximum Detect
Total Semivolatile Organic Compounds								
Pyrene	µg/L	5 U	--	--	--	0	12	NA

Notes:

Average concentrations reported at 3 significant figures. Zero was used for nondetect results.
J = Concentration or reporting limit estimated by laboratory or data validation.
J- = Concentration or reporting limit estimated by laboratory or data validation, biased low
J+ =Concentration or reporting limit estimated by laboratory or data validation, biased high
NA= Not applicable
NE = Not established
U = Not detected at listed reporting limit
µg/L = micrograms per liter

TABLE 4-4

Summary of Hydraulic Conductivity Estimates

United Heckathorn Superfund Site, Richmond, California

Location	Hydraulic Conductivity (cm/sec)	Lithology in Well Screen Interval	Source
Between B33 and B34	8.3×10^{-4} [a]	Fill and Upper Bay Mud	HLA (1986)
Between B29 and B30	7.3×10^{-4} [a]	Fill and Upper Bay Mud	HLA (1986)
Between B5A and B11	8.3×10^{-4} [a]	Fill and Upper Bay Mud	HLA (1986)
Between B25 and B26	7.3×10^{-4} [a]	Fill and Upper Bay Mud	HLA (1986)
Between B24 and B23	7.3×10^{-4} [a]	Fill and Upper Bay Mud	HLA (1986)
MW13-01 (slug in)	7.5×10^{-5}	Upper Bay Mud	CH2M HILL
MW13-01 (slug out)	6.1×10^{-5}	Upper Bay Mud	CH2M HILL
MW13-02 (slug in)	4.3×10^{-4}	Upper Bay Mud	CH2M HILL
MW13-02 (slug out)	8.9×10^{-5}	Upper Bay Mud	CH2M HILL
MW13-03 (slug in)	3.2×10^{-4}	Upper Bay Mud	CH2M HILL
MW13-03 (slug out)	2.5×10^{-4}	Upper Bay Mud	CH2M HILL
MW13-04 (slug in)	2.5×10^{-4}	Upper Bay Mud	CH2M HILL
MW13-04 (slug out)	1.4×10^{-4}	Upper Bay Mud	CH2M HILL

[a] Value also listed in Table 4-1.

Note:

The geometric mean of the hydraulic conductivity values is 2.96×10^{-4} cm/sec.

TABLE 4-5
2013 Tidal Study Summary Statistics
United Heckathorn Superfund Site, Richmond, California

Monitoring Location	Minimum Water Level (ft NAVD88)	Mean Water Level (ft NAVD88) [a]	Maximum Water Level (ft NAVD88)
Stilling Well (Lauritzen Channel)	-0.86	2.62	5.85
MW13-01	2.16	3.49	5.01
MW13-02	2.39	3.36	4.37
MW13-03	0.07	3.14	6.05
MW13-04	1.60	3.65	5.69

[a] Computed using the tidal filtering method described in Serfes (1991).
Note:
Values are representative of the processed water levels for the first 71 hours of the tidal study.
Hourly water level data are tabulated in Appendix A.

TABLE 4-6

Parameters and Results Associated with the Groundwater Discharge and DDT Mass Flux Evaluation

United Heckathorn Superfund Site, Richmond, California

Parameter	Estimate	Units	Comments
Hydraulic Conductivity, K	2.96×10^{-4}	cm/sec	Estimate represents the geometric mean of the K values published by HLA (1986) and estimated by CH2M HILL. These K values are listed in Table 4-4.
Hydraulic Gradient, i	4.80×10^{-3} 0 to 0.016 [a]	foot/foot	Estimate of 4.8×10^{-3} foot/foot represents the hydraulic gradient computed using the mean groundwater levels at MW13-04 and MW13-03 during the 2013 tidal study. Hydraulic gradients toward the channel from this well pair were used because they were larger than those estimated using the MW13-02 and MW13-01 well pair groundwater levels. MW13-04 and MW13-03 are spaced 105.4 feet apart. Time-varying hydraulic gradients between these well pairs toward the channel were also computed using the water-level data collected at 5-minute intervals during the 2013 tidal study. Time-varying landward hydraulic gradient values were replaced with a value of zero, given that DDT would not discharge to the channel during periods of landward flow.
Saturated Thickness of Freshwater-bearing Sediments [b]	32	feet	Value represents the thickness of the freshwater-bearing sediments according to the Ghyben-Herzberg relation. This relation indicates that the freshwater-seawater interface occurs below the water table of an unconfined coastal aquifer by 41 times the water table height above the sea level (Freeze and Cherry, 1979). The mean sea level in Lauritzen Channel was 2.62 feet NAVD88 during the tidal study and the average of the mean groundwater levels of the four monitoring wells is 3.41 feet NAVD88 (Table 4-5). Subtracting 2.62 feet from 3.41 feet yields an average water level height above the mean sea level of 0.79 feet. Thus, 41 times 0.79 feet yields a depth to the freshwater-seawater interface of approximately 32 feet.
Transmissivity, T [b]	27	ft^2/day	Product of the hydraulic conductivity and saturated thickness.
Length of Eastern Lauritzen Channel Shoreline, w [b]	1,500	feet	Approximate length of shoreline between GW13-06 and GW13-14 (Figure 2-2).
Volumetric Groundwater Discharge to Lauritzen Channel from the Eastern Upland Area, Q [b]	4 0 to 13 [a]	L/min	Computed via Darcy's Law using the transmissivity, hydraulic gradient, and length of shoreline. Groundwater discharge is assumed to occur perpendicular to the shoreline. This value is much higher than the estimates provided in Table 4-1 because HLA only considered the discharge from the saturated fill. Time-varying groundwater discharge rates to the channel using time-varying hydraulic gradients between the well pairs were also computed using the water-level data collected at 5-minute intervals during the 2013 tidal study.
Unfiltered Total DDT Concentration, C	69.6	µg/L	Value represents the maximum unfiltered concentration detected during the March 2013 monitoring event (see GW13-11 data in Table 4-2).

TABLE 4-6

Parameters and Results Associated with the Groundwater Discharge and DDT Mass Flux Evaluation

United Heckathorn Superfund Site, Richmond, California

Parameter	Estimate	Units	Comments
Annual Total DDT Mass Flux to Lauritzen Channel from the Eastern Upland Fill, AMF [b]	146 167 [a]	g/yr	Product of the volumetric groundwater discharge and the unfiltered total DDT concentration. Alternatively, time-varying mass fluxes of total DDT were computed for 5-minute intervals during the 2013 tidal study using the time varying groundwater discharge rates between the well pairs, and summed to estimate the total flux over the 3-day tidal study period. The total DDT mass flux for the 3-day 2013 tidal study was then multiplied by a factor of 365.25 ÷ 3 to estimate the annual total DDT mass flux.

[a] Hydraulic gradients and volumetric groundwater discharge to Lauritzen Channel were also computed using tidal study data at 5-minute intervals to account for time-varying hydraulic gradients during the 2013 tidal study.

[b] Value rounded to the nearest whole number.

Notes:

cm/sec = centimeters per second

ft^2/day = square feet per day

L/min = liters per minute

µg/L = micrograms per liter

g/yr = grams per year

TABLE 5-1

Summary of Analytical Results for Creosote-Treated Wood from Pilings

United Heckathorn Superfund Site, Richmond, California

	Concentrations in µg/kg dry weight					
Location	**Total DDT**	**Dieldrin**	**DDE**	**DDD**	**DDT**	**Aroclor 1254**
CR-30	200530	24100	14100	185000	1430	316 U
CR-31	63200	26700	4710	55900	2590	316 U
CR-32	50340	10200	3270	45700	1370	316 U
CR-33	1720	22.6 U	15.8 U	1720	80.7 U	316 U
CR-34	155350	6850	8880	145000	1470	316 U
CR-35	NA	NA	NA	NA	NA	NA

Notes:

Data from Kohn, N.P. and T.J. Gilmore. 2001 *Field Investigation to Determine the Extent of Sediment Recontamination at the United Heckathorn Superfund Site, Richmond, California.* November. PNNL-13730

NA - Sample not analyzed, field immunoassay results indicated that CR-35 was similar to CR-33.

U - parameter not detected above the reporting limit shown

µg/kg - micrograms per kilogram (part per billion)

TABLE 6-1

Summary of Storm Drain Sediment Analytical Results

United Heckathorn Superfund Site, Richmond, California

Location	A-4	B-1	B-3	LC-05	LC-06	SSWL01	SSWL02	SSWL03	SSWL03	SSWP02
SampleID	A-4_09152008	B-1_09152008	B-3_09152008	LC-05-0609	LC-06-0609	SSWL01	SSWL02	SSWL03	SSWL03_09152008	SSWP02
Matrix	Sed	Sed	Sed	Sed	Sed	Sed	Sed	Sed	Sed	Sed
Sample Date	9/15/2008	9/15/2008	9/15/2008	6/26/2009	6/26/2009	7/15/2008	7/15/2008	7/15/2008	9/15/2008	7/15/2008
Sample Type	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Parameter (µg/kg dry weight)										
Dieldrin	**70**	13 U	**150**	**26 J**	2.2 UJ	20 U	21 U	**680**	**640**	23 U
2,4-DDD	**310**	13 U	**170**	**52 J**	2.2 UJ	20 U	21 U	**6100**	**9500**	23 U
2,4-DDE	25 U	13 U	25 U	3.4 UJ	**4.1 J**	20 U	21 U	25 U	21 U	23 U
2,4-DDT	25 U	13 U	25 U	**3.5 J**	2.2 UJ	20 U	21 U	**1100**	**1000**	23 U
4,4-DDD	**1300**	13 U	**580**	**130**	2.2 UJ	20 U	21 U	**21000**	**29000**	23 U
4,4-DDE	**470**	13 U	**210**	**70 J**	2.2 UJ	20 U	21 U	**4300**	**7000**	23 U
4,4-DDT	**120**	**17 J**	**110**	**18 J**	**4.2 J**	20 U	21 U	**6000**	**5600**	23 U
Total DDT	**2200**	**17**	**1070**	**273.5**	**8.3**	ND	ND	**38500**	**52100**	ND

Notes:

J - estimated value

ND - not detected

U - not detected above analytical reporting limit shown

TABLE 7-1

Sediment Chemistry Data Collected by SF USACE - Richmond Inner Harbor

United Heckathorn Superfund Site, Richmond, California

		Concentrations are in µg/kg		
Station ID	**Depth Interval**	**Total DDT**	**Dieldrin**	**Total PCBs**
RIH-6A Composite	NA - Composite	23.8	0.96 J	18.7
RIH-6B Composite	NA - Composite	58.1	1.7 J	8.7
RIH-6A-1	-39.0 to -39.5 MLLW	903	11	14.4
	-39.5 to -40.0 MLLW	6686	14	6.6
	-40.0 to -40.5 MLLW	105	4.1	91.4
RIH-6A-2	-39.0 to -39.5 MLLW	37	2.8	4.3
	-39.5 to -40.0 MLLW	48	2.4	31.3
	-40.0 to -40.5 MLLW	187	5.7	44.0
RIH-6B-1	-39.0 to -39.5 MLLW	57	1.7 J	24.6
	-39.5 to -40.0 MLLW	31	0.64 J	3.0
	-40.0 to -40.5 MLLW	1.2	<0.46	2.3
RIH-6B-2	-39.0 to -39.5 MLLW	65	1.6 J	14.1
	-39.5 to -40.0 MLLW	34	<0.57	2.0
	-40.0 to -40.5 MLLW	0.45	<0.45	6.9

Notes:

J - estimated value

< value is not detected above the detection limit shown

MLLW - Mean Lower Low Water

µg/kg - micrograms per kilogram

Total PCBs are the sum of detected congeners

Data from *Port of Richmond Inner Harbor 2012 Maintenance Dredging Higher Resolution Sediment Testing - Sampling and Analytical Results* prepared for U.S. Army Corps of Engineers, San Francisco District. Prepared by Kinnetic Laboratories, Inc., Santa Cruz, CA.

TABLE 8-1

Summary of Historical Sediment Data used in Source Identification Evaluations

United Heckathorn Superfund Site, Richmond, California

SampleID	LocationID	Sample Type	*Pesticide concentrations in µg/kg dry weight* Dieldrin	2,4-DDD	2,4-DDE	2,4-DDT	4,4-DDD	4,4-DDE	4,4-DDT	Total DDT	Sample Vertical Interval (ft, unless otherwise noted)	Sample Description	Study
HECK-99-10	SW-15	N	**217**	--	--	--	**3,000**	**205**	**2,460**	**5,665**	0-0.5	Sand	1999 Sediment Investigation
HECK-99-11	SW-15	N	**45.6**	--	--	--	**495**	**31.1**	**510**	**1,036**	0.5-1.2	OBM-Dist	1999 Sediment Investigation
HECK-99-12	SW-16	N	**887**	--	--	--	**16,200**	**953**	**26,200**	**43,353**	0-0.5	YBM	1999 Sediment Investigation
HECK-99-14	SW-17	N	**701**	--	--	--	**12,600**	**681**	**7,270**	**20,551**	0-0.8	YBM	1999 Sediment Investigation
HECK-99-16	BC-18	N	**881**	--	--	--	**7,080**	**1,150**	**45,900**	**54,130**	0-0.7	YBM	1999 Sediment Investigation
HECK-99-17	BC-18	N	**3,400**	--	--	--	**85,200**	**3,240**	**92,400**	**180,840**	0.8-1.3	YBM	1999 Sediment Investigation
HECK-99-19	BC-19	N	**531**	--	--	--	**7,820**	**1,030**	**33,500**	**42,350**	0-1.2	YBM	1999 Sediment Investigation
HECK-99-22	BC-21	N	**193**	--	--	--	**3,400**	**220**	**3,150**	**6,770**	0-1.5	YBM	1999 Sediment Investigation
HECK-99-25	BC-23	N	**90.9**	--	--	--	**1,160**	**95.3**	**1,000**	**2,255**	0-1.6	YBM	1999 Sediment Investigation
HECK-99-26	BC-24	N	**132**	--	--	--	**2,040**	**141**	**1,270**	**3,451**	0-2.7	YBM	1999 Sediment Investigation
HECK-99-27	UL-14	N	**3,000**	--	--	--	**40,100**	**1,940**	**62,300**	**104,340**	0-0.3	YBM	1999 Sediment Investigation
HECK-99-30	UL-10	N	22.2 U	--	--	--	**239**	15.4 U	78.9 U	**239**	0-1.0	YBM	1999 Sediment Investigation
HECK-99-31	UL-13	N	**317**	--	--	--	**5,600**	**254**	**2,910**	**8,764**	0-1.1	YBM	1999 Sediment Investigation
HECK-99-32	UL-09	N	**1,910**	--	--	--	**36,300**	**2,410**	**6,510**	**45,220**	0-0.9	YBM	1999 Sediment Investigation
HECK-99-35	PL-08	N	**2,590**	--	--	--	**8,340**	**1,420**	**20,300**	**30,060**	0-0.2	YBM	1999 Sediment Investigation
HECK-99-36	PL-08	N	**1,650**	--	--	--	**6,230**	**1,110**	**14,500**	**21,840**	0.2-0.6	OBM-Dist	1999 Sediment Investigation
HECK-99-37	PL-07	N	18.1 U	--	--	--	**26.3**	12.6 U	64.6 U	**26.3**	0.3-1.0	YBM	1999 Sediment Investigation
HECK-99-39	PL-06	N	**272**	--	--	--	**708**	**220**	**2,330**	**3,258**	0-0.2	OBM	1999 Sediment Investigation
HECK-99-40	PL-05	N	**107**	--	--	--	**1,720**	**202**	**186**	**2,108**	0-0.6	YBM	1999 Sediment Investigation
HECK-99-41	PL-03	N	**68**	--	--	--	**21,100**	**449**	**2,650**	**24,199**	0-1.3	YBM	1999 Sediment Investigation
HECK-99-43	PL-03	N	17.4 U	--	--	--	**3,260**	**58.7**	**200**	**3,519**	1.7-2.2	YBM	1999 Sediment Investigation
HECK-99-44	PL-02	N	**1,220**	--	--	--	**18,100**	**1,160**	**18,600**	**37,860**	0-0.5	YBM	1999 Sediment Investigation
HECK-99-47	PL-01	N	**3,200**	--	--	--	**51,500**	**2,940**	**30,600**	**85,040**	0-2.0	YBM	1999 Sediment Investigation
HECK-99-48	SF-28	N	36 U	--	--	--	**257**	**28.3**	**297**	**582.3**	0-0.4	YBM	1999 Sediment Investigation
LC-1-1286-4	LC-1	N	**3,270**	--	--	--	**15,700**	**84,400**	**30,100**	**130,200**	0-0.1	YBM	EPA, in Battelle 2001 Sediment Recontamination Study Report
LC-2-1286-3	LC-2	N	**382**	--	--	--	**3,150**	**383**	**10,400**	**13,933**	0-0.1	YBM	EPA, in Battelle 2001 Sediment Recontamination Study Report
LC-3-1286-2	LC-3	N	**171**	--	--	--	**4,080**	**323**	**5,850**	**10,253**	0-0.1	YBM	EPA, in Battelle 2001 Sediment Recontamination Study Report
LC-4-1286-1	LC-4	N	**52**	--	--	--	**1,190**	**94**	**1,450**	**2,734**	0-0.1	YBM	EPA, in Battelle 2001 Sediment Recontamination Study Report
0702-S1	0702-S1 (T-4_5)	N	**20 J**	**60**	40 U	**40**	**100**	40 U	**600**	**800**	surface	YBM OBM	Phase I Source Investigation
0702-S11	0702-S11 (T 4_5)	N	**400 J**	**1600 J**	200 U	**2200 J**	**5000 J**	**600 J**	**25000 J**	**34,400**	surface	YBM	Phase I Source Investigation
0702-S12	0702-S12 (T 3_5)	N	**1,400**	**8,700**	**200**	**20,000**	**12,000**	**2,400**	**120,000**	**163,300**	surface	YBM OBM	Phase I Source Investigation
0702-S13	0702-S13 (T 2_5)	N	200 U	**300**	200 U	**3,600**	**900**	**200**	**12,000**	**17,000**	surface	not recorded	Phase I Source Investigation
0702-S14	0702-S14 (T 2_5)	N	**6,500**	**10,000**	**600**	**110,000**	**60,000**	**10,000**	**1400000 J**	**1,590,600**	surface	rocky	Phase I Source Investigation
0702-S15	0702-S15 (T 2)	N	300 U	**400 J**	300 U	**800 J**	**1100 J**	300 U	**6000 J**	**8,300**	surface	YBM	Phase I Source Investigation
0702-S17	0702-S17 (1_5)	N	1000 U	**1000 J**	2000 U	**4,000**	**3,000**	2000 U	**17,000**	**25,000**	surface	Sand	Phase I Source Investigation
0702-S18	0702-S18 (1_5)	FD	**300**	**1,200**	200 U	**2,600**	**1,400**	**200**	**8,000**	**13,400**	surface	Sand	Phase I Source Investigation
0702-S2-Y	0702-S2-YBM (T-4_5)	N	300 U	**200 J**	300 U	300 U	**500**	300 U	**2,500**	**3,200**	surface	YBM	Phase I Source Investigation
0702-S4	0702-S4 (T-2_5)	N	**3000 J**	**3000 J**	4000 U	**22,000**	**9,000**	4000 U	**110,000**	**144,000**	surface	YBM OBM	Phase I Source Investigation
0702-S5	0702-S5 (T 10_5)	N	300 U	**200 J**	300 U	**300**	**600**	**300**	**2,200**	**3,600**	surface	YBM OBM	Phase I Source Investigation
0702-S6	0702-S6 (T 10_5)	N	**200 J**	**700 J**	300 U	**1400 J**	**2300 J**	**500 J**	**10000 J**	**14,900**	surface	not recorded	Phase I Source Investigation
0702-S8	0702-S8 (T 8_5)	N	300 U	**800 J**	300 U	**1000 J**	**2600 J**	**400 J**	**29000 J**	**33,800**	surface	YBM	Phase I Source Investigation
0702-S9	0702-S9 (T 6_5)	N	2000 U	**2000 J**	3000 U	**3,000**	**5,000**	3000 U	**29,000**	**39,000**	surface	YBM	Phase I Source Investigation
T(+11_5)C1	T(+11_5)C1	N	**90**	**480**	**40 J**	**2,000**	**2,000**	**350**	**12,000**	**16,870**	surface	sediment	Phase I Source Investigation
T(+2_5)C1	T(+2_5)C1	N	**50,000**	**150,000**	**10,000**	**3,000,000**	**900,000**	**130,000**	**19,000,000**	**23,190,000**	surface	sediment	Phase I Source Investigation
T(+23_5)C1	T(+23_5)C1	N	**20 J**	**60 J**	**20 J**	**60 J**	**200 J**	**60 J**	**860**	**1,260**	surface	sediment	Phase I Source Investigation

TABLE 8-1

Summary of Historical Sediment Data used in Source Identification Evaluations

United Heckathorn Superfund Site, Richmond, California

			Pesticide concentrations in µg/kg dry weight										
SampleID	**LocationID**	**Sample Type**	**Dieldrin**	**2,4-DDD**	**2,4-DDE**	**2,4-DDT**	**4,4-DDD**	**4,4-DDE**	**4,4-DDT**	**Total DDT**	**Sample Vertical Interval (ft, unless otherwise noted)**	**Sample Description**	**Study**
T(+39_5)C1	T(+39_5)C1	N	**20 J**	**80 J**	**30 J**	**200 J**	**320 J**	**60 J**	**2,000**	**2,690**	surface	sediment	Phase I Source Investigation
T(+55_5)C1	T(+55_5)C1	N	**60 J**	**200 J**	**50**	**20 J**	**1100 J**	**200 J**	**200 J**	**1,770**	surface	sediment	Phase I Source Investigation
T(-0_5)C1	T(-0_5)C1	N	**200 J**	**1,000**	**30 J**	**800**	**3,500**	**200 J**	**5,200**	**10,730**	surface	sediment	Phase I Source Investigation
T(-12_5)C1	T(-12_5)C1	N	**70**	**300**	**20 J**	**800**	**1,000**	**100**	**3,700**	**5,920**	surface	sediment	Phase I Source Investigation
T(-24_5)C1	T(-24_5)C1	N	**200 J**	**1,000**	**40 J**	**200 J**	**4,300**	**370**	**3,000**	**8,910**	surface	sediment	Phase I Source Investigation
T(-4_5)C1	T(-4_5)C1	N	**800**	**1,000**	**80 J**	**1,000**	**3,000**	**600**	**4,700**	**10,380**	surface	sediment	Phase I Source Investigation
0702-S19	0702-S19 (T 8_5)	N	**1000 U**	**2000 U**	**2000 U**	**4,000**	**2000 U**	**2,000**	**29,000**	**35,000**	surface	embankment soil	Phase I Source Investigation
T(+11_5)B	T(+11_5)B	N	**20 J**	**60**	**80**	**3,000**	**200**	**2,000**	**27,000**	**32,340**	surface	embankment soil	Phase I Source Investigation
T(+2_5)B	T(+2_5)B	N	**1000 J**	**3,000**	**600 J**	**30,000**	**7,000**	**13,000**	**160,000**	**213,600**	surface	embankment soil	Phase I Source Investigation
T(+31_5)B	T(+31_5)B	N	**50 J**	**80 J**	**30 J**	**280**	**200**	**230**	**2000 J**	**2,820**	surface	embankment soil	Phase I Source Investigation
T(-0_5)B	T(-0_5)B	N	**2,000**	**2,000**	**200**	**7,000**	**3,000**	**3,000**	**31,000**	**46,200**	surface	embankment soil	Phase I Source Investigation
T(-12_5)C1	T(-12_5)C1	N	**70**	**300**	**20 J**	**800**	**1,000**	**100**	**3,700**	**5,920**	surface	sediment	Phase I Source Investigation
T(-19_5)B	T(-19_5)B	N	**200**	**200 J**	**20 J**	**70 J**	**1,000**	**100**	**400 J**	**1,790**	surface	embankment soil	Phase I Source Investigation
T(-32_5)B	T(-32_5)B	N	**6,000**	**2,000**	**400**	**7,000**	**3,000**	**8,000**	**33,000**	**53,400**	surface	embankment soil	Phase I Source Investigation
T(-4_5)B	T(-4_5)B	N	**12,000**	**9,000**	**2,000**	**46,000**	**20,000**	**20,000**	**220,000**	**317,000**	surface	embankment soil	Phase I Source Investigation
H03-01_0_S	H03-01	N	--	--	--	--	--	--	--	**252,400**	0-12	Black YBM, fine silt, clay smo	Phase II Source Investigation
H03-03_0_S	H03-03	N	--	--	--	--	--	--	--	**12,700**	0-10	YBM, silty clay, smooth, black	Phase II Source Investigation
H03-03_10_S	H03-03	N	--	--	--	--	--	--	--	**62,100**	10-16	YBM, black silty clay with son	Phase II Source Investigation
H03-03_24_5_S	H03-03	N	--	--	--	--	--	--	--	**400**	24.5-30	sand mixed with clay, reddish	Phase II Source Investigation
H03-05_0_S	H03-05	N	--	--	--	--	--	--	--	**7,500**	0-1	YBM, Clay, soft	Phase II Source Investigation
H03-05_1_S	H03-05	N	--	--	--	--	--	--	--	**14,800**	1-24	YBM, Clay, soft	Phase II Source Investigation
H03-05_24_S	H03-05	N	--	--	--	--	--	--	--	**15,400**	24-27	Olive Green Sand	Phase II Source Investigation
H03-05_27_S	H03-05	N	--	--	--	--	--	--	--	**150,600**	27-34	YBM, black	Phase II Source Investigation
Heck03-001	T(-35)old scale	N	**49 U**	**180**	**49 U**	**160**	**680**	**170**	**430**	**1,620**	0-0.3	Bank Soil	Phase II Source Investigation
Heck03-002	T(-35)old scale	N	**570 U**	**2,100**	**570 U**	**570 U**	**7,700**	**1,800**	**2,500**	**14,100**	0.5-1	Bank Soil	Phase II Source Investigation
Heck03-003	T(-29) 36ft N of 8" pipe	N	**3,200**	**9,300**	**1100 U**	**1900 J**	**45000 J**	**3,800**	**15,000**	**75,000**	0.5-1	Bank Soil	Phase II Source Investigation
Heck03-004	T(-29) 36ft N of 8" pipe	N	**5,900**	**2,700**	**520 U**	**5,500**	**8,600**	**5,300**	**46000 J**	**68,100**	0-0.5	Bank Soil	Phase II Source Investigation
Heck03-005	T(-12_5) Bank	N	**24 U**	**24 U**	**24 U**	**24 U**	**24 U**	**24 U**	**24 U**	**24 U**	0.5-1	Bank Soil	Phase II Source Investigation
Heck03-006	T(-12_5) Bank	N	**940 U**	**940 U**	**940 U**	**1,900**	**2,200**	**940 U**	**8,800**	**12,900**	0-0.2	Bank Soil	Phase II Source Investigation
Heck03-007	T(-11_5) Seep 1-ft N	N	**220 U**	**220 U**	**220 U**	**780**	**220 U**	**220 U**	**3,400**	**4,180**	0-0.2	Bank Soil	Phase II Source Investigation
Heck03-008	T(-11_5) Seep 1-ft N	N	**25 U**	**25 U**	**25 U**	**25 U**	**25 U**	**25 U**	**28 J**	**28**	0.5-1	Bank Soil	Phase II Source Investigation
Heck03-009	T(-11_5) Seep 1-ft N	N	**22000 J**	**370000 J**	**5100 J**	**120000 J**	**1500000 J**	**39000 J**	**1600000 J**	**3,634,100**	NA (pipe sed)	Bank Soil	Phase II Source Investigation
Heck03-010	T(-4_5) Bank	N	**23 U**	**23 U**	**23 U**	**23 U**	**23 U**	**23 U**	**23 U**	**23 U**	0.5-1	Bank Soil	Phase II Source Investigation
Heck03-011	T(-4_5) Bank	N	**210 U**	**330 J**	**210 U**	**340 J**	**830**	**410**	**1,900**	**3,810**	0-0.2	Bank Soil	Phase II Source Investigation
Heck03-012	T(+2_25) Bank	N	**270 UJ**	**270 UJ**	**270 UJ**	**520 J**	**270 UJ**	**270 UJ**	**3000 J**	**3,520**	0-0.2	Bank Soil	Phase II Source Investigation
Heck03-013	T(+2_25) Bank	N	**4600 J**	**2600 U**	**2600 U**	**11,000**	**4200 J**	**2600 U**	**120,000**	**135,200**	0.5-1	Bank Soil	Phase II Source Investigation
Heck03-014	H03-06	N	**14 U**	**14 U**	**15 J**	**14 U**	**52**	**14 U**	**25 J**	**92**	0-1.4	YBM	Phase II Source Investigation
Heck03-015	H03-08	N	**57 U**	**140**	**57 U**	**57 U**	**600**	**57 U**	**140**	**880**	0-0.7	YBM	Phase II Source Investigation
Heck03-016	H03-11	N	**11 U**	**13 J**	**11 U**	**11 U**	**58**	**11 U**	**14 J**	**85**	0-0.7	YBM	Phase II Source Investigation
Heck03-017	H03-1-N	N	**120 U**	**120 U**	**120 U**	**120 U**	**120 U**	**120 U**	**920**	**920**	0-0.4	0.1 ft YBM on 0.3 ft OBM	Phase II Source Investigation
Heck03-022	H03-2-NE	N	**1200 U**	**2,500**	**1200 U**	**10,000**	**3,100**	**1200 U**	**10,000**	**25,600**	0-0.25	YBM	Phase II Source Investigation
Heck03-024	H03-1-NW	N	**800 U**	**1,700**	**800 U**	**1500 J**	**4,500**	**800 U**	**21,000**	**28,700**	0-1.7	YBM	Phase II Source Investigation
Heck03-025	H03-1-C	N	**13000 J**	**20000 J**	**2800 U**	**110000 J**	**54000 J**	**6500 J**	**970000 J**	**1,160,500**	0-1.0	YBM	Phase II Source Investigation
Heck03-026	H03-1-NE	N	**540 U**	**1,200**	**540 U**	**4,200**	**3,600**	**540 U**	**34,000**	**43,000**	0-0.75	YBM	Phase II Source Investigation
Heck03-027	H03-1-W	N	**820 U**	**2,800**	**820 U**	**17,000**	**9,100**	**1100 J**	**160000 J**	**190,000**	0-1.5	YBM	Phase II Source Investigation
Heck03-028	H03-2-W	N	**1800 U**	**2800 J**	**1800 U**	**36,000**	**5,700**	**1800 U**	**150,000**	**194,500**	0-1.5	YBM	Phase II Source Investigation
Heck03-029	H03-1-S	N	**1200 U**	**4,300**	**1200 U**	**5,200**	**8,700**	**1400 J**	**34,000**	**53,600**	0-0.6	YBM	Phase II Source Investigation

TABLE 8-1

Summary of Historical Sediment Data used in Source Identification Evaluations

United Heckathorn Superfund Site, Richmond, California

			Pesticide concentrations in µg/kg dry weight										
SampleID	LocationID	Sample Type	Dieldrin	2,4-DDD	2,4-DDE	2,4-DDT	4,4-DDD	4,4-DDE	4,4-DDT	Total DDT	Sample Vertical Interval (ft, unless otherwise noted)	Sample Description	Study
Heck03-030	H03-1-SE	N	1400 U	2400 J	1400 U	3,600	5,600	1400 U	40,000	51,600	0-0.5	0.25 ft YBM on 0.25 ft OBM	Phase II Source Investigation
Heck03-031	H03-1-SW	N	870 U	1500 J	870 U	2,300	4,000	870 U	19,000	26,800	0-1.5	YBM	Phase II Source Investigation
Heck03-032	H03-2-S	N	700 U	1,400	700 U	1300 J	2,400	700 U	17,000	22,100	0-0.4	YBM	Phase II Source Investigation
Heck03-033	H03-2-SE	N	660 U	2,100	660 U	2,400	3,900	660 U	18,000	26,400	0-0.75	YBM w/few blobs OBM	Phase II Source Investigation
Heck03-034	H03-T(+4_5)-E	N	27 U	49 J	27 U	100	120	51 J	530	850	0-0.9	0.1 ft YBM on 0.8 ft OBM	Phase II Source Investigation
Heck03-035	H03-T(+3_5)-E	N	66 U	82 J	66 U	68 J	120 J	66 U	930	1,200	0-0.5	0.25 ft YBM on 0.25 ft OBM	Phase II Source Investigation
Heck03-036	H03-T(+2_5)-E	N	580 U	580 U	580 U	670 J	580 U	580 U	5,200	5,870	0-0.7	0.2 ft YBM on 0.5 ft OBM	Phase II Source Investigation
Heck03-037	H03-T(+1_5)-E	N	670 U	670 U	670 U	1000 J	670 U	670 U	5,500	6,500	0-1.0	0.5 ft YBM on 0.5 ft OBM	Phase II Source Investigation
Heck03-038	H03-12	N	44 U	250	44 U	44 U	1,100	87	680	2,117	0-3.8	YBM	Phase II Source Investigation
Heck03-039	H03-10	N	210 U	1,400	210 U	210 U	6,300	300 J	4,500	12,500	0-3.4	YBM	Phase II Source Investigation
Heck03-040	H03-02	N	75 U	190	75 U	120 J	890	75 U	1,300	2,500	0-0.3	0.1 ft YBM on 0.2 ft OBM	Phase II Source Investigation
Heck03-043	H03-05	N	380 UJ	1600 J	380 UJ	700 J	6700 J	380 UJ	7000 J	16,000	0-2.8	YBM	Phase II Source Investigation
Heck03-044	H03-01	N	2300 J	16,000	1900 U	3200 J	66,000	2200 J	69,000	156,400	0-1.0	YBM	Phase II Source Investigation
Heck03-045	H03-03	N	700 U	3,500	700 U	700 U	8,800	700 U	14,000	26,300	0-1.3	YBM	Phase II Source Investigation
Heck03-046	H03-04	N	140 UJ	650 J	140 UJ	190 J	3100 J	160 J	3000 J	7,100	0-1.5	YBM	Phase II Source Investigation
Heck03-047	H03-04	N	680 U	2,300	680 U	680 U	12000 J	860 J	12000 J	27,160	1.9-3.1	OBM-disturbed	Phase II Source Investigation
Heck03-048	H03-07	N	1500 U	3,600	1500 U	1500 U	20000 J	1500 U	30,000	53,600	0-1.3	YBM	Phase II Source Investigation
B1600A	B16+00	N	67	310	9.1	82	1,700	100	460	2,661	sediment surface	YBM	2007 Data Gap Evaluation
B1600a0807	B16+00	N	70 NJ	440	40 NJ	110	1,900	150	1,500	4,140	sediment surface	YBM	2007 Data Gap Evaluation
B1600B	B16+00	N	33	300	13	36	1,300	60	640	2,349	between surface and interface	Sand	2007 Data Gap Evaluation
B1600b0807	B16+00	N	140	1,200	67 NJ	200	5,100	250	4,400	11,217	between surface and interface	Sand	2007 Data Gap Evaluation
B1600C	B16+00	N	190	1,700	62	45	6,500	220	1,600	10,127	YBM/OBM interface	Interface	2007 Data Gap Evaluation
B1600c0807	B16+00	N	320	1,700	150 NJ	250 NJ	6,700	810	11,000	20,610	YBM/OBM interface	Interface	2007 Data Gap Evaluation
C0400A	C4+00	N	7.2 J	13	4.6 U	4.6 U	51	8.8 J	43	115.8	sediment surface	Surface	2007 Data Gap Evaluation
C0400B	C4+00	N	2.5 U	2.5 U	2.5 U	2.5 U	3.4 J	2.5 U	2.5 U	3.4	-41 MLLW	Interface	2007 Data Gap Evaluation
C0400b0807	C4+00	N	1.8 NJ	12	5.2 U	5.2 U	46	4.7 J	30	92.7	-41 MLLW	Interface	2007 Data Gap Evaluation
C0800a0807	C8+00	N	62	65	19 NJ	21 NJ	350 J	37	340 J	832	sediment surface	YBM	2007 Data Gap Evaluation
C0800b0807	C8+00	N	32	350	64 J	120	1,500	76	1,100	3,210	-41 MLLW	Interface	2007 Data Gap Evaluation
C0900a0807	C9+00	N	15	37	9.8 NJ	18 NJ	260	22	390	736.8	sediment surface	YBM	2007 Data Gap Evaluation
C0900b0807	C9+00	N	19 J	130	15 NJ	53 NJ	510	30 J	1,400	2,138	-41 MLLW	Interface	2007 Data Gap Evaluation
C1400a0807	C14+00	N	260 J	3,900	590 U	510 NJ	17,000	310 J	4,900	26,620	sediment surface	YBM	2007 Data Gap Evaluation
C1400c0807	C14+00	N	3.9 J	23	3.1 J	4.1 U	100	2.8 J	24	152.9	YBM/OBM interface	Interface	2007 Data Gap Evaluation
C1800a0807	C18+00	N	2,800	14,000	730 NJ	1800 NJ	51,000	4,300	17,000	88,830	sediment surface	YBM	2007 Data Gap Evaluation
C1800b0807	C18+00	N	660	2,300	820 NJ	92 U	4,100	11,000	480	18,700	between surface and interface	YBM	2007 Data Gap Evaluation
C1800c0807	C18+00	N	15 J	110	3.5 NJ	8.7 NJ	440 J	19	96	677.2	YBM/OBM interface	Sand	2007 Data Gap Evaluation
C2 1800a0807	C218+00	N	590	2,700	230 NJ	45 NJ	9,000	1,100	1,900	14,975	sediment surface	YBM	2007 Data Gap Evaluation
C2 1800b0807	C218+00	N	11	58	12 NJ	2.8 NJ	330	17	7.1	426.9	between surface and interface	YBM	2007 Data Gap Evaluation
C2 1800c0807	C218+00	N	1100 NJ	5600 NJ	930 NJ	100 U	1,000	25,000	3,300	35,830	YBM/OBM interface	YBM	2007 Data Gap Evaluation
C8600a0807	C14+00	FD	110	570	63 NJ	390 NJ	3600 J	160 NJ	4600 J	9,383	sediment surface	YBM	2007 Data Gap Evaluation
C9100b0807	C9+00	FD	16 J	110	17 NJ	35 J	440	27 J	1,100	1,729	-41 MLLW	Interface	2007 Data Gap Evaluation
C9600a0807	C4+00	N	40 J	1,300	94 U	94 U	6,000	100 NJ	150	7,550	sediment surface	YBM	2007 Data Gap Evaluation
CB0650A	CB6+50	N	9.7	8.5 J	4.7 U	4.7 U	31	4.7 U	47	86.5	sediment surface	YBM	2007 Data Gap Evaluation
CB0650B	CB6+50	N	12	80	6.9	11	330	27	140	594.9	-41 MLLW	Interface	2007 Data Gap Evaluation
CB650a0807	CB6+50	N	75	50	3.7 NJ	36	170 J	34 NJ	340 J	633.7	sediment surface	YBM	2007 Data Gap Evaluation
CB650b0807	CB6+50	N	55	290	36 NJ	100 NJ	1,700	120	2,400	4,646	-41 MLLW	Interface	2007 Data Gap Evaluation
CB950A	CB9+50	N	15	110	7 J	140	460	51	2,000	2,768	sediment surface	YBM	2007 Data Gap Evaluation
CB950a0807	CB9+50	N	610	1500 J	110 NJ	4600 J	3000 J	640	23000 J	32,850	sediment surface	YBM	2007 Data Gap Evaluation

TABLE 8-1

Summary of Historical Sediment Data used in Source Identification Evaluations

United Heckathorn Superfund Site, Richmond, California

SampleID	LocationID	Sample Type	Dieldrin	2,4-DDD	2,4-DDE	2,4-DDT	4,4-DDD	4,4-DDE	4,4-DDT	Total DDT	Sample Vertical Interval (ft, unless otherwise noted)	Sample Description	Study
			Pesticide concentrations in μg/kg dry weight										
CB950B	CB9+50	N	**22**	**120**	**22**	**310**	**520**	**44**	**1,900**	**2,916**	-41 MLLW	YBM	2007 Data Gap Evaluation
CB950b0807	CB9+50	N	**160**	**860**	**190**	**1500 J**	**3,300**	**390**	**11,000**	**17,240**	-41 MLLW	YBM	2007 Data Gap Evaluation
D0600a0807	D6+00	N	**19**	**30**	**6.7 NJ**	**42**	**220**	**20**	**780**	**1,099**	sediment surface	YBM	2007 Data Gap Evaluation
D0600b0807	D6+00	N	**51**	**190**	**96**	**120**	**1,000**	**110**	**1,900**	**3,416**	-41 MLLW	Interface	2007 Data Gap Evaluation
D1000a0807	D10+00	N	**25 NJ**	**150**	**36 NJ**	**24 J**	**780**	**59**	**910**	**1,959**	sediment surface	YBM	2007 Data Gap Evaluation
D1000b0807	D10+00	N	4.5 U	4.5 U	4.5 U	4.5 U	**3.2 J**	4.5 U	**3.6 J**	**6.8**	-41 MLLW	Interface	2007 Data Gap Evaluation
D1300a0807	D13+00	N	**33**	**240**	**12 NJ**	**52**	**1,000**	**64**	**980 J**	**2,348**	sediment surface	YBM	2007 Data Gap Evaluation
D1300b0807	D13+00	N	**14**	**140**	**6.4 NJ**	**7.4 NJ**	**510**	**21**	**150**	**834.8**	between surface and interface	YBM	2007 Data Gap Evaluation
D1300c0807	D13+00	N	**0.97 NJ**	**6.9**	**0.92 NJ**	4.1 U	**26**	**1.3 J**	**7**	**42.12**	YBM/OBM interface	Interface	2007 Data Gap Evaluation
D1500a0807	D15+00	N	**53 NJ**	**340**	**38 NJ**	**68**	**1,500**	**120**	**1,400**	**3,466**	sediment surface	YBM	2007 Data Gap Evaluation
D1500b0807	D15+00	N	**320**	**2,500**	**120 NJ**	**440 NJ**	**9,700**	**560**	**12,000**	**25,320**	between surface and interface	YBM	2007 Data Gap Evaluation
D1500c0807	D15+00	N	**36**	**330**	**10 NJ**	**11 NJ**	**1,300**	**35**	**120**	**1,806**	YBM/OBM interface	Interface	2007 Data Gap Evaluation
D1700a0807	D17+00	N	**220**	**1,700**	**88 NJ**	**140 NJ**	**6,800**	**680**	**4,800**	**14,208**	sediment surface	YBM	2007 Data Gap Evaluation
D1700c0807	D17+00	N	**39**	**210**	**16 NJ**	8.6 U	**710**	**59**	**81**	**1,076**	YBM/OBM interface	Sand	2007 Data Gap Evaluation
D8300c0807	D17+00	FD	**21**	**160**	**11 NJ**	4.3 U	**600**	**33**	**21**	**825**	YBM/OBM interface	Sand	2007 Data Gap Evaluation
E0325a0807	E3+25	N	**6.1 J**	**12**	**4.8 NJ**	**4.1 NJ**	**38**	**8.1 NJ**	**45**	**112**	sediment surface	YBM	2007 Data Gap Evaluation
E0325b0807	E3+25	N	**9 NJ**	**47**	**17 NJ**	**28**	**170**	**29**	**150**	**441**	-41 MLLW	YBM	2007 Data Gap Evaluation
E0950a0807	E9+50	N	**200**	**1,400**	**83 NJ**	**360**	**7,100**	**320**	**8,800**	**18,063**	sediment surface	YBM	2007 Data Gap Evaluation
E0950b0807	E9+50	N	**3.3 J**	**20**	**4.4 NJ**	4.1 U	**93**	4.1 U	**43**	**160.4**	-41 MLLW	Sand	2007 Data Gap Evaluation
F0525a0807	F5+25	N	4.7 U	**2.2 J**	4.7 U	4.7 U	**9.2**	**1.1 J**	**11**	**23.5**	sediment surface	YBM	2007 Data Gap Evaluation
F0700a0807	F7+00	N	**1.3 J**	**6**	**2.1 J**	4.9 U	**26**	**2.2 J**	**4.8 J**	**41.1**	sediment surface	Sand	2007 Data Gap Evaluation
F0800a0807	F8+00	N	**34**	**130**	**11 NJ**	**7.9 NJ**	**640**	**40**	**400**	**1,229**	sediment surface	YBM	2007 Data Gap Evaluation
F0800c0807	F8+00	N	**61**	**230**	**25 NJ**	**26 NJ**	**1,400**	**71**	**300**	**2,052**	1 foot below -41 MLLW	Interface	2007 Data Gap Evaluation
F9300a0807	F7+00	FD	**2.4 J**	**9.3**	**3.4 J**	5 U	**35**	**2.8 J**	**3.6 J**	**54.1**	sediment surface	Sand	2007 Data Gap Evaluation
G0300a0807	G3+00	N	**9.6 NJ**	**35**	**4.1 NJ**	**19**	**120**	**26**	**140**	**344.1**	sediment surface	YBM	2007 Data Gap Evaluation
G0300b0807	G3+00	N	**18**	**79**	**13 NJ**	**53 NJ**	**370**	**51**	**320**	**886**	-41 MLLW	Sand	2007 Data Gap Evaluation
G9700a0807	G3+00	FD	**7.7**	**42**	**8.2 NJ**	**5.2 NJ**	**250**	**24**	**280**	**609.4**	sediment surface	YBM	2007 Data Gap Evaluation
M30320807	303_2S	N	**6.2 NJ**	**8.9 NJ**	**2 NJ**	**11**	**32**	**9 J**	**53**	**115.9**	sediment surface	YBM	2007 Data Gap Evaluation
M30330807	303_3S	N	**490**	**370**	**22 NJ**	**1,500**	**850**	**240**	**11,000**	**13,982**	sediment surface	YBM	2007 Data Gap Evaluation
M30340807	303_4S	N	**2.4 NJ**	**3.3 NJ**	**2.7 NJ**	**3.3 J**	**16**	**7.2 J**	**120**	**152.5**	sediment surface	YBM	2007 Data Gap Evaluation
SF29a0807	SF-29	N	**4 NJ**	**11 NJ**	**1.9 NJ**	**3.8 NJ**	**49**	**7.9 J**	**60**	**133.6**	sediment surface	YBM	2007 Data Gap Evaluation
SF29b0807	SF-29	N	**3.5 J**	**15**	**2.8 NJ**	6 U	**63**	**9**	**140**	**229.8**	-41 MLLW	Interface	2007 Data Gap Evaluation
SF31a0807	SF-31	N	18 U	**7.9 NJ**	18 UJ	**9 J**	**55**	**11 NJ**	**830**	**912.9**	sediment surface	YBM	2007 Data Gap Evaluation
SF31b0807	SF-31	N	**8.4 NJ**	**28**	**7.2 NJ**	**5.1 NJ**	**110**	**22**	**30**	**202.3**	-41 MLLW	Interface	2007 Data Gap Evaluation
SF32a0807	SF-32	N	**4.3 NJ**	**11**	**4 NJ**	7.2 U	**38**	**8.7**	**17**	**78.7**	sediment surface	YBM	2007 Data Gap Evaluation
SF32b0807	SF-32	N	**2.7 J**	**4.9 NJ**	**2.6 NJ**	5 U	**21**	**4.9 J**	**2.5 NJ**	**35.9**	-41 MLLW	Interface	2007 Data Gap Evaluation
SF34a0807	SF-34	N	**5.4 NJ**	**6.6 J**	**4.5 NJ**	8.7 U	**21**	**9.9 NJ**	**14 NJ**	**56**	sediment surface	YBM	2007 Data Gap Evaluation
T1001a0807	Embankment Transect 100	N	**8.9 NJ**	**23 NJ**	**12 NJ**	**4.1 NJ**	**69**	**21**	**67**	**196.1**	0-0.5'	Shell hash	2007 Data Gap Evaluation
T1002a0807	Embankment Transect 100	N	**4.8 NJ**	**16 NJ**	**6.3 NJ**	**1.8 NJ**	**50**	**13**	**12**	**99.1**	0-0.5'	Shell hash	2007 Data Gap Evaluation
T1003a0807	Embankment Transect 100	N	**6.3 NJ**	**8.1**	**6.4 NJ**	5.7 U	**22**	**8.5 NJ**	**14 NJ**	**59**	0-0.5'	Shell hash	2007 Data Gap Evaluation
T3001a0807	Embankment Transect 300	N	**24**	**30 NJ**	**19 NJ**	**4.3 NJ**	**100**	**37**	**85**	**275.3**	0-0.5'	Shell hash	2007 Data Gap Evaluation
T3001b0807	Embankment Transect 300	N	**24**	**39 NJ**	**22 NJ**	**1.8 NJ**	**210**	**38**	**170**	**480.8**	2.5-3.0'	Shell hash	2007 Data Gap Evaluation
T3002a0807	Embankment Transect 300	N	**8.7 NJ**	**22**	**14 NJ**	**6.6**	**130**	**23**	**36**	**231.6**	0-0.5'	Shell hash	2007 Data Gap Evaluation
T3002b0807	Embankment Transect 300	N	**15 NJ**	**41**	**18 J**	4.7 U	**190**	**51 NJ**	**23**	**323**	2.5-3.0'	Shell hash	2007 Data Gap Evaluation
T3003a0807	Embankment Transect 300	N	**25**	**99**	**35**	**4.3 NJ**	**490**	**57**	**17**	**702.3**	0-0.5'	Shell hash	2007 Data Gap Evaluation
T3003b0807	Embankment Transect 300	N	5 U	**2 J**	**1.1 NJ**	5 U	**7.1**	**1.5 J**	**15**	**26.7**	2.5-3.0'	Shell hash	2007 Data Gap Evaluation
T5001a0807	Embankment Transect 500	N	**55**	**400**	**65 NJ**	12 U	**1,300**	**220**	**91 J**	**2,076**	0-0.5'	Shell hash	2007 Data Gap Evaluation

TABLE 8-1

Summary of Historical Sediment Data used in Source Identification Evaluations

United Heckathorn Superfund Site, Richmond, California

			Pesticide concentrations in µg/kg dry weight											
SampleID	**LocationID**	**Sample Type**	**Dieldrin**	**2,4-DDD**	**2,4-DDE**	**2,4-DDT**	**4,4-DDD**	**4,4-DDE**	**4,4-DDT**	**Total DDT**	**Sample Vertical Interval (ft, unless otherwise noted)**	**Sample Description**	**Study**
T5001b0807	Embankment Transect 500	N	**26 NJ**	**130**	**80 J**	**45**	**760 J**	**110 NJ**	**3400 J**	**4,525**	2.5-3.0'	Shell hash	2007 Data Gap Evaluation
T5002a0807	Embankment Transect 500	N	**97**	**320**	**65 NJ**	**4.9 NJ**	**1,100**	**340**	**260**	**2,090**	0-0.5'	Shell hash	2007 Data Gap Evaluation
T5002b0807	Embankment Transect 500	N	**49 NJ**	**270**	**57 NJ**	**7.2 NJ**	**1,000**	**250**	**80**	**1,664**	2.5-3.0'	Shell hash	2007 Data Gap Evaluation
T5003a0807	Embankment Transect 500	N	**4.1 NJ**	**16**	**13 NJ**	4.5 U	**53**	**18**	**7.9 NJ**	**107.9**	0-0.5'	Shell hash	2007 Data Gap Evaluation
T5003b0807	Embankment Transect 500	N	**56 NJ**	**180 NJ**	**73**	**70 NJ**	**630**	**270**	**450**	**1,673**	2.5-3.0'	Shell hash	2007 Data Gap Evaluation

Notes:

Bold values indicate detected result.

Total DDT is the sum of the detected isomers.

FD - field duplicate

ft - feet

MLLW - mean lower low water level

N (sample type) - normal sample

N (data qualifier) - This flag indicates presumptive evidence of a compound.

OBM - Older Bay Mud

YBM - Younger Bay Mud

µg/kg - micrograms per kilogram

J - estimated value

U - not detected above reporting limit shown

-- not analyzed / not reported

TABLE 8-2

Summary of Pesticide and Organic Carbon Results - 2013 Sediment Core Data

United Heckathorn Superfund Site, Richmond, California

					Pesticide results are µg/kg dry weight								
Location ID	Sample ID	Sample Type	Top Depth (ft)	Bottom Depth (ft)	Dieldrin	2,4-DDD	2,4-DDE	2,4-DDT	4,4-DDD	4,4-DDE	4,4-DDT	Total DDT	Total Organic Carbon (mg/kg)
SD13-04	SD13-04-0005	N	0.0	0.5	**1100**	**5900**	**850**	3.2 U	**33000**	**1100**	**2000**	**42850**	**25300**
SD13-04	SD13-04-0515	N	0.5	1.5	**880**	**4600**	**990**	**97 J**	**31000**	**1200**	**11000**	**48887**	**32900**
SD13-05	SD13-05-0002	N	0.0	0.2	**19**	**110 J**	3.2 U	3.2 U	**600**	**120**	**200**	**1030**	**37600**
SD13-05	SD13-05-0203	N	0.2	0.3	**8.9 J**	**60 J**	3.3 U	**22 J**	**220**	**40**	**120**	**462**	**35900**
SD13-05	SD13-05-0305	N	0.3	0.5	**24**	**74**	3.3 U	3.3 U	**360**	**79**	**220**	**733**	**36900**
SD13-05	SD13-05-0507	N	0.5	0.7	**62 J**	**150 J**	3.3 U	**140 J**	**640**	**130 J**	**440**	**1500**	**38900**
SD13-05	SD13-05-0708	N	0.7	0.8	**46 J**	**110 J**	3 U	3 U	**310**	**100**	**210**	**730**	**38000 >**
SD13-05	SD13-05-0810	N	0.8	1.0	**47 J**	**210**	**240**	**500**	**940**	**420**	**1100**	**3410**	**38000 >**
SD13-05	SD13-05-1020	N	1.0	2.0	**110**	**700**	**1000**	3.3 U	**2700**	**1100**	**2300**	**7800**	**38100**
SD13-05	SD13-05-2040	N	2.0	4.0	**120**	**340**	**460**	**94**	**2500**	**680**	**1000**	**5074**	**38000 >**
SD13-06	SD13-06-0005	N	0.0	0.5	**100 J**	**320**	3.2 U	3.2 U	**1200**	**260**	**1300**	**3080**	**31200**
SD13-06	SD13-06-0520	N	0.5	2.0	**110 J**	**380**	3.3 U	**93**	**1200**	**260**	**460**	**2393**	**38700**
SD13-06	SD13-06-2040	N	2.0	4.0	**120 J**	**430**	**150**	**27 J**	**1700**	**160**	**190**	**2657**	**14200**
SD13-06	SD13-06-4050	N	4.0	5.0	**190**	**870**	3.2 U	**1400**	**5000**	**260**	**5600**	**13130**	**28200**
SD13-08	SD13-08-0005	N	0.0	0.5	**23 J**	**44 J**	3.3 U	3.3 U	**150 J**	**15 J**	**130 J**	**339**	**26700**
SD13-08	SD13-08-0520	N	0.5	2.0	**41 J**	**140**	3.3 U	3.3 U	**650**	**93 J**	**850**	**1733**	**28100**
SD13-08	SD13-92-0520	FD	0.5	2.0	**14 J**	**67 J**	3.3 U	3.3 U	**490**	**36 J**	**700**	**1293**	--
SD13-08	SD13-08-2040	N	2.0	4.0	**140**	**1100**	3.3 U	**95**	**5800**	**310**	**8000 J**	**15305**	**22200**
SD13-08	SD13-08-4655	N	4.6	5.5	3.3 U	**2 J**	3.3 U	3.3 U	**8.1**	3.3 U	**4.9**	**15**	**1250**
SD13-09	SD13-09-0002	N	0.0	0.2	**5.7 J**	**38 J**	3.3 U	**8.7 J**	**260**	**22 J**	**230**	**558.7**	**25500**
SD13-09	SD13-09-0203	N	0.2	0.3	**15 J**	**59 J**	3.3 U	**20 J**	**390**	**39 J**	**460**	**968**	**26100**
SD13-09	SD13-09-0305	N	0.3	0.5	**9.2 J**	**62 J**	3.2 U	**51 J**	**460**	**33 J**	**400**	**1006**	**26500**
SD13-09	SD13-09-0507	N	0.5	0.7	**26 J**	**91 J**	3.3 U	**44 J**	**500**	**63 J**	**580**	**1278**	**28800**
SD13-09	SD13-09-0708	N	0.7	0.8	**27 J**	**97 J**	3.3 U	**56 J**	**350**	**47 J**	**820**	**1370**	**23400**
SD13-09	SD13-09-0810	N	0.8	1.0	**21 J**	**54 J**	3.2 U	**42 J**	**160**	**25 J**	**200**	**481**	**23000**
SD13-09	SD13-09-1020	N	1.0	2.0	**31 J**	**140**	3.2 U	**34 J**	**770**	**69 J**	**730**	**1743**	**25600**
SD13-09	SD13-09-2040	N	2.0	4.0	**390**	**2800**	**700**	**140**	**15000**	**720**	**3100**	**22460**	**13000**
SD13-09	SD13-09-4055	N	4.0	5.5	**150**	**1300**	**250**	**91**	**7400**	**180**	**2200**	**11421**	**4150**
SD13-10	SD13-10-0005	N	0.0	0.5	**150 J**	**610**	**140 J**	**130 J**	**3500**	**580**	**590**	**5550**	**20600**
SD13-10	SD13-10-0520	N	0.5	2.0	**1300**	**7000**	**1700**	**120 J**	**29000**	**2000**	**5200**	**45020**	**33000**
SD13-10	SD13-10-2040	N	2.0	4.0	3.2 U	**26**	3.2 U	3.2 U	**110**	**20**	**13**	**169**	**7000**
SD13-10	SD13-10-4066	N	4.0	6.6	3.2 U	**6.2**	3.2 U	3.2 U	**15**	**2.2 J**	**1 J**	**24.4**	**5500**
SD13-10	SD13-10-6066	N	6.0	6.6	3.2 U	**2.1 J**	3.2 U	3.2 U	**8.3**	3.2 U	3.2 U	**10.4**	--
SD13-13	SD13-13-0005	N	0.0	0.5	**11 J**	**72 J**	3.2 U	**200**	**160**	**37 J**	**430**	**899**	**9700**
SD13-13	SD13-87-0005	FD	0.0	0.5	**19 J**	**44 J**	3.2 U	**38 J**	**2500**	**28 J**	**360**	**2970**	--

TABLE 8-2

Summary of Pesticide and Organic Carbon Results - 2013 Sediment Core Data

United Heckathorn Superfund Site, Richmond, California

					Pesticide results are µg/kg dry weight								
Location ID	Sample ID	Sample Type	Top Depth (ft)	Bottom Depth (ft)	Dieldrin	2,4-DDD	2,4-DDE	2,4-DDT	4,4-DDD	4,4-DDE	4,4-DDT	Total DDT	Total Organic Carbon (mg/kg)
SD13-13	SD13-13-0520	N	0.5	2.0	26	46	3.2 U	34	130	19	210	439	2450
SD13-13	SD13-13-2025	N	2.0	2.5	3.2 U	1.8 J	3.2 U	1.7 J	7.7	1.1 J	2.7 J	15	970
SD13-13	SD13-87-2025	FD	2.0	2.5	3.2 U	1.6 J	3.2 U	3.2 U	6.2	3.2 U	2.2 J	10	--
SD13-14	SD13-14-0005	N	0.0	0.5	140	1000	230	120 J	7200	150	3600	12300	12500
SD13-14	SD13-14-0509	N	0.5	0.9	110	900	230	90 J	5600 J	140 J	8000	14960	15700
SD13-14	SD13-14-1020	N	1.0	2.0	3.2 U	1.2 J	3.2 U	3.2 U	1.5 J	3.2 U	1.5 J	4.2	3050
SD13-14	SD13-14-2040	N	2.0	4.0	8.2	54	3.2 U	11	170	14	8.4	257.4	2950
SD13-15	SD13-15-0005	N	0.0	0.5	86	300	50	660	1200 J	420	3000 J	5630	19200
SD13-15	SD13-15-0520	N	0.5	2.0	96	220	85	140	1100 J	270	7900	9715	7700
SD13-15	SD13-15-2040	N	2.0	4.0	1.1 J	2.4 J	3.2 U	3.2 U	15	1.3 J	4.4	23.1	2350
SD13-15	SD13-15-4049	N	4.0	4.9	3.2 U	3.2 U	3.2 U	3.2 U	5.1	3.2 U	3.2 U	5.1	580
SD13-18	SD13-18-0005	N	0.0	0.5	45 J	170	3.2 U	170	820 J	74 J	750	1984	14200
SD13-18	SD13-18-0510	N	0.5	1.0	280	1300	330	400	4900	270	4400	11600	10100
SD13-18	SD13-18-1530	N	1.5	3.0	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	0 U	760
SD13-18	SD13-82-1530	FD	1.5	3.0	3.2 U	3.2 U	3.2 U	3.2 U	2.3 J	3.2 U	1.4 J	3.7	--
SD13-19	SD13-19-0005	N	0.0	0.5	41 J	140	3.3 U	1000	650 J	69 J	2700	4559	16300
SD13-19	SD13-19-0520	N	0.5	2.0	95	440	3.2 U	320	2300 J	130	8600	11790	10100
SD13-19	SD13-19-2040	N	2.0	4.0	77	440	64	620	1900 J	100	2500	5624	1350
SD13-19	SD13-19-4560	N	4.5	6.0	86	170	3.2 U	240	820 J	86	2800	4116	1600
SD13-20	SD13-20-0005	N	0.0	0.5	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	2.8 J	2.8	9600
SD13-20	SD13-20-0520	N	0.5	2.0	110	400	3.2 U	1500	1300	310	17000	20510	7800
SD13-20	SD13-20-2040	N	2.0	4.0	100	600	3.2 U	16000	8200	350	80000	105150	6350
SD13-20	SD13-20-4052	N	4.0	5.2	320	1200	98 J	1300	1300	450	13000	17348	9750
SD13-23	SD13-23-0005	N	0.0	0.5	180	740	3.2 U	2500	3500	260	23000	30000	10800
SD13-23	SD13-23-0520	N	0.5	2.0	360	1600	390	1000	8200 J	370	8100	19660	7150
SD13-23	SD13-77-0520	FD	0.5	2.0	520	430	430	900	2200	310	2500	6770	--
SD13-23	SD13-23-2037	N	2.0	3.7	630	6900	1600	1900	2300	1300	3500	17500	13600
SD13-24	SD13-24-0005	N	0.0	0.5	14 J	51 J	3.2 U	36 J	260	25 J	770	1142	17100
SD13-24	SD13-24-0520	N	0.5	2.0	10 J	55 J	3.2 U	15 J	100 J	20 J	86 J	276	4050
SD13-24	SD13-24-2040	N	2.0	4.0	3.3 U	17	3.3 U	15	72	6.1	47	157.1	3750
SD13-24	SD13-24-4060	N	4.0	6.0	40	350	79	210	1700	100	4700	7139	6200
SD13-25	SD13-25-0005	N	0.0	0.5	3.3 U	31 J	3.3 U	41 J	120	15 J	740	947	21100
SD13-25	SD13-25-0520	N	0.5	2.0	27 J	110	3.2 U	260	620	45 J	2800	3835	20700
SD13-25	SD13-25-2040	N	2.0	4.0	16 J	140	3.2 U	190	690	60 J	3600	4680	24300
SD13-25	SD13-75-2040	FD	2.0	4.0	20 J	180	3.3 U	650	730	86 J	3500	5146	--

TABLE 8-2

Summary of Pesticide and Organic Carbon Results - 2013 Sediment Core Data

United Heckathorn Superfund Site, Richmond, California

					Pesticide results are µg/kg dry weight								
Location ID	Sample ID	Sample Type	Top Depth (ft)	Bottom Depth (ft)	Dieldrin	2,4-DDD	2,4-DDE	2,4-DDT	4,4-DDD	4,4-DDE	4,4-DDT	Total DDT	Total Organic Carbon (mg/kg)
SD13-25	SD13-25-4059	N	4.0	5.9	70 J	110	92 J	180	900	190 J	3100	4572	12300
SD13-27	SD13-27-0005	N	0.0	0.5	13	34	17	2.1 J	210	13	97	373.1	5950
SD13-27	SD13-27-0520	N	0.5	2.0	5	35	17	0.99 J	240	15	8.4	316.39	1550
SD13-27	SD13-27-2031	N	2.0	3.1	3.2 U	3.2 U	3.2 U	3.2 U	4.9	3.2 U	3.2 U	4.9	570
SD13-28	SD13-28-0005	N	0.0	0.5	5.4 J	25 J	3.3 U	15 J	110 J	12 J	250	412	20500
SD13-28	SD13-28-0520	N	0.5	2.0	4.5 J	14 J	3.3 U	9.3 J	220	7.8 J	670	921.1	18900
SD13-28	SD13-28-2040	N	2.0	4.0	9	46	3.2 U	79	200	17	570	912	17300
SD13-28	SD13-28-4060	N	4.0	6.0	52	290	160	85	1600	93	2900	5128	19600
SD13-29	SD13-29-0005	N	0.0	0.5	4.8 J	14 J	3.3 U	18 J	66 J	8.1 J	240	346.1	23500
SD13-29	SD13-29-0520	N	0.5	2.0	14 J	36 J	3.2 U	67 J	100 J	24 J	500	727	24300
SD13-29	SD13-71-0520	FD	0.5	2.0	12 J	40 J	3.2 U	54 J	130	24 J	280 J	528	--
SD13-29	SD13-29-2040	N	2.0	4.0	3.3 U	31 J	3.3 U	3.3 U	150 J	20 J	120 J	321	23800
SD13-29	SD13-29-4060	N	4.0	6.0	3.3 U	60 J	16 J	18 J	230	35 J	130 J	489	23300
SD13-31	SD13-31-0005	N	0.0	0.5	3.2 U	1.2 J	3.2 U	3.2 U	4.9	1 J	4.9	12	1700
SD13-31	SD13-31-0520	N	0.5	2.0	3.2 U	3.2 U	3.2 U	3.2 U	1.5 J	3.2 U	3.2 U	1.5	930
SD13-31	SD13-31-2040	N	2.0	4.0	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	0.69 J	0.69	810
SD13-31	SD13-69-2040	FD	2.0	4.0	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	0.69 J	0.69	--
SD13-32	SD13-32-0005	N	0.0	0.5	3.2 U	3.2 U	3.2 U	4.6 J	24	3.2 U	150 J	178.6	17100
SD13-32	SD13-32-0520	N	0.5	2.0	4.1 J	18 J	3.2 U	23 J	100 J	8.6 J	91 J	240.6	16700
SD13-32	SD13-32-2040	N	2.0	4.0	3.5 J	24 J	3.3 U	17 J	130	9.1 J	170 J	350.1	17700
SD13-32	SD13-32-4060	N	4.0	6.0	33 J	120	57 J	48 J	630	56 J	1000 J	1911	11300
SD13-33	SD13-33-0005	N	0.0	0.5	5.5 J	19 J	3.2 U	15 J	68 J	12 J	91 J	205	20400
SD13-33	SD13-33-0520	N	0.5	2.0	3.2 U	48 J	3.2 U	69 J	120	29 J	140 J	406	20400
SD13-33	SD13-33-2040	N	2.0	4.0	4.2 J	12 J	3.3 U	18 J	89 J	11 J	130 J	260	25300
SD13-33	SD13-33-4060	N	4.0	6.0	2.1 J	14 J	3.2 U	3.2 U	39 J	6.4 J	140 J	199.4	24500
SD13-35	SD13-35-0005	N	0.0	0.5	6.1 J	22 J	3.2 U	8.1 J	80 J	11 J	71 J	192.1	14200
SD13-35	SD13-65-0005	FD	0.0	0.5	1.7 J	5.3	3.3 U	2.4 J	28	4.1	61	100.8	--
SD13-35	SD13-35-0520	N	0.5	2.0	4.9	40	3.3 U	3.3 U	130	13	50	233	14200
SD13-35	SD13-35-2040	N	2.0	4.0	16	86	26	3.2 U	310	36	130	588	7050
SD13-35	SD13-35-4058	N	4.0	5.8	15	120	38	3.2 U	390	25	130	703	6500
SD13-36	SD13-36-0005	N	0.0	0.5	3.3 U	4.2 J	3.3 U	3.3 U	16 J	2.7 J	33 J	55.9	16100
SD13-36	SD13-36-0520	N	0.5	2.0	5.1	53	19	18	270	15	330	705	16500
SD13-36	SD13-36-2040	N	2.0	4.0	39	550	180	17	3300	100	2000	6147	13000
SD13-36	SD13-36-4065	N	4.0	6.5	3.2 U	11 J	3.2 U	3.7 J	73 J	14 J	56 J	157.7	10400
SD13-37	SD13-37-0005	N	0.0	0.5	3.2 U	4.5 J	3.2 U	3.3 J	28 J	6.2 J	31 J	73	21200

TABLE 8-2

Summary of Pesticide and Organic Carbon Results - 2013 Sediment Core Data

United Heckathorn Superfund Site, Richmond, California

					Pesticide results are µg/kg dry weight								
Location ID	**Sample ID**	**Sample Type**	**Top Depth (ft)**	**Bottom Depth (ft)**	**Dieldrin**	**2,4-DDD**	**2,4-DDE**	**2,4-DDT**	**4,4-DDD**	**4,4-DDE**	**4,4-DDT**	**Total DDT**	**Total Organic Carbon (mg/kg)**
SD13-37	SD13-63-0005	FD	0.0	0.5	**4.3 J**	**10 J**	3.2 U	**1 J**	**45 J**	**6.5 J**	**60 J**	**122.5**	--
SD13-37	SD13-37-0520	N	0.5	2.0	3.2 U	**4.2 J**	3.2 U	3.2 U	**24 J**	**5.4 J**	**21 J**	**54.6**	**20800**
SD13-37	SD13-37-2040	N	2.0	4.0	**6.3 J**	**31 J**	**27 J**	3.2 U	**160**	**34 J**	**110**	**362**	**24100**
SD13-37	SD13-37-4060	N	4.0	6.0	3.2 U	**7 J**	3.2 U	3.2 U	**23 J**	**3.6 J**	**23 J**	**56.6**	**21400**
SD13-39	SD13-39-0005	N	0.0	0.5	3.2 U	3.2 U	3.2 U	3.2 U	**12 J**	**2.4 J**	**8.6 J**	**23**	**16400**
SD13-39	SD13-39-0520	N	0.5	2.0	3.8 U	**4**	3.8 U	3.8 U	**26**	**5.2**	**23**	**58.2**	**17300**
SD13-39	SD13-39-2034	N	2.0	3.4	3.3 U	**7.9**	**3.5**	3.3 U	**21**	**3.7**	**17**	**53.1**	**15900**
SD13-39	SD13-39-4049	N	4.0	4.9	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	**1.1 J**	**1.1**	**4050**
SD13-40	SD13-40-0005	N	0.0	0.5	**1.7 J**	**3.8 J**	**6.3 J**	3.3 U	**24 J**	**3.6 J**	**11 J**	**48.7**	**15400**
SD13-40	SD13-40-0520	N	0.5	2.0	**3.5 J**	**4.7 J**	3.2 U	3.2 U	**14 J**	**4.2 J**	**9.1 J**	**32**	**13200**
SD13-40	SD13-40-2040	N	2.0	4.0	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	0 U	**1350**
SD13-41	SD13-41-0005	N	0.0	0.5	3.2 U	**2.5 J**	3.2 U	3.2 U	**9.3 J**	**3.7 J**	**8.4 J**	**23.9**	**18100**
SD13-41	SD13-41-0520	N	0.5	2.0	**3.5 J**	**32 J**	**9 J**	**3.5 J**	**100 J**	**16 J**	**30 J**	**190.5**	**14900**
SD13-41	SD13-41-2040	N	2.0	4.0	3.2 U	**8.1 J**	3.2 U	3.2 U	**48 J**	**9.3 J**	**94 J**	**159.4**	**14200**
SD13-41	SD13-41-4049	N	4.0	4.9	3.2 U	3.2 U	3.2 U	3.2 U	**2.4 J**	3.2 U	3.2 U	**2.4**	**1400**
SD13-41	SD13-59-4049	FD	4.0	4.9	3.2 U	3.2 U	3.2 U	3.2 UJ	**3 J**	**0.78 J**	**1.7 J**	**5.48**	--
SD13-41	SD13-41-5565	N	5.5	6.5	3.2 U	3.2 U	3.2 U	3.2 UJ	3.2 U	3.2 U	**1.2 J**	**1.2**	--

Notes:

Bold values indicate detected result.

Total DDT is the sum of the detected isomers.

FD - field duplicate

N - normal sample

ft - feet

g/g - grams per gram

mg/kg - milligrams per kilogram

µg/kg - micrograms per kilogram

J - estimated value

U - not detected above reporting limit shown

> actual value is greater than result shown

TABLE 9-1

Conclusions of Source Identification Study

United Heckathorn Superfund Site, Richmond, California

Potential Ongoing Source	Character of Potential Source
Embankment Areas	Pipes and outfalls are unlikely to be significant sources of pesticides to the Lauritzen Channel during dry weather conditions because they do not convey dry weather flow. One seep that was sampled contained low levels of pesticides. Pipes and outfalls have not been inspected or sampled during wet weather conditions. Some of the identified and possible unidentified pipes and conveyances could have and may still act as preferential pathways for contaminant transport from upland areas with DDT-contaminated soil and groundwater to the Lauritzen Channel. DDT contamination above the remediation goal is widespread along the eastern, northern, and northwestern shorelines of the channel. Although the shoreline is largely armored with rip rap, concrete, and sheetpile, fine-grained sediments are present in pockets in the rip rap and soils are eroding from under the sheetpile in some areas.
Groundwater Seepage	Estimated contribution to channel is 167 g DDT per year, which is not sufficient to account for concentrations currently observed in sediments but continues to impact channel sediments, surface water, and biota.
Wood Pilings	Desorption is not a significant source of DDT to surface water or sediment. Mechanical weathering of the pilings could result in incorporation of DDT-contaminated particles into the sediment bed and potentially into the food web.
Stormwater Outfalls	The municipal storm drain system cannot be fully evaluated as an ongoing source of contamination until DDT-contaminated residual sediments are removed from the system. The storm drain system that serves the upland cap on the Levin Richmond Terminal property is generally functioning as designed. Low levels of pesticides are periodically detected in stormwater samples.
Source Material Outside of the Lauritzen Channel	There were no sources of DDT outside of the Lauritzen Channel that were identified as having potential to act as an outside source to the site.
Areas Not Previously Dredged	Dredging residuals appear to be the primary source of present day contamination in the Lauritzen Channel.

Figures

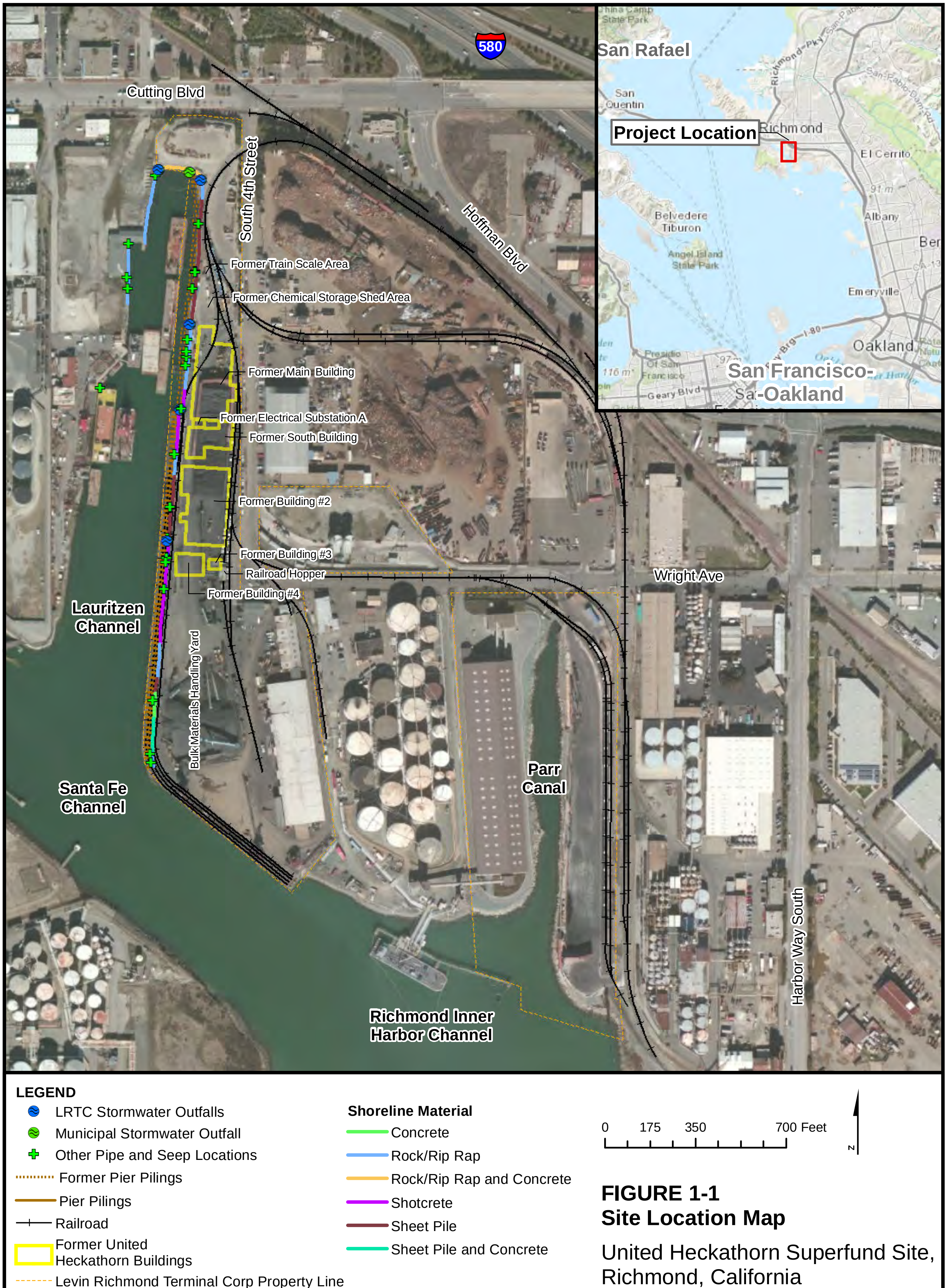

FIGURE 1-1
Site Location Map

United Heckathorn Superfund Site, Richmond, California

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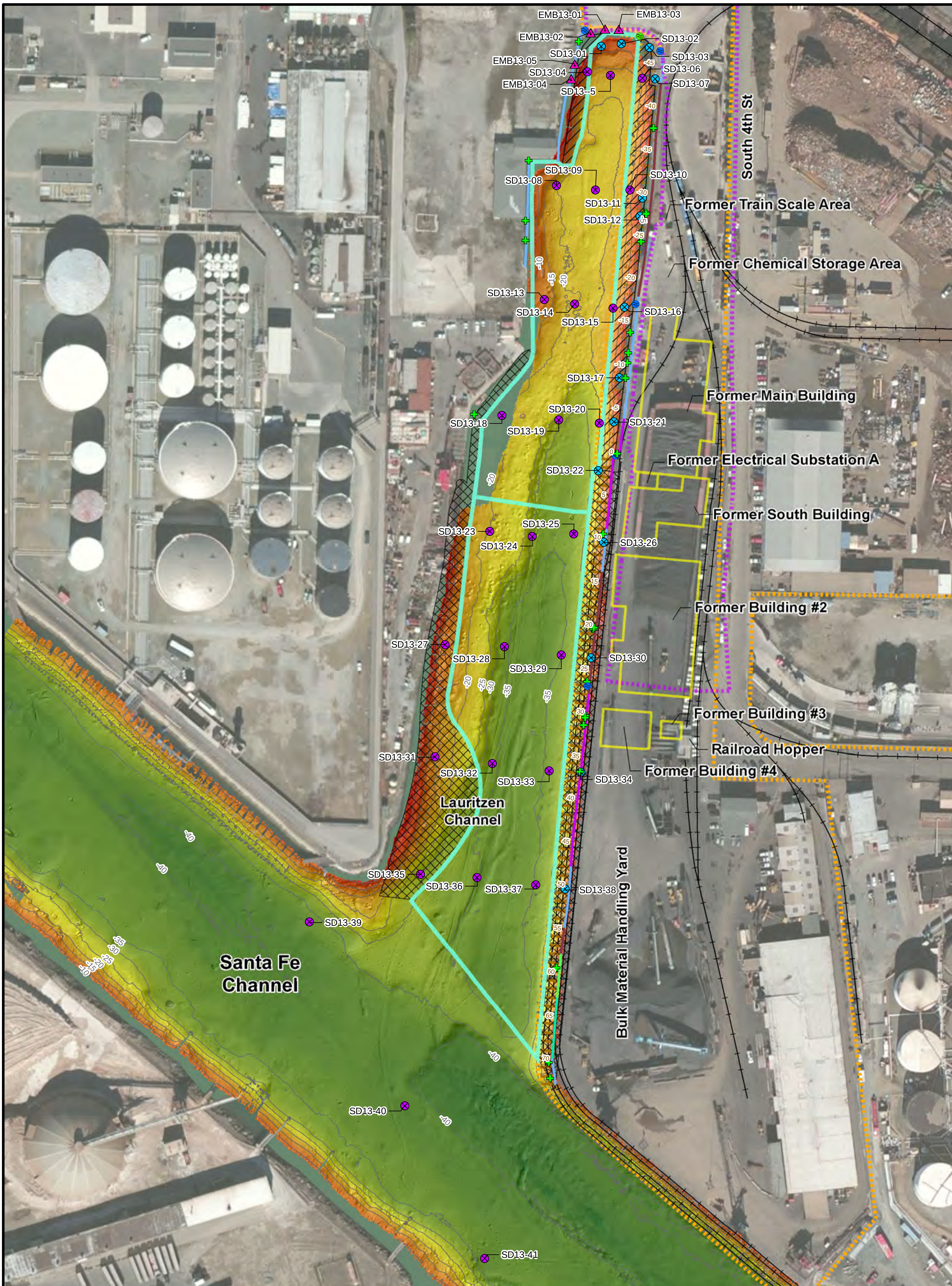
Document Path: D:\Projects\EPA_UnitedHeckathorn\MapFiles\2013\August\SiteLocationMap8.5x11.mxd



LEGEND

- Sediment Grab Sample Location
- Vibracore Sample Location
- Embankment Soil Grab Sample Location

Bathymetry

- 1 ft
- 44 ft
- -40 Bathymetric Contour (5 foot Interval)
- Contour depth label

- LRTC Stormwater Outfalls
- Municipal Stormwater Outfall
- Other Pipe and Seep Locations
- 10 Former Pier Pilings (bent number)
- -10 Pier Pilings (bent number)
- Railroad
- Former Buildings
- Dredged Area
- Partially Dredged Area
- Un-Dredged Area

- Concrete
- Rock/Rip Rap
- Rock/Rip Rap and Concrete
- Shotcrete
- Sheet Pile
- Sheet Pile and Concrete

N

0 60 120 240 Feet

FIGURE 2-1
2013 Sediment Sampling Locations
United Heckathorn Superfund Site
Richmond, California

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BAO \\ZINFANDEL\PROJ\USENVIRONMENTALPROTE\340138UHFS\GIS\EPA_UNITED_HECKATHORN\MAPFILES\2013\AUGUST\SEDIMENTSAMPLELOCATIONS.MXD JCARR3 11/18/2013 1:41:28 PM

LEGEND

- Groundwater Sample Location
- Groundwater Monitoring Well - Sampled
- Groundwater Monitoring Well
- Removed Groundwater Well
- B24 = Removed Groundwater Well Name
- GW13-14 = Sample Location ID
- Railroad
- Pier Pilings (bent number)
- Former Pier Pilings (bent number)
- Buildings
- Concrete
- Rock/Rip Rap
- Rock/Rip Rap and Concrete
- Shotcrete
- Steel Pile
- Steel Sheets and Concrete

Note:
Groundwater samples were collected at MW13-01 and MW13-03.
These wells were also used for groundwater hydrogeologic evaluations.
MW13-02 and MW13-04 were only used for groundwater hydrogeologic evaluation.

0 50 100 200 Feet

Figure 2-2
2013 Groundwater Sampling Locations
United Heckathorn Superfund Site
Richmond, California

CH2MHILL

BAO \\ZINFANDEL\PROJ\USENVIRONMENTALPROTE\340138UHFS\GIS\EPA_UNITED_HECKATHORN\MAPFILES\2013\AUGUST\GROUNDWATERSAMPLING_2013.MXD JCARR3 2/28/2014 10:39:21 AM

LEGEND

- LRTC Stormwater Outfalls
- Municipal Stormwater Outfall
- Other Pipe and Seep Locations
- Former Pier Pilings
- Pier Pilings
- Levin Richmond Terminal Corp Property Line
- Railroad
- Former Buildings
- Approximate Extent of Upland Cap
- Dredged Area
- Partially Dredged Area
- Un-Dredged Area
- Approximate Location of Stormwater Interceptor
- Former Excavation Area

Shoreline Material

- Concrete
- Rock/Rip Rap
- Rock/Rip Rap and Concrete
- Shotcrete
- Sheet Pile
- Sheet Pile and Concrete

- Historical soil stockpile with total pesticide concentrations greater than 1,000 mg/kg.
- Historical soil stockpile with total pesticide concentrations less than 1,000 mg/kg.

Note:
Stockpile locations determined from Removal of Pesticide-Affected Soils, United Heckathorn Site, Richmond, California (Levine-Fricke, 1991). Prepared for Levin Richmond Terminal Corporation. May. Stockpiles were generated during interim remedial actions in 1990 - 1991.

0 75 150 300 Feet

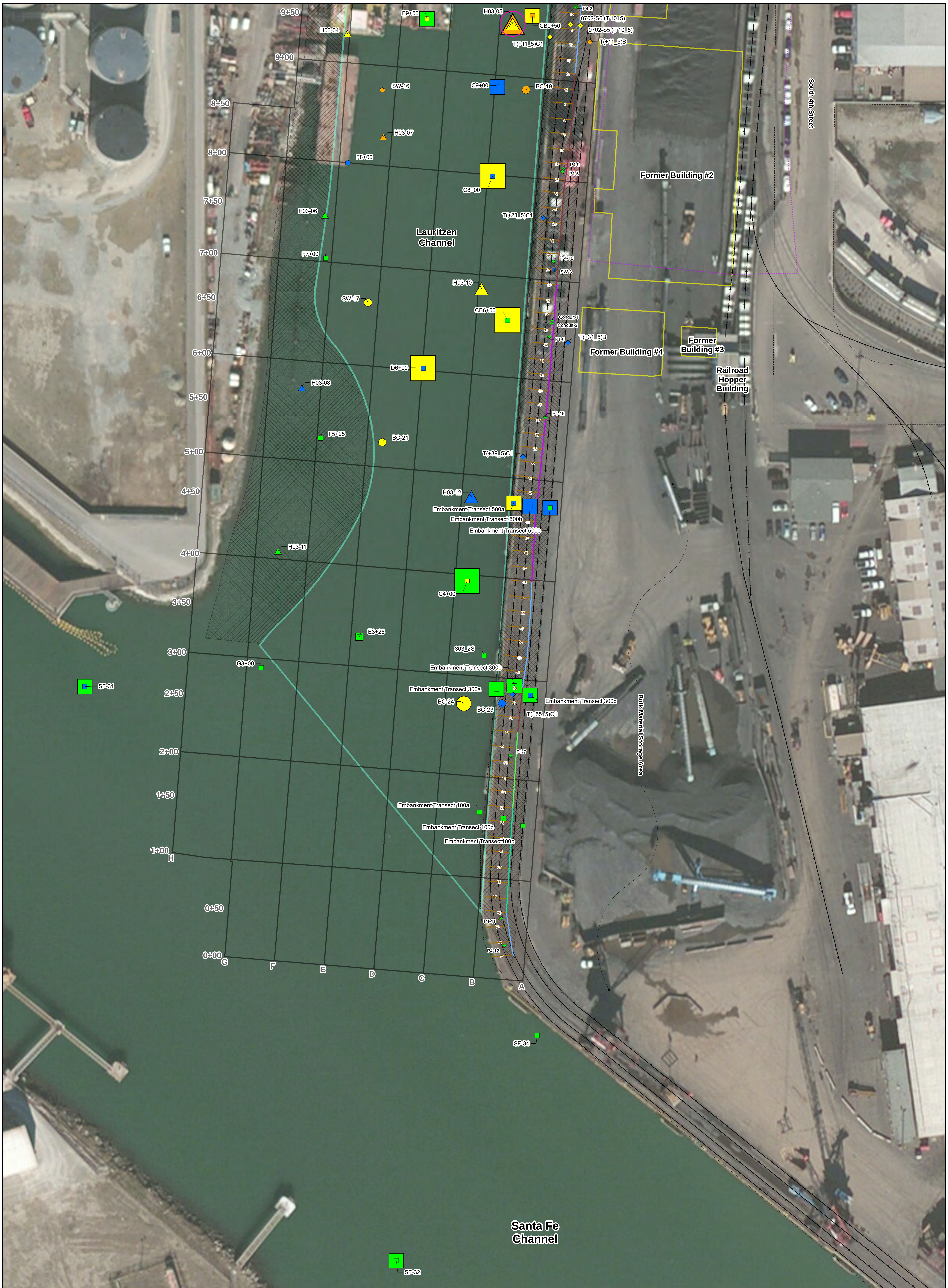
Figure 3-1
Site Features
United Heckathorn Superfund Site,
Richmond, California

BAO \\ZINFANDEL\PROJ\USENVIRONMENTALPROTE\340138UHFS\GIS\EPA_UNITED_HECKATHORN\MAPFILES\2013\AUGUST\SITEFEATURES.MXD JCARR3 11/19/2013 2:32:30 PM

CH2MHILL

FIGURE 3-2A
DDT Results (prior to 2013)
in the Northern Reach of the
Lauritzen Channel
United Heckathorn Superfund Site
Richmond, California

Document Path: D:\Projects\EPA_UnitedHeckathorn\MapFiles\2013\August\YBM_Results_DDT_NorthEnd.mxd



LEGEND

- LRTC Stormwater Outfalls
- Municipal Stormwater Outfall
- Other Pipe and Seep Locations
- Former Pier Pilings
- Pier Pilings
- Railroad
- Property Line
- Approximate Upland Cap Area
- Former Building
- Sampling Grid
- Dredged Area
- Partially Dredged Area
- Un-Dredged Area
- Concrete
- Rock/Rip Rap
- Rock/Rip Rap and Concrete
- Shotcrete
- Sheet Pile
- Sheet Pile and Concrete

Sample Depth

- 0 - 6"
- 7" - 2 feet
- 2.1 - 4 feet
- > 4 feet

Result Concentration (µg/kg)

- 0-590 (Remediation Goal)
- 591-2,950 (5 x RG)
- 2,951 - 29,500 (50 x RG)
- 29,501 - 295,000 (500 x RG)
- 295,001 - >590,000 (1,000 x RG)

Sample Year

- 1999
- 2002
- 2003
- 2007

Results reported by Stanford. ΣDDT reported values are the sum of the o,p' and p,p' isomers of DDT and DDD and the p,p' isomer of DDE and DDMU

N

0 40 80 160 Feet

FIGURE 3-2B
DDT Results (prior to 2013)
in the Southern Reach of the
Lauritzen Channel

United Heckathorn Superfund Site
Richmond, California

Document Path: D:\Projects\EPA_UnitedHeckathorn\MapFiles\2013\August\YBM_Results_DDT_SouthEnd.mxd

LEGEND

- Wood Chip Sample Location
- LRTC Stormwater Outfalls
- Municipal Stormwater Outfall
- Other Pipe and Seep Locations
- Former Pier Pilings
- Pier Pilings
- Levin Richmond Terminal Corp Property Line
- Railroad
- Former Buildings
- Approximate Extent of Upland Cap
- Dredged Area
- Partially Dredged Area
- Un-Dredged Area

Shoreline Material

- Concrete
- Rock/Rip Rap
- Rock/Rip Rap and Concrete
- Shotcrete
- Sheet Pile
- Sheet Pile and Concrete

Notes

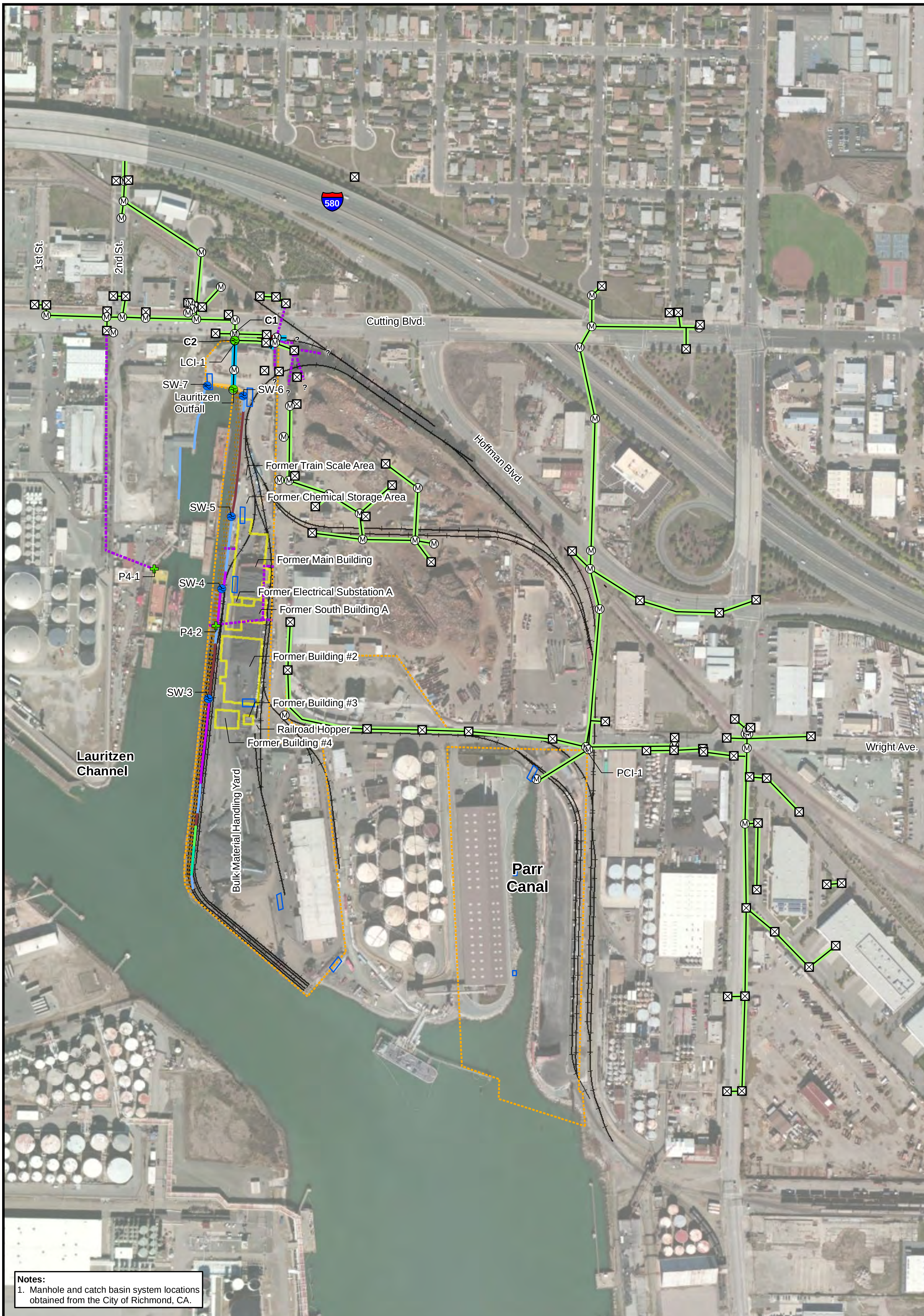
1. NA - Sample not analyzed, field immunoassay results indicated that CR-35 was similar to CR-33.
2. U - parameter not detected above the reporting limit shown
3. Concentrations presented in µg/kg - micrograms per kilogram (part per billion).

0 70 140 280 Feet

FIGURE 5-1
Wood Chip Sample Locations and Results
United Heckathorn Superfund Site, Richmond, California

CH2MHILL

Document Path: D:\Projects\EPA_UnitedHeckathorn\MapFiles\2013\August\WoodChipSamples.mxd



LEGEND

- LRTC Stormwater Outfalls
- Municipal Stormwater Outfall
- Other Pipe or Seep Location
- Railroad
- Pier Pilings
- Former Pier Pilings
- Levin Richmond Terminal Corp Property Line
- Catch Basin
- Manhole
- City of Richmond Stormwater Line
- Hydraulically isolated
- Video Surveyed
- Municipal lines -Unknown status
- Approximate Location of Stormwater Interceptor

Shoreline Material

- Concrete
- Rock/Rip Rap
- Rock/Rip Rap and Concrete
- Shotcrete
- Sheet Pile
- Sheet Pile and Concrete

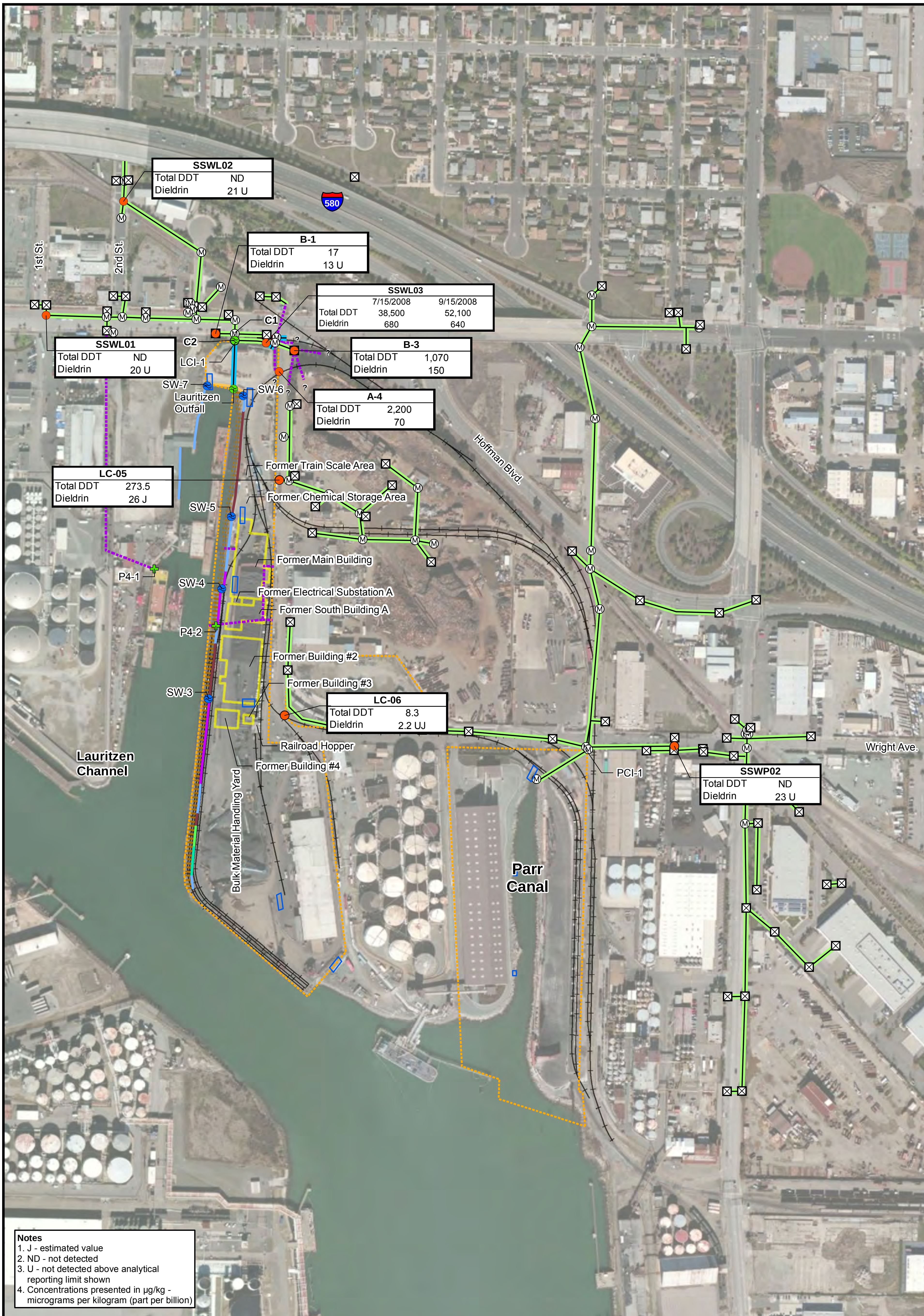
0 125 250 500 Feet

N

FIGURE 6-1
Stormwater System Map
United Heckathorn Superfund Site,
Richmond, California

CH2MHILL

Document Path: D:\Projects\EPA_UnitedHeckathorn\MapFiles\2013\August\Stormwater_System11X17.mxd Date Saved: 8/8/2013 10:54:03 AM



LEGEND

- Stormwater Sample Location
- LRTC Stormwater Outfalls
- Municipal Stormwater Outfall
- Other Pipe or Seep Location
- Railroad
- Pier Pilings
- Former Pier Pilings
- Levin Richmond Terminal Corp Property Line
- Catch Basin
- Manhole
- City of Richmond Stormwater Line
- Hydraulically isolated
- Video Surveyed
- Municipal lines -Unknown status
- Approximate Location of Stormwater Interceptor

Shoreline Material

- Concrete
- Rock/Rip Rap
- Rock/Rip Rap and Concrete
- Shotcrete
- Sheet Pile
- Sheet Pile and Concrete

0 125 250 500 Feet

N

FIGURE 6-2
Storm Drain Sediment Analytical Results
United Heckathorn Superfund Site
Richmond, California

CH2MHILL

BAO \\ZINFANDEL\PROJ\USENVIRONMENTALPROTE\340138UHFS\GIS\EPA_UNITED_HECKATHORN\MAPFILES\2013\AUGUST\STORMWATER_SYSTEM_PESTICIDERESULTS.MXD JCARR3 2/26/2014 2:50:59 PM

Data collected for the USACE investigation were used to determine dredge disposal requirements and targeted sample depths were selected relative to mean lower low water (MLLW). The actual as-sampled intervals of the USACE samples are different than those collected as part of the site characterization for Lauritzen Channel. Please see Table 7-1 of the Source ID Report for a listing of USACE sample depths relative to the sediment surface.

LEGEND

- LRTC Stormwater Outfalls
- Municipal Stormwater Outfall
- Other Pipe and Seep Locations
- Former Pier Pilings
- Pier Pilings
- Railroad
- Former Buildings
- Dredged Area
- Partially Dredged Area
- Un-Dredged Area
- Concrete
- Rock/Rip Rap
- Rock/Rip Rap and Concrete
- Shotcrete
- Sheet Pile
- Sheet Pile and Concrete
- No YBM Observed

2013 Sample Depth	USACE Sample Depths
0 - 0.5 feet	-39.0 to -39.5 MLLW
0.5 - 2 feet	-39.5 to -40.0 MLLW
2 - 4 feet	-40.0 to -40.5 MLLW
> 4 feet	

Sediment Core DDT Results

0 - 10 µg/kg	1,001 - 2,000 µg/kg
10.1 - 100 µg/kg	2,001 - 5,000 µg/kg
101 - 300 µg/kg	5,001 - 10,000 µg/kg
301 - 500 µg/kg	10,001 - 20,000 µg/kg
501 - 1,000 µg/kg	>20,000 µg/kg

Figure 7-1
USACE 2012 Richmond Inner Harbor Samples
United Heckathorn Superfund Site
Richmond, California

CH2MHILL

BAO \\ZINFANDEL\PROJ\USENVIRONMENTALPROTE\340138UHFS\GIS\EPA_UNITED_HECKATHORN\MAPFILES\2013\AUGUST\USACE2012INNERHARBORSAMPLES.MXD JCARR3 2/26/2014 2:44:27 PM

LEGEND

- LRTC Stormwater Outfalls
- Municipal Stormwater Outfall
- Other Pipe and Seep Locations
- Lauritzen Channel Site Boundary
- Pier Pilings (bent number)
- Former Pier Pilings (bent number)
- Former Buildings
- Dredged
- Partially Dredged
- Not Dredged
- Channel Area
- Embankment Area
- Levin Richmond Terminal Corp Property Line
- Railroad

Shoreline Material

- Concrete
- Rock/Rip Rap
- Rock/Rip Rap and Concrete
- Shotcrete
- Sheet Pile
- Sheet Pile and Concrete

N

0 62.5 125 250 Feet

FIGURE 8-1
Dredged Areas

UNITED HECKATHORN SUPERFUND SITE
RICHMOND, CALIFORNIA

CH2MHILL

D:\Projects\EPA_UnitedHeckathorn\MapFiles\2013\August\DredgeingMap.mxd

LEGEND

- LRTC Stormwater Outfalls
- Municipal Stormwater Outfall
- Other Pipe and Seep Locations
- Former Buildings
- Levin Richmond Terminal Corp Property Line
- Railroad
- Concrete
- Rock/Rip Rap
- Rock/Rip Rap and Concrete
- Shotcrete
- Sheet Pile
- Sheet Pile and Concrete

Bathymetry

- Bathymetric Contour MLLW Feet (5 foot Interval)
- -1 ft
- -44 ft

Younger Bay Mud Thickness (ft)

- 0 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- >5

- Benthic Sand Layer Present
- Benthic Sand Layer Absent

Data Notes:
Young Bay Mud thicknesses have been corrected for less than 100 percent core recovery.

Bathymetric Data Source:
Sea Engineering Inc. (SEI)
January 29, 2013.

Data was collected by SEI in 2012 using a Reson 7125 multibeam echosounder operating at 400 kHz.

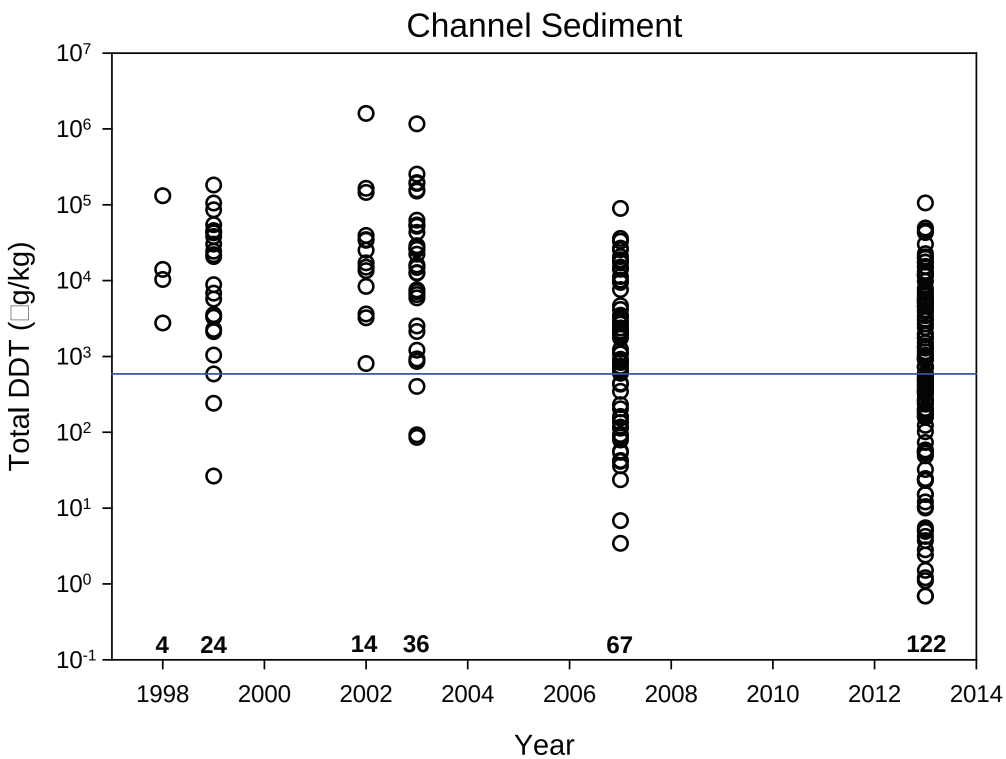
N

0 100 200 400 Feet

FIGURE 8-2
Younger Bay Mud Thickness and Evidence of Benthic Sand Layer
United Heckathorn Superfund Site, Richmond, California

CH2MHILL

Document Path: D:\Projects\EPA_UnitedHeckathorn\MapFiles\2013\August\YBM_BenthicSandLayer.mxd



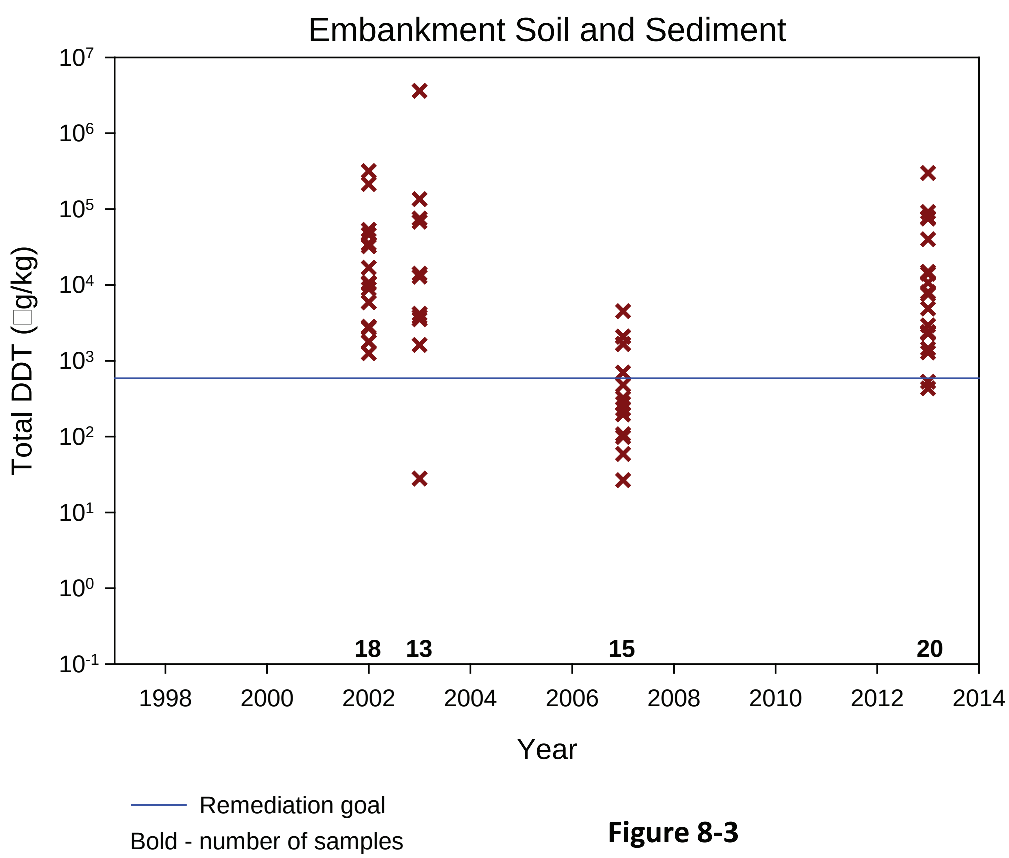
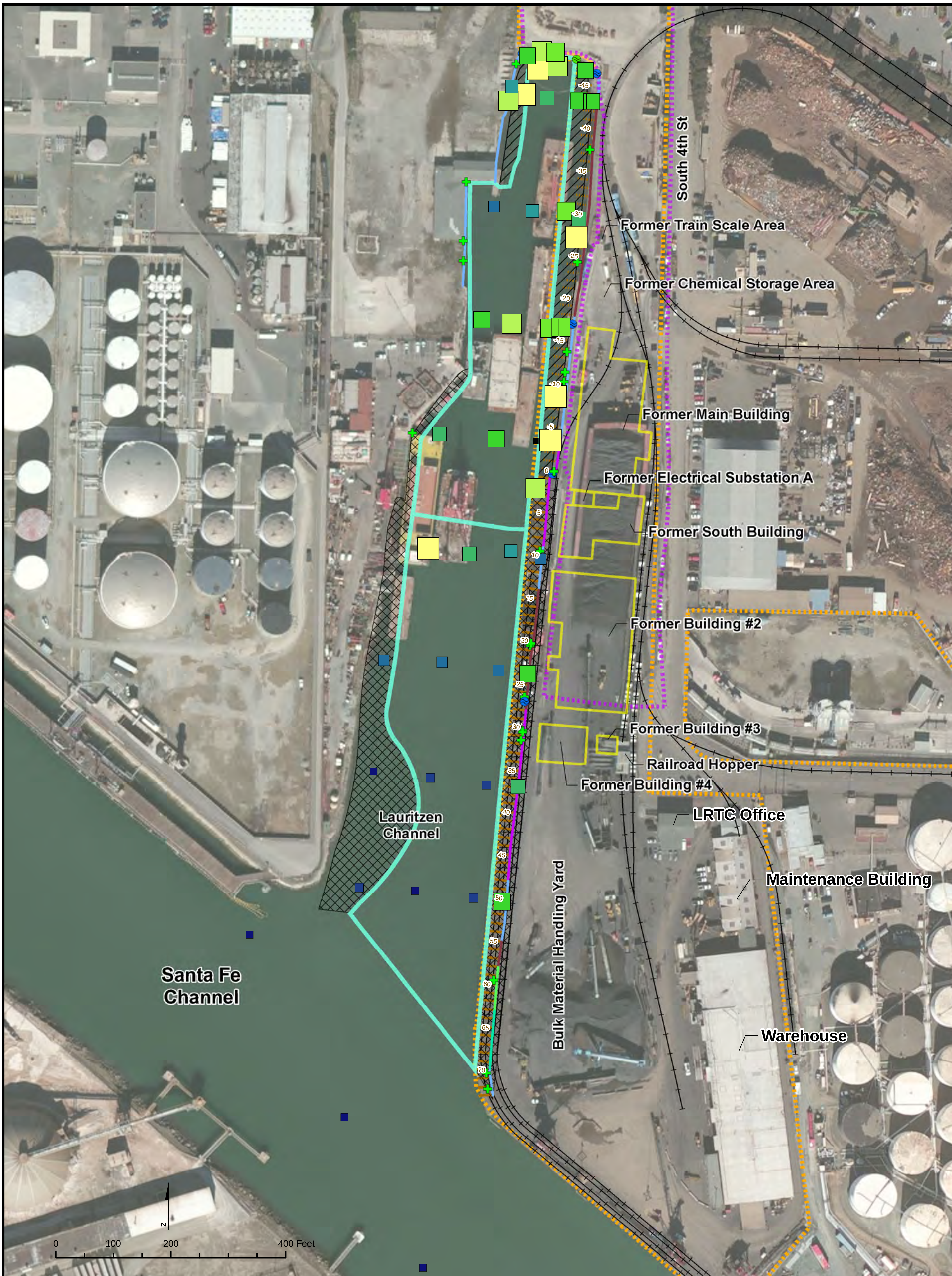


Figure 8-3

Total DDT Concentrations in Channel and Embankment Samples from 1998-2013

United Heckathorn Superfund Site, Richmond, California



LEGEND

- LRTC Stormwater Outfalls
- Municipal Stormwater Outfall
- Other Pipe and Seep Locations
- Former Pier Pilings
- Pier Pilings
- Railroad
- Former Buildings
- Dredged Area
- Partially Dredged Area
- Un-Dredged Area
- Concrete
- Rock/Rip Rap
- Rock/Rip Rap and Concrete
- Shotcrete
- Sheet Pile
- Sheet Pile and Concrete

Sediment Surface Max DDT Results

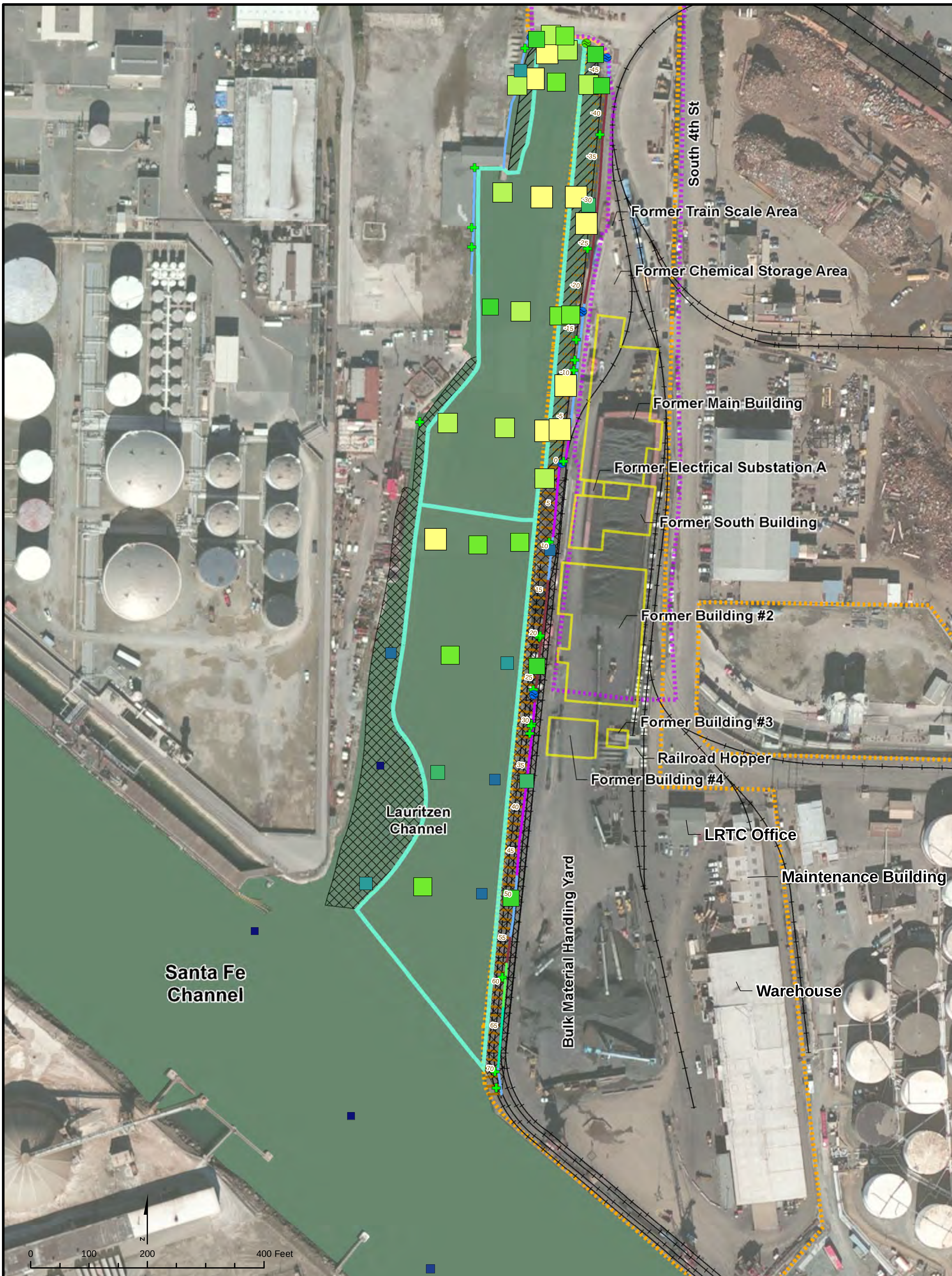
- 0 - 10 µg/kg
- 10.1 - 100 µg/kg
- 101 - 300 µg/kg
- 301 - 500 µg/kg
- 501 - 1,000 µg/kg
- 1,001 - 2,000 µg/kg
- 2,001 - 5,000 µg/kg
- 5,001 - 10,000 µg/kg
- 10,001 - 20,000 µg/kg
- >20,000 µg/kg

Notes
bss - below sediment surface
RG - remediation goal
µg/kg - microgram per kilogram

Figure 8-4
Total DDT Concentration in Surface Samples (0 to 0.5 feet bss) from 2013 Sediment Locations
United Heckathorn Superfund Site, Richmond, California

CH2MHILL

BAO \\ZINFANDEL\PROJ\USENVIRONMENTALPROTE\340138UHFS\GIS\EPA_UNITED_HECKATHORN\MAPFILES\2013\AUGUST\SEDIMENTRESULTS_TOTAL.MXD JCARR3 11/19/2013 2:08:55 PM



LEGEND

- LRTC Stormwater Outfalls
- Municipal Stormwater Outfall
- Other Pipe and Seep Locations
- Former Pier Pilings
- Pier Pilings
- Railroad
- Former Buildings
- Dredged Area
- Partially Dredged Area
- Un-Dredged Area
- Concrete
- Rock/Rip Rap
- Rock/Rip Rap and Concrete
- Shotcrete
- Sheet Pile
- Sheet Pile and Concrete

Sediment Core Max DDT Results

- 0 - 10 µg/kg
- 10.1 - 100 µg/kg
- 101 - 300 µg/kg
- 301 - 500 µg/kg
- 501 - 1,000 µg/kg
- 1,001 - 2,000 µg/kg
- 2,001 - 5,000 µg/kg
- 5,001 - 10,000 µg/kg
- 10,001 - 20,000 µg/kg
- >20,000 µg/kg

Notes
(0) Represents the top depth of the sample interval with the maximum detected DDT concentration at this location

bss - below sediment surface
RG - remediation goal
µg/kg - microgram per kilogram

Figure 8-5
Maximum DDT Concentrations in All Sample Depths (0 to 6 feet bss) from 2013 Sediment Locations
United Heckathorn Superfund Site
Richmond, California

CH2MHILL

BAO \\ZINFANDEL\PROJ\USENVIRONMENTALPROTE\340138UHFS\GIS\EPA_UNITED_HECKATHORN\MAPFILES\2013\AUGUST\SEDIMENTRESULTS_CORE.MXD JCARR3 11/19/2013 2:07:43 PM

Appendix A
Hourly Tidal Study Data and Monitoring Well Boring Logs

APPENDIX A

Hourly Tidal Study Data - March 2013

United Heckathorn Superfund Site, Richmond, California

		Elevation - feet NAVD88			
Date and Time	Lauritzen Channel	MW13-01	MW13-02	MW13-03	MW13-04
3/26/2013 16:00:00	1.19	3.02	3.23	2.01	3.27
3/26/2013 17:00:00	0.36	2.63	2.88	1.21	2.58
3/26/2013 18:00:00	-0.13	2.38	2.62	0.72	2.11
3/26/2013 19:00:00	0.35	2.43	2.56	1.06	2.09
3/26/2013 20:00:00	1.13	2.65	2.65	1.71	2.35
3/26/2013 21:00:00	2.64	3.20	3.05	3.00	3.13
3/26/2013 22:00:00	3.82	3.73	3.31	4.04	3.84
3/26/2013 23:00:00	4.73	4.19	3.66	4.90	4.53
3/27/2013 00:00:00	5.29	4.52	3.93	5.45	5.02
3/27/2013 01:00:00	5.20	4.60	4.07	5.46	5.24
3/27/2013 02:00:00	4.54	4.42	4.05	4.95	5.09
3/27/2013 03:00:00	3.15	3.93	3.80	3.80	4.49
3/27/2013 04:00:00	1.69	3.37	3.45	2.51	3.68
3/27/2013 05:00:00	0.39	2.82	3.03	1.30	2.81
3/27/2013 06:00:00	-0.17	2.49	2.73	0.73	2.22
3/27/2013 07:00:00	-0.30	2.31	2.52	0.53	1.87
3/27/2013 08:00:00	0.38	2.40	2.52	1.06	2.01
3/27/2013 09:00:00	1.45	2.71	2.71	1.96	2.49
3/27/2013 10:00:00	2.92	3.26	3.07	3.24	3.29
3/27/2013 11:00:00	3.95	3.71	3.38	4.18	4.02
3/27/2013 12:00:00	4.71	4.11	3.69	4.91	4.62
3/27/2013 13:00:00	4.89	4.29	3.87	5.13	4.87
3/27/2013 14:00:00	4.56	4.25	3.93	4.92	4.92
3/27/2013 15:00:00	3.58	3.95	3.81	4.12	4.55
3/27/2013 16:00:00	2.28	3.50	3.53	3.00	3.93
3/27/2013 17:00:00	1.06	3.02	3.18	1.89	3.14
3/27/2013 18:00:00	0.44	2.72	2.89	1.28	2.59
3/27/2013 19:00:00	0.34	2.57	2.72	1.11	2.28
3/27/2013 20:00:00	0.96	2.69	2.74	1.58	2.42
3/27/2013 21:00:00	2.14	3.07	2.96	2.57	2.93
3/27/2013 22:00:00	3.44	3.61	3.29	3.71	3.67
3/27/2013 23:00:00	4.61	4.16	3.65	4.79	4.43
3/28/2013 00:00:00	5.33	4.56	3.95	5.48	5.04
3/28/2013 01:00:00	5.66	4.81	4.17	5.84	5.42
3/28/2013 02:00:00	5.27	4.76	4.25	5.58	5.44
3/28/2013 03:00:00	4.15	4.39	4.10	4.67	5.04
3/28/2013 04:00:00	2.58	3.79	3.77	3.32	4.27
3/28/2013 05:00:00	1.10	3.19	3.36	1.98	3.38
3/28/2013 06:00:00	-0.07	2.68	2.94	0.88	2.53
3/28/2013 07:00:00	-0.61	2.35	2.60	0.32	1.92
3/28/2013 08:00:00	-0.40	2.24	2.45	0.39	1.70
3/28/2013 09:00:00	0.32	2.36	2.50	0.97	1.91
3/28/2013 10:00:00	1.61	2.75	2.75	2.08	2.52
3/28/2013 11:00:00	2.99	3.26	3.09	3.29	3.29
3/28/2013 12:00:00	3.99	3.71	3.43	4.22	4.00
3/28/2013 13:00:00	4.68	4.09	3.70	4.88	4.55
3/28/2013 14:00:00	4.71	4.19	3.85	4.97	4.81
3/28/2013 15:00:00	4.33	4.16	3.88	4.70	4.78
3/28/2013 16:00:00	3.27	3.81	3.73	3.84	4.40
3/28/2013 17:00:00	2.09	3.40	3.46	2.81	3.77

APPENDIX A

Hourly Tidal Study Data - March 2013

United Heckathorn Superfund Site, Richmond, California

		Elevation - feet NAVD88			
Date and Time	**Lauritzen Channel**	**MW13-01**	**MW13-02**	**MW13-03**	**MW13-04**
3/28/2013 18:00:00	1.06	3.02	3.16	1.87	3.10
3/28/2013 19:00:00	0.66	2.81	2.94	1.46	2.66
3/28/2013 20:00:00	0.86	2.79	2.86	1.55	2.55
3/28/2013 21:00:00	1.71	3.03	2.97	2.25	2.85
3/28/2013 22:00:00	2.99	3.50	3.25	3.35	3.48
3/28/2013 23:00:00	4.27	4.05	3.59	4.50	4.34
3/29/2013 00:00:00	5.30	4.55	3.93	5.41	4.94
3/29/2013 01:00:00	5.81	4.88	4.20	5.94	5.44
3/29/2013 02:00:00	5.85	5.01	4.37	6.05	5.69
3/29/2013 03:00:00	5.05	4.78	4.33	5.43	5.49
3/29/2013 04:00:00	3.70	4.29	4.10	4.31	4.92
3/29/2013 05:00:00	2.11	3.66	3.73	2.91	4.07
3/29/2013 06:00:00	0.61	3.06	3.28	1.54	3.09
3/29/2013 07:00:00	-0.40	2.59	2.92	0.58	2.28
3/29/2013 08:00:00	-0.86	2.25	2.51	0.07	1.71
3/29/2013 09:00:00	-0.59	2.16	2.39	0.24	1.60
3/29/2013 10:00:00	0.32	2.30	2.48	0.96	1.87
3/29/2013 11:00:00	1.64	2.69	2.74	2.10	2.52
3/29/2013 12:00:00	2.98	3.19	3.06	3.28	3.28
3/29/2013 13:00:00	3.90	3.62	3.36	4.11	3.89
3/29/2013 14:00:00	4.43	3.94	3.63	4.66	4.44
Minimum	-0.86	2.16	2.39	0.07	1.60
Maximum	5.85	5.01	4.37	6.05	5.69

Notes:

NAVD88 - North American Vertical Datum - 1988

PROJECT NUMBER:	BORING NUMBER:
385441.FI.01	MW13-01 SHEET 1 OF 1

SOIL BORING LOG

PROJECT : March 2013 Groundwater Sampling and Hydraulic Evaluation
LOCATION : United Heckathorn Superfund Site, Richmond, CA
ELEVATION : --
DRILLING CONTRACTOR : National Exploration, Wells and Pumps, Inc.
DRILLING EQUIPMENT AND METHOD : Geoprobe 7700, Direct Push - Dual Probe
WATER LEVELS : --
START : 3/19/2013
END : 3/19/2013
LOGGER : R. Lucich/J. Salinas

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	RECOVERY (%)	LAB SAMPLE	USCS CODE/ LITHOLOGY	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	WELL CONSTRUCTION DIAGRAM: WELL DIAMETER: 2" SCREENED INTERVAL: 20' - 30' BGS
					Concrete 0 - 8"	
5	5.0			SW	**Gravelly Sand (SW)** 8" - 7.5' - dark grayish brown, moist, loose, medium to coarse grained, subrounded, gravel is fine to coarse grained	
		50%		CL	**Clay (CL)** 7.5' - 9.5' - greenish gray, slightly moist, medium plasticity, medium hard	
10	10.0			CH	**Clay (CH)** 9.5' - 15' - greenish black, moist, medium plasticity, slightly stiff	
		95%				
15	15.0			CL	**Clay (CL)** 15' - 22' - dark greenish gray, slightly moist, medium plasticity, stiff 17'' - Color change to olive brown (2.5Y 4/3)	
		100%				
20	20.0					
		95%		ML	**Clayey Silt (ML)** 22' - 23' - olive brown, moist, stiff	
				CL	**Clay (CL)** 23' - 29' - olive brown, moist, very stiff	
25	25.0					
		100%			27' - 28' - wet	
30	30.0			SM	**Silty Sand (SM)** 29' - 30' - olive brown, moist, very fine grained, slightly dense	
					End Drilling on 3/19/2013 Total Borehole Depth: 30.0 ft bgs	
35						

PROJECT NUMBER: 385441.FI.01	BORING NUMBER: MW13-02	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : March 2013 Groundwater Sampling and Hydraulic Evaluation   LOCATION : United Heckathorn Superfund Site, Richmond, CA

ELEVATION : --   DRILLING CONTRACTOR : National Exploration, Wells and Pumps, Inc.

DRILLING EQUIPMENT AND METHOD : Geoprobe 7700, Direct Push - Dual Probe

WATER LEVELS : --   START : 3/19/2013   END : 3/19/2013   LOGGER : R. Lucich/J. Salinas

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	RECOVERY (%)	LAB SAMPLE	USCS CODE/ LITHOLOGY	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	WELL CONSTRUCTION DIAGRAM: WELL DIAMETER: 2" SCREENED INTERVAL: 14.5' - 24.5' BGS
					Concrete 0 - 8"	
				GW	**Sandy Gravel (GW)** 8" - 5" - yellowish brown, dry, loose, fine to coarse sand and gravel, subangular	
5	5.0					
		10%			5' - 10' - No recovery	
10	10.0					
		100%		CL	**Silty Clay (CL)** 10' - 14' - gray, moist to very moist, medium stiff	
				CH	**Peaty Clay (CH)** 14' - 15' - dark grayish brown, very moist, slightly stiff, medium plasticity; 14.5' - Change to very dark gray (10YR 3/1), moist, medium plasticity, slightly stiff	
15	15.0					
		100%		CL	**Clay (CL)** 15' - 17' - dark greenish gray, moist, slightly stiff, medium plasticity	
				ML	**Clayey Silt (ML)** 17' - 21' - dark greenish gray, very moist, slightly stiff; 20' - Becomes brown	
20	20.0					
		80%		SM	**Silty Sand (SM)** 21' - 23.5' - grayish brown, wet, slightly dense, fine grained; 22' - Becomes yellowish brown	
				SM	**Silty Sand (SM)** 23.5' - 25' - brown, wet, slightly dense, fine to coarse grained, subangular to subrounded, with minor fine subangular gravel	
25	25.0				End Drilling on 3/19/2013; Total Borehole Depth: 25.0 ft bgs	
30						
35						

PROJECT NUMBER:	BORING NUMBER:
385441.FI.01	MW13-03 SHEET 1 OF 1

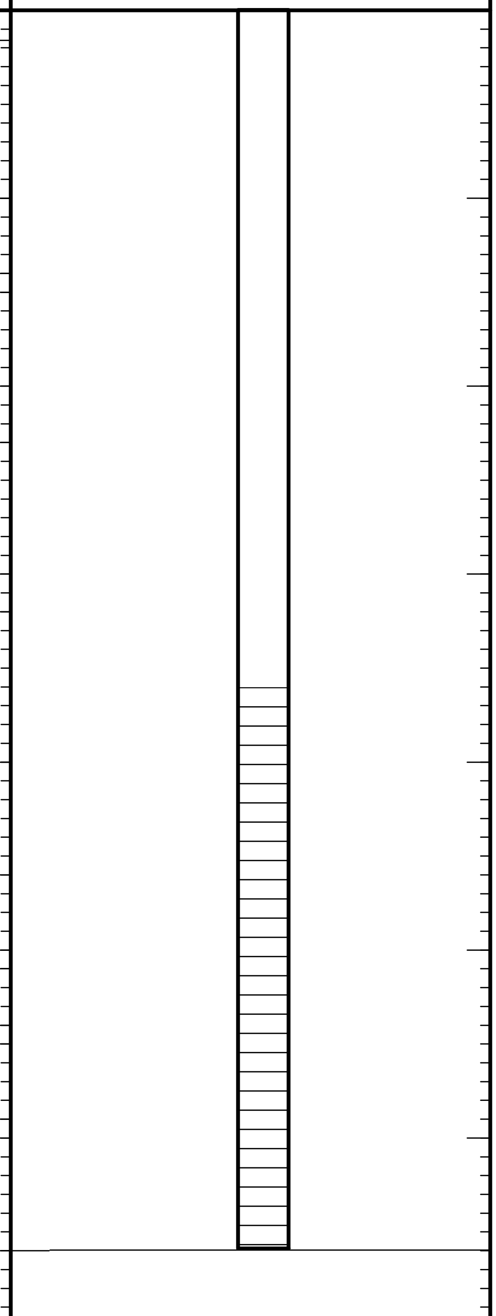
SOIL BORING LOG

PROJECT : March 2013 Groundwater Sampling and Hydraulic Evaluation
LOCATION : United Heckathorn Superfund Site, Richmond, CA
ELEVATION : --
DRILLING CONTRACTOR : National Exploration, Wells and Pumps, Inc.
DRILLING EQUIPMENT AND METHOD : Geoprobe 7700, Direct Push - Dual Probe
WATER LEVELS : --
START : 3/20/2013
END : 3/20/2013
LOGGER : J. Salinas

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	RECOVERY (%)	LAB SAMPLE	USCS CODE/ LITHOLOGY	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY
					CONCRETE
				GW	**Sandy Gravel (GW)** 8" - 5' - moist, loose, subangular clasts, fine to coarse sand and gravel
5	5.0				
		50%		CL	**Clay (CL)** 5' - 7' - dark gray, moist, soft, medium plasticity
				GW	**Gravel (GW)** 7' - 7.5' - very dark gray, loose, subangular, subangular clasts, some red clasts
				GW	**Sandy Gravel (GW)** 7.5' - 11.5' - grayish brown, moist, loose
10	10.0				
		75%		CL	**Clay (CL)** 11.5' - 16' - greenish black, moist, medium stiff, medium plasticity 14.5' - some rusting
15	15.0				
		100%		ML	**Clayey Silt (ML)** 16' - 23' - dark greenish gray, moist, medium stiff, medium plasticity 18' - subangular, Color change to light olive brown (2.5Y 5/4)
20	20.0				
		100%		GW	**Sandy Gravel (GW)** 23' - 25.5' - light olive brown, wet, loose, fine to coarse grained sand and gravel
25	25.0				
		100%		CL	**Clay (CL)** 25.5' - 27' - dark greenish gray, wet, soft, medium plasticity, subangular, some subangular clasts
				SW	**Sand (SW)** 27' - 27.5' - olive brown, wet, loose, subangular, fine to coarse grained
				GW	**Gravel (GW)** 27.5' - 29.5' - olive brown, wet, loose, subangular
30	30.0				
				SW	**Sand (SW)** 29.5' - 33' - olive brown, wet, loose, fine to coarse grained
					End Drilling on 3/20/2013 Total Borehole Depth: 33.0 ft bgs
35					

WELL CONSTRUCTION DIAGRAM

WELL DIAMETER: 2"
SCREENED INTERVAL: 18' - 33' BGS



PROJECT NUMBER: 385441.FI.01	BORING NUMBER: MW13-04 SHEET 1 OF 1

SOIL BORING LOG

PROJECT : March 2013 Groundwater Sampling and Hydraulic Evaluation
LOCATION : United Heckathorn Superfund Site, Richmond, CA
ELEVATION : --
DRILLING CONTRACTOR : National Exploration, Wells and Pumps, Inc.
DRILLING EQUIPMENT AND METHOD : Geoprobe 7700, Direct Push - Dual Probe
WATER LEVELS : --
START : 3/22/2013
END : 3/22/2013
LOGGER : R. Lucich

DEPTH BELOW EXISTING GRADE (ft)	INTERVAL (ft)	RECOVERY (%)	LAB SAMPLE	USCS CODE/ LITHOLOGY	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	WELL CONSTRUCTION DIAGRAM: WELL DIAMETER: 2" SCREENED INTERVAL: 20' - 30' BGS
					Concrete 0-8"	
				SW	**Gravelly Sand (SW)** 8" - 6' - reddish brown, dry, loose, medium to coarse grained and subrounded gravel, fine to coarse grained, subrounded sand	
5						
				ML	**Sandy Silt (ML)** 6' - 7' - gray, moist, soft	
				SM	**Silty Sand (SM)** 7' - 8.5' - gray, wet, loose, very fine grained	
				ML	**Sandy Silt (ML)** 8.5' - 9' - gray, moist, soft	
10				SM	**Silty Sand (SM)** 9' - 12' - gray, wet, loose, very fine grained	
				ML	**Sandy Silt (ML)** 12' - 13.5' - gray, moist, soft	
				CH	**Peaty Clay (CH)** 13.5' -15' - very dark gray, moist, stiff, low plasticity	
15				CL	**Silty Clay (CL)** 15' - 17' - greenish gray, moist, slightly stiff, medium plasticity	
				SM	**Silty Sand (SM)** 17' - 20' - gray, very moist, slightly dense, very fine grained 19.5' - Becomes light olive brown (2.5Y 4/3)	
20				ML	**Sandy Silt (ML)** 20' - 25' - olive brown, very moist, slightly stiff, medium plasticity	
25				SM	**Silty Sand (SM)** 25' -30' - olive brown, wet, subrounded, slightly dense, very fine grained	
30					End Drilling on 3/22/2013 Total Borehole Depth: 30.0 ft bgs	
35						