1.0 PURPOSE AND SCOPE OF STUDY

1.1 Purpose of Study

The Basewide Surface Water Outfall Investigation (Basewide SWOI) assessed environmental conditions at surface water outfalls or concentrated surface drainage areas across Fort Ord. Organic or inorganic compounds released onto the ground surface in areas of known historical or present chemical usage could be transported away from these areas via surface drainage features such as storm drain inlets, concrete ditches, or natural channels. The purpose of this investigation was to evaluate the quality of the discharges from the surface water drainage system (including the storm drain system) and characterize the impact of these discharges on soil at the outfalls. This document summarizes the *Draft Basewide Surface Water Outfall Investigation*, dated April 5, 1993 and the *Draft Data Summary Report and Work Plan, Phase 1 Sampling*, dated April 18, 1994. Surface water drainage areas and the storm drain system are shown on Plates 1 and 2, respectively.

1.2 Scope of Study

Phase 1 of the field investigation and the draft Basewide SWOI report (*HLA, 1993*) were completed in accordance with the final RI/FS Work Plan (*HLA, 1991c*), the RI/FS Sampling and Analysis Plan (SAP [*HLA, 1991b*]), Part 2 of the Site Characterization Report for Site 34 (*HLA, 1992d*), and the Site Safety and Health Plan (*EA, 1991c; HLA, 1992b*). Deviations from the SAP are noted when appropriate. The following activities were conducted in 1991 and 1992 under the final RI/FS Work Plan:

- Available maps of the topography of Fort Ord and the existing storm drain system were reviewed. Topographic information was used to delineate the surface drainage areas within Fort Ord. Base personnel were interviewed (1) to identify drainage components that may have functioned as transport mechanisms for known contaminants, (2) to assess the relative age of these components, and (3) to assemble information regarding contaminant releases suspected to have entered the surface water or storm drain system.

- Outfall locations or points of surface water concentration were identified. These locations were prioritized for sampling on the basis of (1) the potential for contamination, (2) known chemical usage in the upstream drainage area, (3) known instances of releases to a system inlet, and (4) accessibility for sampling equipment.

- Sampling conducted at the identified priority outfalls in 1992 consisted of collecting soil samples from soil borings, sediment samples from pipes where possible, and soil gas samples. Field procedures are described in Part 2 of the Site Characterization Report for Site 34 (*HLA, 1992d*).

- Soil samples were analyzed for total petroleum hydrocarbons as diesel (TPHd) and gasoline (TPHg), volatile organic compounds (VOCs), priority pollutant metals, pesticides and polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), and total organic carbon (TOC). Particle size analyses were conducted on samples from 12 locations.

- Soil gas samples in 1992 were analyzed for total hydrocarbons, tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), trans 1,2-dichloroethene (DCE), cis 1,2-DCE, vinyl chloride, and benzene, toluene, ethylbenzene, and xylenes (BTEX).

- Sediment samples collected from storm drain pipes or drainage structures were analyzed for TPHd and TPHg, VOCs, priority pollutant metals, pesticides and PCBs, PAHs, and TOC.

- Stormwater runoff sampling events proposed in the Work Plan (*HLA, 1991c*) and the SAP (*HLA, 1991b*) were deleted from the scope of this investigation at the request of the Department of the Army (Army), Corps of Engineers, Sacramento District (Sacramento

COE). Stormwater runoff sampling was included in the Ecological Risk Assessment (Volume IV).

- Preparation of the *Draft Basewide Surface Water Outfall Investigation*, dated April 5, 1993 report, which included a work plan describing additional Phase 1 investigative and assessment activities.

The additional Phase 1 investigative and assessment activities completed in 1993 under the draft Basewide SWOI report work plan included:

- A source area evaluation (SAE) to identify additional outfalls for sampling based upon RI/FS site data and related the 1992 Basewide SWOI data to known or suspected sources of contamination in the upgradient watersheds. Three additional sampling locations were identified.

- Additional field investigations at the sampling locations identified by the SAE and at locations where samples were not obtained in 1992. Soil, sediment, and particle size samples were collected in 1993 and analyzed using the same procedures as for the 1992 sampling activities.

- Remote video reconnaissance and sampling for sediment in the storm drain lines from the four ocean outfalls to beneath Highway 1.

- A human health risk evaluation of the 1992 and 1993 data, addressing possible source areas, human health impacts, potential impacts to groundwater, and recommendations for further work under Phase II investigative and assessment activities.

- Preparation of a *Draft Data Summary Report and Work Plan, Phase 1 1992 and 1993 Sampling*, dated April 18, 1993.

Additional Phase 2 investigative and assessment activities completed in 1994 under the draft Basewide SWOI report work plan included:

- Excavation of soil by hand at Sampling Location OF-15 to determine the extent of the buried concrete channel present beneath the soil at the outfall.

- The completion of 10 additional soil borings at Sampling Location OF-15 to characterize the horizontal and vertical extent of contamination above and surrounding the buried concrete channel.

- Additional soil borings (four total) at two outfalls at Fritzsche Army Airfield (FAAF) identified for sampling on a June 9, 1994 site visit with personnel employed at FAAF.

- A human health risk evaluation of the 1994 Phase 2 data, addressing possible source areas, human health impacts, potential impacts to groundwater, and recommendations for further work.

2.0 SITE DESCRIPTION

This section describes the surface water drainage system and the storm drain system. The distinction between these systems is as follows: The surface water drainage system consists of the above-ground drainages (either natural or manmade) that discharge to other above-ground drainages or discharge to or receive discharge from the subsurface storm drain system (i.e., the distinction between the surface water drainage and storm drain systems is based on whether the structure is above or below ground). The storm drain system discharges via surface water outfalls (i.e., those on land) or ocean outfalls that are in the surf zone.

2.1 Topography and Surface Water Drainage System

The surface water drainage area boundaries and flow directions for the base were delineated by Harding Lawson Associates (HLA) personnel using the available topographic information. Plate 1, a 20-foot contour interval topographic map, shows the watershed boundaries and surface drainage flow directions for the entire base and presents the most detailed topographic information available for undeveloped portions of the base. The drainage area boundaries and surface water flow directions for the surface water drainage systems within the Main Garrison, the FAAF, and the East Garrison area are shown in greater detail on Plates 3 through 12. Minor variations exist between the drainage area boundaries delineated on Plate 1 and those delineated on Plates 3 through 12 due to differences in the topographic information on the base maps.

The Fort Ord surface water drainage system can be divided into three major drainage basins (Plate 1). These basins are composed of many small subbasins that concentrate surface runoff in channels that run to unique outfalls or points of discharge. These channels flow only intermittently because rainfall is seasonal and rapidly infiltrates the characteristically sandy surface soil at Fort Ord. These drainage basins and subbasins are described below.

Drainage Basin A is east of a drainage divide that extends from the FAAF on the north to Laguna Seca on the south (Plate 1). This drainage basin consists of several north- and northeasterly oriented subbasins that drain toward El Toro Creek along the southeast boundary of the base or to the Salinas River Valley.

Drainage Basin B lies in the central portion of the base (Plate 1). The subbasins within Drainage Basin B concentrate runoff toward internal, localized closed depressions. Many of these drainage subbasins contribute flow to no other surface water feature and surface runoff from the intermittent streams within the drainage subbasins infiltrates into the soil within the depressions. This internal drainage basin has been only slightly altered by development.

Drainage Basin C, which extends approximately 4 or 5 miles inland from the coast, is composed of a series of gently rolling active and inactive sand dunes (Plate 1). This basin encompasses the Main Garrison and drains to the west toward Monterey Bay. Many of the natural surface drainage features in Basin C have been altered by development in the Main Garrison. Many of the RI/FS sites lie within this drainage basin.

Much of the surface runoff in Drainage Basin C flows intermittently to localized depressions in the hills or dune area (particularly in the central portion of the Main Garrison) or toward constructed drainage structures and storm drain system inlets. Despite the diversions created by the constructed drainage structures, most surface runoff from Drainage Basin C is directed toward the dune and ocean environment of Monterey Bay.

2.2 Storm Drain System

The initial storm drain system at Fort Ord was constructed in the early 1940s (Plate 2). Review of construction drawings available at Fort Ord and discussions with base personnel indicated that the storm drain system was expanded as the base grew. The system collects surface runoff

that is directed to grated catch basins or pipe inlets near housing and recreational areas, motor pools, maintenance yards, and industrial facilities such as paint shops, machine shops, laundry/dry cleaning facilities, and photographic laboratories. The system discharges the collected runoff to Monterey Bay, the Salinas River, the dune environment adjacent to Monterey Bay, localized closed depressions and channels in the base interior. Plates 3 through 12 detail the storm drain system for the Main Garrison, the FAAF, and the East Garrison areas. The system includes a complicated network of tributary lines that feed into the main lines.

The storm drain system is constructed of both reinforced concrete pipe and corrugated metal pipe. Most of the main line or pipes of larger diameter are made of concrete; the smaller-diameter laterals are made of corrugated metal pipe. According to base personnel, during repairs completed on the storm drain system within the last 10 years, damaged or worn sections of pipe have been replaced with new pipe of similar material.

Corrugated metal storm drain pipe (CMP) is constructed from sheet steel that is composed of iron, carbon, manganese, phosphorus, silicon, and sulfur (*AASHTO, 1990b*). A coating is applied to the steel sheet that is composed of one of the following: 99.98 percent zinc, 99 percent aluminum, or 55 percent aluminum and 45 percent zinc (*AASHTO, 1990a*). Manufacturing standards indicate the coating is a thickness of no less than 0.005 inch, or weighs no less than 2.0 ounces per square foot of steel.

The main storm drain lines in the Main Garrison (Plates 3 through 8 and 11 and 12) discharge storm runoff at two outfalls in the dune areas and five outfalls directly above the beach or surf zone along the Monterey Bay coastline. The four storm drain outfalls that discharge into the surf zone of Monterey Bay were designated Sampling Locations OF-01 through OF-04 (increasing in a southerly direction). The single beach outfall located to the south of the Ord Village Sewage Treatment Plant (OVSTP) was designated Sampling Location OF-30.

The northernmost storm drain outfall that discharges into the surf zone of Monterey Bay (Sampling Location OF-01) served as the discharge outfall for the Main Garrison Sewage Treatment Plant (MGSTP) until 1984 when the MGSTP was connected to the regional treatment system. After 1984, the MGSTP effluent was discharged into Monterey Bay at the Marina outfall, and OF-01 functioned as an overflow for the sewage system when mechanical failures or malfunctions occurred. Operations at the MGSTP ceased in May 1990. The connection from the MGSTP to OF-01 is located in a junction box near the west end of the MGSTP.

At the FAAF, the main storm drain line discharges offbase to the agricultural land south of the main channel of the Salinas River (Plate 9). Other smaller storm drain system lines at FAAF discharge into open fields east and west of the main airfield structures. Several topographic depressions within the base intercept the surface runoff downstream of these outfall locations.

In the East Garrison, surface runoff is directed to grated storm drain inlets (Plate 10). The main storm drain lines run northeast toward three pipe outfalls in the agricultural land south of the Salinas River. Runoff from these three outlets is conveyed in irrigation ditches across the agricultural fields. There are no onbase outfall locations within the East Garrison area.

3.0 SITE CHARACTERIZATION

3.1 Previous Investigations

Previous investigations have presented only general information about the storm drain and sanitary sewer system at Fort Ord. In 1990, EA Engineering, Science, and Technology (EA) completed a background literature review and base inventory (*1991a*). A comprehensive list of areas of potential contamination, including sites where storage or disposal of hazardous materials or hazardous waste might have occurred, was developed. The review and inventory did not include sample collection or analysis.

In 1992, HLA investigated the integrity of the storm drain system by excavating representative pipe sections and obtaining and analyzing soil samples from beneath the exposed pipe joints. At the locations investigated, the storm drain system was found to be in good condition with no evidence of open pipe fractures. Chemical concentrations in samples collected during that investigation did not exceed the human health-protective concentrations for exposure to surface soil (*HLA, 1992h*).

3.2 Locations of Known or Suspected Chemical Discharges into the Surface Water Systems

Before the mid-1960s, influent into the storm drain system was not treated before it entered the system. In the mid-1960s, oil/water separators were installed to treat runoff from motor pools and maintenance yards. In the early 1970s, National Pollutant Discharge Elimination System (NPDES) permits were obtained to allow runoff from wash racks at the 14th Engineers Motor Pool, the Transportation Motor Pool, the 4th Brigade Motor Pool, the 155th Aviation Motor Pool, and the autocraft shop to be discharged directly into the storm drain system without treatment (*Weston, 1990*). By 1990, all of the wash racks were connected to the sanitary sewer system.

Overflows from improperly operated oil/water separators may have resulted in releases of hazardous materials to the storm drain or sanitary sewer systems, depending on the location of the oil/water separators and the adjacent system inlets (*EA, 1991a*). Chemicals from unauthorized releases onto the ground surface could also have entered the storm drain system. Utility and maintenance workers at Fort Ord have reported that past disposal practices have made the storm drain system a receptor and a potential depository and transport mechanism for oil, fuel, and solvents (*HLA, 1991c*).

In December 1979, Fort Ord personnel began reporting the location, date, and approximate volume of sewage releases or overflows, some of which could have accumulated on the ground surface and potentially entered the storm drain system. Table 1 lists sewage releases reported between December 1979 and February 1992. Before December 1979, releases do not appear to have been documented by Fort Ord personnel. Plates 3 through 12 show the locations of those releases, referenced by the nearest building number.

As discussed in the RI/FS Work Plan (*HLA, 1991c*), identified the locations of historical contaminant discharges related to the RI/FS sites (*EA, 1991a*). Existing base records and discussions with base personnel identified locations where chemicals were probably discharged directly or indirectly into the storm drain system or released in an area that drains to a system inlet. This discharge information is summarized in Table 2, and the locations of the discharges are depicted on Plates 3 through 12.

3.3 Sampling Locations

The section describes how sampling locations were determined and what designation scheme was used for sample stations.

3.3.1 Determination of Sampling Locations

Twenty-nine locations were identified for investigation in 1992 within the Main Garrison, the FAAF, and the East Garrison (Tables 3 and 4; Plates 3 through 12). The 29 sampling locations met the following conditions:

- Historical discharges from one or more RI/FS sites were reported, or there was a high potential for discharges to have occurred within the outfall drainage basin.
- One or more reported sewage releases or overflows occurred in the drainage basin upstream of the outfall or point of discharge.
- The potential existed at the outfall for contamination by several chemical compounds.
- Accessibility was adequate to allow field personnel to obtain soil samples.

The Sampling and Analysis Plan (*HLA, 1991b*) identified 20 sampling locations (4 of which were to be the Monterey Bay ocean outfalls) where surface water (during two storm events), soil gas, soil, and sediment samples were to be obtained. The number of sampling locations was increased to 29 for the 1992 Phase 1 sampling to allow HLA to sample all of the highest priority outfalls or points of concentration within the Main Garrison, FAAF, and East Garrison. Several outfall locations inaccessible during the 1992 field investigation were included in the 1993 Phase 1 sampling. Three additional sampling locations identified by the source area evaluation (SAE) were included in the 1993 Phase 1 sampling. The locations of these outfalls and the drainage areas contributing surface runoff to each are shown on Plates 3 through 12.

The extent of the impervious material that prevented penetration of the Phase 1 soil borings to depths greater than 2.5 feet at Sampling Location OF-15 was investigated during Phase 2 field activities. Excavation of the soil at locations downgradient of the outfall revealed the presence of a buried trapezoidal concrete channel that extends approximately 61 feet west of the pipe outfall (Plate 13). The bottom of the buried channel is 14 feet wide and is located at depths ranging from 2.5 feet bgs near the outfall to 3.5 feet bgs at the end of the channel. The top of the sides of the channel are 23.5 feet apart and lie beneath at least 0.5 feet of soil. The soil above the buried concrete channel supports a dense covering of shrubs and large trees. The sampling locations around this buried channel are described in Section 3.4.3.

Two additional sampling locations at storm drain outfalls were identified during a June 9, 1994 site visit to FAAF with previous employees of the base. These two outfalls (Sampling Locations OF-34 and OF-35) discharge into a vegetated drainage channel west of Buildings 533 and 535 at the western end of FAAF (Plate 9). Chemicals used in the sheet metal shop and paint stripping activities in the buildings may have entered the storm drain inlets adjacent to the buildings.

Soil boring and soil gas samples were taken at sampling stations immediately adjacent to and 20 feet downgradient of the outfall. Samples were collected 20 feet away from the outfalls to facilitate assessment of the horizontal migration of any contaminants from the outfall or point of concentration. The characterization of the contamination of Sampling Location OF-15 (Phase 2 sampling) included 10 additional soil borings completed downgradient of the outfall pipe. The location of these borings is described in Section 3.4.3. The sample locations are presented on Plates 3 through 13 and listed sequentially by sample and station number in Tables 3 and 4, respectively.

3.3.2 Sample Station Designation Scheme

The sample station designation scheme is as follows: OF-20-01N, where OF is an abbreviation for outfall, and the first two digits in the sample station number (20) identify a specific outfall of the 29 prioritized sampling locations. The second set of numbers (01 or 02) represents the sampling stations immediately adjacent to and 20 feet downgradient of the outfall, respectively. If more than one outfall was sampled at a particular location, a directional designation

(such as N or S) was added. This numbering system was maintained for all outfalls except Pete's Pond (Location 16) and the four ocean outfalls.

The six pipe outfalls at Pete's Pond were originally designated as Sampling Locations 9, 10, 16, 17, 18, and 28. During the field investigation, the samples taken at these locations were all referenced as multiple sampling stations within Sampling Location 16 rather than five separate sampling locations. Thus, no samples were taken that reference Sampling Locations 9, 10, 17, 18, or 28. The sampling station numbering system for Pete's Pond has the following format: OF-16-04-02, where OF is an abbreviation for outfall, 04 designates the fourth pipe outfall location at Sampling Location 16, and 02 indicates that the sampling station was the boring 20 feet from the pipe outfall (an 01 in this location would indicate that the sampling station was located immediately adjacent to the pipe outfall). These revisions to the sample station numbering system are shown on a detail of Pete's Pond presented on Plate 12.

Ten additional soil borings were completed at Sampling Location OF-15 during the 1994 Phase 2 sampling activities. These 10 borings, completed above and surrounding a buried concrete channel at the outfall, were given sample station designations of OF-15-03 through OF-15-12. Section 3.4.3 and Plate 13 detail the location of these 10 additional borings.

The ocean outfall manholes were given unique sampling location designations for the remote video reconnaissance and sediment sampling completed in 1993. The sample station designation scheme is as follows: OF-01-MH-01, where OF is an abbreviation for outfall and the first two digits identify one of the four ocean outfall storm drain lines (01 is the northernmost ocean outfall; 04 the southernmost). MH is an abbreviation for manhole, and the last two digits identify an individual storm drain line manhole (01 is the first manhole west of Highway 1 on each ocean outfall storm drain line with the number increasing with subsequent manholes toward the ocean outfall).

3.4 Field Investigation

3.4.1 Borehole Clearance

All sampling locations were cleared before intrusive activity began. The appropriate clearance at each location was obtained in accordance with the field procedures presented in the Site Characterization Report for Site 34 *(HLA, 1992d)*.

3.4.2 Soil Gas Sampling

Soil gas probes were completed in 1992 by Hydro Geo Chem, Inc., Tucson, Arizona, using the methods described in Part 2 of the Site Characterization Report for Site 34 (*HLA, 1992d*). Soil gas samples were obtained immediately adjacent to and 20 feet downgradient of each outfall or point of concentration that could be accessed by the soil gas rig. Soil gas probes were completed to 40 feet below ground surface (bgs) unless rock or consolidated material prevented penetration by the sampling equipment. If consolidated material was encountered, soil gas samples were obtained at depths as close as possible to 40 feet bgs. Steep slopes, dense vegetation, or loose dune sand near the sampling locations precluded the soil gas rig from obtaining samples at some locations.

During the field investigation, the following samples were obtained:

- Thirty soil gas survey probes were completed at 16 locations during the 1992 field investigation. Soil gas sampling was not completed at Sampling Locations 5, 11, 12, 13, 15, and 20 (both locations) due to environmental conditions that prevented access.
- Fifty-nine soil gas samples (including duplicate samples) were obtained.
- Forty-five soil gas samples were obtained at 40 feet bgs; five were obtained at 38 feet bgs; four were obtained at 37 feet bgs; two were obtained at 35 feet bgs; two were obtained at 32 feet bgs; and one was obtained at 28 feet bgs.

- No soil gas samples were obtained during the 1993 Phase 1 or the 1994 Phase 2 field activities.

Soil gas samples were analyzed for total hydrocarbons, PCE, TCE, 1,1,1-TCA, cis-1,2-DCE, trans-1,2-DCE, vinyl chloride, and BTEX.

3.4.3 Soil Boring and Sampling

Soil borings were drilled by hand augering, as described in Part 2 of the Site Characterization Report for Site 34 *(HLA, 1992d)*. Wherever possible, borings were augered at locations immediately adjacent to and 20 feet downgradient of an outfall or point of concentration. Tables 3 and 4 list the soil and sediment samples collected during this investigation.

Soil samples were generally obtained at depths of 0.0 to 0.5 foot bgs and 5.0 to 5.5 feet bgs, as detailed in the SAP (*HLA, 1991b*). Erosion control material such as rock riprap was encountered at several sampling stations. This rock prevented the penetration of the soil boring equipment to the targeted depth of 5.5 feet at some locations. Boring logs are presented in Appendix A.

During the 1992 Phase 1 field investigation,

- Seventy-two samples were obtained and analyzed.

- Forty-one soil borings were completed to depths of up to 5.5 feet. Sixty-two samples were collected from the soil borings completed to 5.5 feet bgs. Soil samples were collected from two intervals in each boring (0.0 to 0.5 foot bgs and 5.0 to 5.5 foot bgs). In 10 borings, only a 0.0 to 0.5 foot-deep sample was obtained because rock or erosion control materials prevented sampling at greater depth.

During the 1993 Phase 1 field investigation,

- Twenty-three samples were obtained and analyzed.

- Twelve soil borings were completed to depths up to 9.5 feet. Eighteen samples were collected from nine borings completed to 5.5 feet bgs. Two samples were collected from two soil borings completed to 2.5 feet bgs. Three samples were collected from one soil boring completed to 9.5 feet bgs (5.5 feet bgs in a 4.0 foot deep scour hole at OF-31).

Soil samples were analyzed for a broad spectrum of chemicals: TPHd and TPHg, VOCs, priority pollutant metals, pesticides and PCBs, PAHs, and TOC.

During the 1994 Phase 2 field investigation,

- Thirty samples were obtained and analyzed.

- Ten soil borings were completed at Sampling Location OF-15 to characterize the lateral and horizontal extent of contamination detected in Phase 1. A 23-foot-wide (top width), 61-foot-long concrete trapezoidal channel was located beneath the sand and trees in the drainage channel west of outfall pipe at Sampling Location OF-15. Eight soil borings were completed to 5.5 feet bgs around the buried concrete channel perimeter, one boring was completed to 3.25 feet bgs above the end of the buried concrete channel and one boring was completed to 20.5 feet bgs immediately downgradient of the buried channel. Plate 13 details the locations of the Phase 1 and Phase 2 soil borings at Sampling Location OF-15.

- Four soil borings were completed to 5.5 feet bgs at two FAAF storm drain outfalls (Sampling Locations OF-34 and OF-35).

- Soil samples were collected from intervals of 0.0 to 0.5 feet bgs and 5.0 to 5.5 feet bgs in the 5.5-foot-deep soil borings, 0.0 to 0.5 feet bgs and 2.75 to 3.25 feet bgs in the 3.25-foot-deep borings, and 0.0 to 0.5 feet bgs, 5.0 to 5.5 feet bgs, 10.0 to 10.5 feet bgs and 20.0 to 20.5 feet bgs in the 20.5-foot-deep soil borings.

- Phase 2 soil samples at Sampling Location OF-15 were analyzed for TPHd and TPHg, VOCs, and PAHs. Phase 2 soil

samples at Sampling Locations OF-34 and OF-35 were analyzed for TPHd, TPHg,VOCs, priority pollutant metals, pesticides, PCBs, PAHs, and TOC.

3.4.4 Sediment Sampling

The Sampling and Analysis Plan (*HLA, 1991b*) proposed collection of a single sediment sample at each prioritized outfall and samples of flowline sediment within pipes or drainage structures. In 1992, all 29 sampling locations were examined for sediment in sufficient quantities to allow sampling. In 1993, additional sediment samples were obtained during the remote video reconnaissance of the ocean outfall storm drain lines, and the additional investigative activities detailed in the draft Basewide SWOI. Tables 3 and 4 list the sediment samples collected during this investigation.

During the field investigations in 1992 and 1993, the following sediment samples were obtained:

- Eleven sediment samples were obtained in 1992 from outfalls, manholes, or points of concentration that contained adequate quantities of sediment. Eleven additional sediment samples were obtained in 1993.

- In 1992, sufficient quantities of sediment were found at Sampling Locations OF-03-MH-01, OF-05-01, OF-13, OF-16-01, OF-16-02, OF-16-04, OF-16-05, OF-20N, OF-20S, OF-21, and OF-23. In 1993, sediment samples were obtained at Sampling Locations OF-01-MH-01, OF-01-MH-03, OF-04-MH-03, OF-04-MH-04, OF-07, OF-11, OF-15, OF-24-MH-02, OF-25-MH-02, OF-26-MH-06, and OF-32-MH-01.

- At all other sampling locations, insufficient sediment was present to permit sampling.

- No sediment samples were obtained during the 1994 Phase 2 field investigation.

Sediment samples were analyzed for TPHd, TPHg, VOCs, priority pollutant metals, pesticides and PCBs, PAHs, and TOC. The concentrations of the compounds detected by the chemical analyses of the sediment samples are presented in Tables 8 and 9.

3.4.5 Particle Size Sampling

During the 1992 and 1993 field investigations, 24 samples were obtained for particle size analysis. These samples were obtained from OF-01-01N, OF-01-02N, OF-05-01, OF-07-01, OF-08-02, OF-11-01, OF-11-02, OF-12-01, OF-12-02, OF-13-01, OF-14-01, OF-15-01 (two samples), OF-15-02, OF-16-05-02, OF-16-06-02, OF-20-01S, OF-24-02, OF-25-01, OF-25-02, 0F-26-01, OF-26-02, OF-31-01, and OF-31-02.

3.4.6 Remote Video Reconnaissance and Sediment Sampling

During the 1992 field investigation activities, only one ocean outfall manhole, OF-03-MH-01, contained sufficient quantities of sediment for sampling. The Work Plan in the 1993 draft Basewide SWOI report included a video reconnaissance of the four ocean outfall storm drain lines to locate sediment in the pipeline between manholes. If sufficient quantities were located by the remote video camera, a sample of the sediment was to be obtained by remote sampling.

The video reconnaissance completed in 1993 investigated 7,720 linear feet of storm drain pipeline in the four ocean outfall storm drain systems. Sediment samples were collected in manholes OF-01-MH-01 and OF-01-MH-03 of ocean outfall OF-01 and in manholes OF-04-MH-03 and OF-04-MH-04 of ocean outfall OF-04. No sediment samples were obtained from ocean outfall OF-02 or OF-30 during the 1992 field investigation or the 1993 video reconnaissance sediment sampling. The video reconnaissance inspection reports are presented in Appendix E.

The video reconnaissance of the four ocean outfalls investigated each storm drain line from the outfall above the surf zone in Monterey Bay to beneath Highway 1. The remote video reconnaissance equipment was sent eastward to the limits of the video cable through each storm drain line from the first manhole west of

Highway 1. This allowed the video camera to film up to 386 linear feet of storm drain line east of the first manhole.

The ocean outfall storm drain lines filmed during the video reconnaissance contained no visible cracks, broken sections, or vertical or horizontal displacement of any pipeline sections.

3.5 Results

3.5.1 Soil Gas

Table 5 summarizes the results for analysis of the 59 soil gas samples collected during this investigation. As shown in Table C5 of Appendix C, no organic compounds attributable to environmental conditions were detected in these samples. Organic compounds were either (1) not detected in soil gas samples or (2) detected but qualified as nondetect because of laboratory quality control problems. The qualified results indicate that low-level contamination of sampling equipment was the likely cause of the positive results and they are therefore not considered representative of site conditions. Additional discussion of the laboratory blank contamination associated with these soil gas samples was provided in the *Draft Basewide Surface Water Outfall Investigation*, dated April 5, 1994.

For the majority of the sample results no qualifiers were assigned and the analytical results are considered representative of site conditions. These data showed no target analytes above the reporting limits. The entire dataset suggests that few, if any, organic compounds were present in the soil gas samples at levels above the reporting limits (Table C1).

3.5.2 Soil and Sediment

3.5.2.1 Inorganics

The results of the chemical analyses for soil and sediment samples are summarized in Tables 6 through 9 and presented in Appendix C. Priority pollutant metals were detected in all of the soil and sediment samples. The maximum concentrations detected in the outfall soil and sediment samples at each sampling location were compared to the background soil concentrations developed for the Basewide Background Soil Investigation (Basewide BSI) to determine the maximum site-related concentration. Soil samples collected at depths of less than 2.0 feet bgs and sediment samples were compared to shallow background soils concentrations. Soil samples collected at depths greater than 2.0 feet bgs were compared to deep background soils concentrations. These maximum detected concentrations and the maximum site-related concentrations were used in the Data Risk Evaluation, as discussed in Sections 4.0 and 5.0. Tables 11 through 66 present the maximum soil and sediment concentrations for each sampling location. Table 67 is a key to the abbreviations used in Tables 11 through 66.

In general, the near-surface (0.0- to 0.5-foot bgs) soil and sediment samples had higher metals concentrations than the deeper (5.0- to 5.5-feet bgs) soil samples at sampling locations both near the outfalls and 20 feet downgradient of the outfalls.

The results of the analyses for priority pollutant metals for each sampling location are summarized as follows:

- At Sampling Location 1, manholes of the northernmost ocean outfall (Plate 5):
  - Mercury, arsenic, lead, chromium, copper, zinc and antimony were detected in both sediment samples. Selenium and nickel were the only priority pollutant metals not detected in either sediment sample.
- At Sampling Location 1S, the storm drain system inlets downgradient of RI/FS Site 37 (Plate 3):
  - Arsenic, lead, and chromium were detected in all four soil samples (Appendix C).
  - The maximum concentrations for priority pollutant metals were detected in the near surface (0.0- to 0.5-foot bgs) samples collected immediately adjacent to the grated storm drain inlets.

- At Sampling Location 1N, the pipe outfall of the storm drain pipe system downgradient of RI/FS Site 37 (Plate 3):
  - The maximum concentrations of all the priority pollutant metals, except arsenic, were from samples obtained immediately adjacent to the outfall.
- At Sampling Location 3, manhole of an ocean outfall (OF-03-MH-01; Plate 3):
  - Arsenic, lead, cadmium, chromium, copper, and zinc were detected in the sediment sample (Appendix C).
- At Sampling Location 4, manholes of the southernmost ocean outfall (OF-04-MH-03, -04; Plate 5):
  - Arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc were detected in the sediment.
- At Sampling Location 5, the dune storm drain outfall immediately south of the Stilwell Hall south entrance road (Plate 5):
  - Antimony, selenium, and silver were not detected in any soil sample (Appendix C).
  - The maximum concentrations of priority pollutant metals were detected in the near surface (0.0- to 0.5-foot bgs) sample obtained 30 feet downgradient of the outfall (Appendix C).
  - The maximum concentrations of priority pollutant metals detected in the sediment sample were all less than the maximum detected concentrations in the soil samples.
- At Sampling Location 7, downgradient of RI/FS Site 20 (Plate 5):
  - Antimony, arsenic, beryllium, cadmium, chromium, copper, nickel, lead, and zinc were detected in a soil or sediment sample.
- At Sampling Location 8, downgradient of RI/FS Site 11 (Plate 6):
  - Arsenic, chromium lead, and zinc were detected in all four soil samples (Appendix C).
  - Mercury was detected at a concentration of 1.6 mg/kg in the 0.0- to 0.5-foot bgs sample obtained 30 feet downgradient of the pipe outfall.
- At Sampling Location 11, the pipe outfall immediately north of Inter-Garrison Road between 7th and 8th avenues (Plate 6):
  - The maximum concentrations of priority pollutant metals were from the near surface (0.0 to 0.5 foot bgs) soil samples and the sediment sample (Appendix C).
- At Sampling Location 12, the pipe outfall near Third Street and 7th Avenues (Plate 6):
  - The maximum concentrations for antimony, arsenic, beryllium, cadmium, copper, lead, mercury, and zinc were detected in the 0.0- to 0.5-foot bgs soil sample obtained 20 feet from the outfall (Appendix C).
- At Sampling Location 13, the pipe outfall immediately north of Inter-Garrison Road between 7th and 8th avenues (Plate 6):
  - Arsenic, chromium, lead, nickel, and zinc were detected in all four of the soil samples (Appendix C).
  - The maximum concentrations for priority pollutant metals detected at this outfall, except for arsenic and silver, were found in the samples obtained immediately adjacent to the outfall.
  - The concentrations of arsenic, cadmium, chromium, and zinc detected in the sediment sample were lower than the concentrations detected in the near surface (0.0- to 0.5-foot bgs) samples at the pipe outfall, but greater than the

concentrations detected in the 5.0- to 5.5-foot bgs sample.

- At Sampling Location 14, the canal outfall downstream of RI/FS Site 21 (Plate 6):
  - The maximum concentrations of arsenic, selenium, and beryllium were found in a 5.0- to 5.5-foot bgs sample. The maximum concentrations of other inorganics were found in near surface (0.0- to 0.5-foot bgs) samples (Appendix C).
- At Sampling Location 15, the dune outfall downgradient of RI/FS Site 12 (Plate 7):
  - Arsenic, cadmium, chromium, copper, lead, mercury, and zinc were detected in the soil samples collected at the outfall (Appendix C).
- At Sampling Location 16, the six pipe outfalls at Pete's Pond (Plates 6, 8, and 12):
  - Arsenic, chromium, and lead were detected in all 15 soil and sediment samples collected at Pete's Pond (Appendix C). Cadmium, copper, and nickel were also detected in all 4 sediment samples.
  - The maximum concentrations of priority pollutant metals detected in soil samples at Pete's Pond were found in near surface (0.0- to 0.5-foot bgs) samples.
  - The maximum concentrations of priority pollutant metals detected in sediment samples were in the sample from outfall OF-16-02 (Appendix C).
- At Sampling Location 19, at FAAF (Plate 9):
  - The maximum priority pollutant metal concentrations for the soil samples collected at this outfall were found in the near surface (0.0- to 0.5-foot bgs) samples collected immediately adjacent to the outfall (Appendix C).
- At Sampling Location 20N at FAAF (Plate 9):
  - Arsenic, beryllium, chromium, copper, lead, nickel, and zinc were detected in at least one sample.
- At Sampling Location 20S at FAAF (Plate 9):
  - Cadmium, chromium, lead, nickel, and zinc were the only priority pollutant metals detected in the soil or sediment samples (Appendix C).
- At Sampling Location 21 at FAAF (Plate 9):
  - Nickel and zinc were detected in the near surface (0.0- to 0.5-foot bgs) soil samples at both boring locations (Appendix C). Lead and selenium were detected in the near surface soil sample obtained from the boring adjacent to the outfall. Chromium was the only inorganic detected in the 5.0- to 5.5-foot bgs soil samples.
  - Only arsenic, beryllium, chromium, lead, and selenium were detected in the sediment sample (Appendix C).
- At Sampling Location 22, at FAAF (Plate 9):
  - Arsenic, cadmium, chromium, copper, lead, selenium and zinc were detected in soil samples at Sampling Location 22.
- At Sampling Location 23, at FAAF which ultimately discharges to the Salinas Valley (Plate 9):
  - Arsenic, beryllium, cadmium, chromium, copper, lead, nickel, silver, and zinc were detected.
  - The maximum concentration of all priority pollutant metals except arsenic was detected in the sediment sample.
- At Sampling Location 24, an off-base outfall draining the western portion of the East Garrison (Plate 10):

- Arsenic, beryllium, chromium, copper, lead, nickel, mercury, thallium, and zinc were detected in at least one sediment or soil sample (Appendix C).

- At Sampling Location 25, an off-base outfall draining the central portion of the East Garrison (Plate 10):

  - The maximum concentration of all priority pollutant metals was detected in the sediment sample.

- At Sampling Location 26, an off-base outfall draining the eastern and southern portions of the East Garrison (Plate 10):

  - Arsenic, beryllium, cadmium, chromium, copper, lead, nickel, and zinc, were detected in the soil and upgradient sediment samples (Appendix C).

  - All of the maximum concentrations were detected in the upgradient sediment sample (from Sampling Location OF-26-MH-06) or from the two 0.0- to 0.5-foot bgs soil samples (Appendix C).

- Sampling Location 27 (Plates 9 and 11):

  - Arsenic, cadmium, chromium, copper, lead, nickel, silver, and zinc were detected in the soil samples (Tables 57 and 58).

- At Sampling Location 31, a Lower Meadow pipe outfall and grated inlet in Site 12 (Plate 7):

  - Antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury and zinc were detected in the soil samples obtained at the outfall (Appendix C).

  - The maximum concentrations of copper, lead, and zinc were detected in the 0.0- to 0.5-foot bgs soil samples.

- At Sampling Location 32, a grated inlet draining the Site 15 yard (Plate 6):

  - Arsenic, cadmium, copper, chromium, lead, mercury, and nickel, and zinc were detected in the sediment sample (Appendix C).

3.5.2.2 Organics

Organic compounds were generally detected less frequently than the inorganic compounds. Acetone and methylene chloride, two common laboratory contaminants, were detected in 35 or more soil and sediment samples (Tables 7 and 9). Although acetone and methylene chloride are common laboratory contaminants, the human health risk of all the concentrations detected in the soil or sediment at an outfall were evaluated in Tables 12 through 66. 4,4'-DDT was found in 29 soil samples and sediment samples. TPH as an unknown extractable hydrocarbon was detected in 27 of the soil and sediment samples. The remaining detected organic compounds were found in less than 11 soils and sediment samples. No organic compounds were detected in 18 of the 83 soil and sediment samples (Appendix C).

The findings of this investigation with respect to organic compounds are summarized as follows:

- Pesticides were detected in the soil and sediment samples collected from Sampling Locations 1N, 1S, 3, 5, 7, 8, 15, 16, 22, 23, 25, 26, and 31 (Appendix C; Plates 12 and 13).

- Pesticides were generally detected in the near surface soil samples or sediment samples at the locations noted above, except at Sampling Locations 1S, 1N, and 5, where pesticides were detected in the 5.0- to 5.5-foot bgs samples.

- PAHs were detected at Sampling Locations 1, 1N, 3, 4, 7, 11, 12, 15, 20N, 20S, 21, 22, 23, 24, 25, 26, 31, and 32 (Appendix C and Plate 12). The PAHs identified included acenaphthene, anthracene, benzo(a)anthracene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene.

- Eighteen of the 23 samples in which PAHs were detected in near surface soil samples.

- VOCs were detected at Sampling Locations 1, 5, 15, 16, 19, 24, 26, and 31.

The results of the analyses for organic compounds for each sampling location are summarized as follows:

- At Sampling Location 1, manholes of the northernmost ocean outfall (Plate 3):

  - Eleven PAHs, three VOCs, including one BTEX compound were detected in the sediment samples from manhole OF-01-MH-01 and OF-01-MH-03 (Appendix C).

  - TPH diesel as an extractable unknown hydrocarbon was detected at concentrations of 10,000 and 140 mg/kg in the manhole sediments (Appendix C).

- At Sampling Location 1S - downgradient of RI/FS Site 37 (Plate 3):

  - 4,4'-DDT was detected in the near surface (0.0- to 0.5-foot bgs) and deeper (5.0- to 5.5-foot bgs) soil samples collected at the inlet grates.

- At Sampling Location 1N - downgradient of RI/FS Site 37 (Plate 3):

  - 4,4'-DDE, 4,4'-DDT, fluoranthene, and pyrene were detected in near surface (0.0- to 0.5-foot bgs) and deeper (5.0- to 5.5-foot bgs) soil samples collected from the vicinity of the outfall and 20 feet downgradient from the north outfall (Appendix C).

- At Sampling Location 3 - manhole upgradient of an ocean outfall (Plate 3):

  - 4,4'-DDT, chrysene, naphthalene and tentatively identified organic compounds were detected in the sediment sample (Appendix C).

- At Sampling Location 4, manholes of the southernmost ocean outfall (Plate 5):

  - Anthracene, chrysene, fluoranthene, phenothrene, pyrene, and toluene were detected in manhole sediments at sampling locations OF-04-MH-03 and OF-04-MH-04.

  - Unknown hydrocarbons were detected at a maximum concentration of 570 mg/kg.

- At Sampling Location 5 - dune outfall south of Stilwell Hall (Plate 5):

  - Chlorobenzene and toluene were detected in the deeper (5.0- to 5.5-foot bgs) soil sample obtained from the soil boring completed at the pipe outfall.

  - 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT were detected in the near surface (0.0- to 0.5-foot bgs) soil samples located both at the outfall and 30 feet downgradient from the outfall.

  - 4,4'-DDD and 4,4'-DDT were detected in the deeper (5.0- to 5.5-foot bgs) soil sample located 30 feet downgradient from the outfall and in the sediment samples.

  - 4,4'-DDT was detected at 590 μg/kg in the sediment sample and 1,400 μg/kg of 4,4'-DDT in the near surface (0.0- to 0.5-foot bgs) sample 30 feet downgradient of the outfall. Total organic carbon concentrations at these same locations were 14,900 mg/kg and 27,600 mg/kg, respectively.

- At Sampling Location 7 - downgradient of RI/FS Site 20 (Plate 5):

  - 4,4'-DDT and dieldrin were detected in the near surface (0.0- to 0.5-foot bgs) soil samples at concentrations of 100 and 14.0 μg/kg, respectively (Appendix C). Total organic carbon in this same sample was measured at 23,800 mg/kg.

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Target detection limits for PAH and PCB analyses in some samples were not achieved due to the presence of extractable petroleum hydrocarbons or matrix interference. There is a potential at these locations for PAHs and PCBs to be present at concentrations above the PRGs but below the detection limits of the analysis. Additional sampling at these locations would not eliminate the effects of this matrix interference. The potential for these compounds to be present at each of the outfalls from known upgradient source areas was evaluated in Section 4.0.

- Organic compounds were not detected in the deeper (5.0- to 5.5-foot bgs) soil samples.

- Fluoranthene and unknown extractable hydrocarbons were detected in the sediment sample.

- At Sampling Location 8 - downgradient of RI/FS Site 11 (Plate 6):

  - 4,4'-DDT was detected in the near surface (0.0- to 0.5-foot bgs) soil sample at a concentration of 9.6 μg/kg. Total organic carbon in the sample was 10,600 mg/kg.

  - Organics were not detected in the deeper (5.0- 5.5-foot bgs) soil samples.

  - An unknown hydrocarbon was detected in the sediment sample.

- At Sampling Location 11 - downgradient of RI/FS Site 22 (Plate 6):

  - Benzo(ghi)perylene was detected at a concentration of 370.0 μg/kg in the near surface (0.0- to 0.5-foot bgs) soil sample located at the outfall (Appendix C). Total organic carbon in this sample was 75,500 mg/kg.

  - Chrysene and an unknown hydrocarbon were detected in the sediment sample.

- At Sampling Location 12, the pipe outfall near Third Street and 7th Avenue (Plate 6):

  - Chrysene was detected at a concentration of 150 μg/kg in the 5.0- to 5.5-foot bgs soil sample from the soil boring completed at the outfall.

  - Unknown hydrocarbons were present in all four soil samples (Appendix C).

- At Sampling Location 13 - downgradient of RI/FS Site 21 (Plate 6):

  - Unknown hydrocarbons and tentatively identified organic compounds were the only organic compounds detected in the soil and sediment samples (Appendix C).

- At Sampling Location 14 - canal outfall downgradient of RI/FS Site 21 (Plate 6):

  - One unknown hydrocarbon was the only organic compound present in the soil samples. The total organic carbon of the sample was 34,200 mg/kg (Appendix C).

- At Sampling Location 15 - dune outfall downgradient of RI/FS Site 12 (Plate 7):

  - 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, and dieldrin were detected in the near surface (0.0- to 0.5-foot bgs) soil samples located at the pipe outfall and 20 feet downgradient from the outfall (Appendix C).

  - 1,1,1-trichloroethane and tetrachloroethane were detected in the 2.0- to 2.5-foot bgs soil sample obtained immediately adjacent to the outfall, in the 0.0- to 0.5-foot bgs soil sample obtained 20 feet downgradient of the outfall, and in the 0.0- to 0.5-foot bgs soil sample obtained on the southern top of bank near the end of the buried channel.

  - Unknown hydrocarbons were detected in the near surface and deep soil samples of the borings completed within the limits of the buried channel. The maximum unknown hydrocarbon concentration was detected in the 2.0- to 2.5-foot bgs sample obtained 20 feet downgradient of the outfall. Unkown hydrocarbons were detected in three near surface soil samples at concentrations that ranged from 10 mg/kg to 54 mg/kg in borings completed around the buried channel perimeter. The unknown hydrocarbon concentrations attenuated to none detected in the 5.0- to 5.5-foot bgs samples in all borings completed around the channel perimeter.

  - Dibromochloromethane and bromoform were detected in the 0.0- to 0.5-foot bgs

sample obtained at the end of the buried channel.

- Benzo(a)anthrancene, benzo(b)fluoranthene and an unknown hydrocarbon were detected in the sediment sample.

- At Sampling Location 16 - Pete's Pond pipe outfalls (Plate 12):
  - 4,4'-DDT and unknown hydrocarbons were detected in the near surface (0.0- to 0.5-foot bgs) soil and sediment samples.
  - Methyl ethyl ketone, methyl isobutyl ketone (MIBK), and xylenes were detected in the sediment sample at Sampling Station OF-16-05-01.
  - Total organic carbon was found at concentrations ranging from 471.0 mg/kg to 31,400 mg/kg.
  - Organics compounds were not detected in the deeper (5.0- to 5.5-foot bgs) soil samples.
  - The highest concentration of total organic carbon for all 83 soil and sediment samples was found in the sediment at sampling station OF-16-02, at a concentration of 60,900 mg/kg.
- At Sampling Location 19 - FAAF (Plate 9):
  - Chloromethane and unknown hydrocarbons were detected in the near surface (0.0- to 0.5-foot bgs) soil samples located at the pipe outfall (Appendix C).
- At Sampling Location 20N - FAAF (Plate 9):
  - Fluorene was detected at a concentration of 60 µg/kg in the 5.0- to 5.5-foot bgs soil sample in the soil boring completed at the outfall (Appendix C).
- At Sampling Location 20S - FAAF (Plate 9):
  - PAHs were detected in the near surface (0.0- to 0.5-foot bgs) and deeper (5.0- to 5.5-foot bgs) soil samples located at the pipe outfall (Appendix C)
  - PAHs were not detected in the soil samples located 20 feet downgradient of the outfall.
- At Sampling Location 21 - FAAF (Plate 9):
  - Benzo(b)fluoranthene was detected in the near surface (0.0- to 0.5-foot bgs) soil sample located at the pipe outfall.
  - Other organic compounds were not detected.
- At Sampling Location 22 - FAAF (Plate 9):
  - PAHs and pesticides were detected in the near surface (0.0- to 0.5-foot bgs) and deeper (5.0- to 5.5-foot bgs) soil samples located at the pipe outfall and 20 feet downgradient from the outfall.
  - Unknown hydrocarbons were detected in the near surface (0.0- to 0.5-foot bgs) soil sample at both boring locations.
- At Sampling Location 23 - FAAF outfall which ultimately discharges off-base to the Salinas Valley (Plate 9):
  - Six PAHs were identified in the near surface (0.0- to 0.5-foot bgs) soil samples (Appendix C). All six PAHs were detected in the near surface soil sample obtained at the pipe outfall; concentrations ranged from 15.0 µg/kg to 58.0 µg/kg. The total organic carbon concentration in this sample was 28,000 mg/kg. Two PAHs (benzo(b)fluoranthene and benzo(k)fluoranthene) were detected in the near surface soil sample obtained 20 feet downgradient of the outfall at concentrations of 11.0 µg/kg and 5.0 µg/kg.
  - Benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and benzo(ghi)perylene were detected in the sediment sample, at concentrations

which ranged from 13.0 μg/kg to 350 μg/kg. The total organic carbon concentration in this sample was 25,300 mg/kg.

- Endosulfan sulfate and 4,4'-DDT were detected in the near surface (0.0- to 0.5-foot bgs) soil samples. Endosulfan sulfate was detected at a concentration of 32.0 μg/kg and 4,4'-DDT was detected at concentrations of 29.0 and 74.0 μg/kg (Appendix C).

- 4,4'-DDE, 4,4'-DDT, dieldrin, and endosulfan II were detected in the sediment sample (Appendix C).

- At Sampling Location 24, an off-base outfall draining the western portion of the East Garrison (Plate 10):

  - Benzo(ghi)perylene and methyl ethyl ketone were detected in the 0.0- to 0.5-foot bgs and 5.0- to 5.5-foot bgs soil samples obtained 20 feet downgradient from the outfall.

  - Toluene, an unknown hydrocarbon, and a TIC of 2-oxabicyclo[2.2.2] octane, 1,2,3-trimet were detected in the sediment sample obtained from the on-base inlet.

- At Sampling Location 25, an off-base outfall draining the central portion of the East Garrison (Plate 10):

  - Six pesticides, three PAHs, toluene, and one unknown hydrocarbon were detected in the sediment obtained from manhole OF-25-MH-02.

  - Two pesticides were detected in the 0.0- to 0.5-foot bgs soil sample obtained at the outfall (Appendix C).

- At Sampling Location 26, an off-base outfall draining the eastern and southern portions of the East Garrison (Plate 10):

  - Arochlor-1248 was detected at a concentration of 84 mg/kg in the sediment of storm drain inlet OF-26-MH-06, and was not detected in any soil sample obtained at the outfall (Appendix C)

  - Four pesticides were detected in the soil sample at inlet OF-26-MH-06.

  - Four pesticides were detected in the soil samples obtained from the agricultural drainage ditch 20 feet downgradient from the outfall.

  - Benzo(b)fluoranthene was detected in the near surface (0.0- to 0.5-foot bgs) soil sample obtained immediately adjacent to the outfall (Appendix C).

- At Sampling Location 27 - RI/FS Site 27 (Plates 9 and 11):

  - Unknown hydrocarbons were detected in the near surface (0.0- to 0.5-foot bgs) and deeper (5.0- to 5.5-foot bgs) soil samples located at the pipe outfall.

  - No other organic compounds were detected.

- At Sampling Location 31, a lower meadow pipe outfall and grated inlet in Site 12 (Plate 7):

  - Three PAHs were detected in the 0.0- to 0.5-foot bgs soil sample obtained 20 feet downgradient from the outfall (adjacent to the grated inlet).

  - 4,4'-DDT was detected in the near surface (0.0 to 0.5-foot bgs) soil sample obtained adjacent to the outfall.

  - Tetrachloroethane was detected in the 9.0-foot bgs soil sample (5 foot bgs of the 4-foot-deep scour hole).

  - Extractable unknown hydrocarbons were detected in concentrations ranging from 13 mg/kg to 26,000 mg/kg in the soil samples obtained at the outfall.

- At Sampling Location 32, a grated inlet in the Site 15 yard (Plate 6):
  - Fluoranthene was detected in the sediment at a concentration of 0.094 mg/kg.
  - An extractable unknown hydrocarbon was detected in the sediment at a concentration of 180 mg/kg.
  - No other organics were detected.

3.5.3 Particle Size

The sampled soils from 24 sampling locations were predominantly fine- to medium-grained sand. Gravel and fines (less than #200 sieve size) were present in significant quantities only at sampling locations OF-11, OF-12, OF-15 and OF-24, OF-25, OF-26, and OF-31. The results of the particle size analyses on the samples from these representative locations are presented in Appendix B and are summarized below:

- The sampled soil at 22 sampling locations was predominantly sand with a sand (particle size diameters of 0.075 to 4.75 mm) content that ranged from 84.1 percent of the total sample composition at Sampling Location OF-15-02 to 99.1 percent at Sampling Location OF-01-02N. Sampling Locations OF-24-02 and OF-25-01 had sand contents of 52.4 and 39.3 percent, respectively.
- The gravel content (particle size greater than 4.75 mm in diameter) ranged from a minimum of 0 percent to a maximum of 7.3 percent at Sampling Location OF-15-01.
- The fines content of the particle size samples ranged from 0.3 percent at Sampling Station OF-15-01 to 60.7 percent at Sampling Location OF-25-01.

3.5.4 Data Validation

The analytical data for the Basewide SWOI were subjected to data validation. The results of the data validation for the 1993 Phase 1 and 1994 Phase 2 samples are presented in Appendix D: the data validation procedures are described in Part 2 of the Site 34 Site Characterization Report (*HLA, 1992d*). The results of the data validation for the 1992 Phase 1 samples are described in the *Draft Basewide Surface Water Outfall Investigation* report dated April 5, 1993.

Analytical results from the Basewide SWOI 1993 Phase 1 and 1994 Phase 2 sampling events, consisting of ten sample delivery groups (SDGs 071406, 071463, 072143, 072144, 073171, 073217, 077947, 077981, 077982, and 078621) were validated according to procedures specified in the Fort Ord QAPP (*HLA, 1991*), Revisions to the QAPP (*HLA, 1992k*), and the *Draft Site Characterization, Site 34, Part 2*, dated June 12, 1992. The validation evaluated the quality of the data with respect to a set of quality control (QC) criteria, including precision, accuracy, and completeness. The QC samples used to assess data quality consisted of laboratory duplicate samples, matrix spike/matrix spike duplicates (MS/MSD), blank spike/blank spike duplicate samples (BS/BSD: also known as laboratory control samples [LCS]), and laboratory blanks. Holding times and laboratory surrogate spike recoveries were also evaluated. In addition, SDG 073217 underwent a detailed validation in which calibrations, internal standards, gas chromatography/mass spectrometry (GC/MS) tuning, inductively coupled plasma (ICP) interference check samples, ICP serial dilution analysis, graphite furnace atomic absorption (GFAA) duplicate injection precision, GFAA post-digestion spikes, and compound quantifications were evaluated. The results of the data validation presented in Appendix D indicate the data are useable when the data quality objectives of the project are considered.

4.0 METHODOLOGY FOR DATA EVALUATION

The data evaluation of each outfall addressed the following:

- Possible source area issues
- Possible human health impacts (Screening Risk Evaluation [SRE])
- Potential impacts to groundwater.

Data from individual surface water outfalls or sampling locations were evaluated separately. Table 10 summarizes additional action proposed at each sampling location based upon the human health data evaluation. Because the Basewide Ecological Risk Assessment (ERA) (Volume IV) evaluates the potential ecological effects of the surface water outfall samples, ecological issues are not addressed in this part of the RI/FS. Table 10 also presents the results of the Ecological Risk Assessment discussed in Volume IV.

Two tables are presented for each sampling location addressed (Tables 11 through 63). The first table presents source area issues, human health issues, potential impacts to groundwater evaluation, and recommendations; the second table presents comparisons of sediment and soil chemical concentrations at the sampling location with background soil concentrations and preliminary remediation goals (PRGs) and is referred to herein as the SRE table.

4.1 Source Area Issues

RI/FS sites upgradient of outfalls having in-pipe sediment concentrations exceeding PRGs and substantially elevated concentrations of chemicals (approximately 5 times the sediment concentrations) in the site soil were qualitatively identified as possible contaminant sources.

4.2 Screening Risk Evaluation

The SRE was performed to evaluate possible human health impacts of chemicals detected in the outfall sediment and soil samples. Table 10 presents a summary of the human health SRE for each sampling location and the results of the ERA discussed in Volume IV. The human health SRE tables compare concentrations of chemicals detected in sediment and soil samples with background soil concentrations and PRGs.

The PRGs were developed specifically to assess potential human health impacts for sites at Fort Ord on the basis of EPA-derived toxicity values and reasonable maximum exposure assumptions, using EPA guidance for developing risk-based PRGs (*EPA, 1991*d). PRGs represent soil concentrations considered to result in estimated daily doses (1) associated with an estimated one-in-one-million probability that an exposed individual would develop cancer (10^{-6} cancer risk) or (2) expected to be without appreciable risk of deleterious noncancer health effects (hazard quotient less than 1; *EPA, 1989b, 1991*d) based on a conservative residential exposure scenario. The methodology and assumptions used to develop PRGs for priority pollutant metals are presented in the *Draft Final Basewide Background Soil Investigation* report, dated March 15, 1993; PRGs for organic chemicals, barium, and vanadium are developed in the *Draft Technical Memorandum, Preliminary Remediation Goals*, dated June 14, 1993 and subsequent addenda.

Following review of sediment and soil sample analytical results, detected chemicals were divided into two categories: (1) chemicals that may be present as a result of Army activities (i.e., site-related), and (2) chemicals considered to be naturally occurring and not related to Army activities (i.e., background). A chemical can have both site- and background-related components where there are contributions from site activities as well as from natural occurrences.

The concentrations of the chemicals detected in the sediment and soil samples from individual outfalls were used to calculate ratios of chemical concentrations to the PRGs. The chemical concentrations used in the ratios include the:

- Maximum detected site concentration (MSC)
- Calculated component concentration representing the portion of the MSC attributable to background, i.e., the threshold or maximum background concentration (MBC)
- Calculated component concentration representing the portion attributable to site activities, i.e., maximum site-related concentration (MSRC)

A chemical-specific ratio less than or equal to 1 indicates that the maximum detected or calculated concentration is less than or equal to the PRG and therefore, that substantial health risks are not likely to be associated with that chemical. A ratio greater than 1 indicates that the concentration of the chemical exceeds the PRG. To evaluate possible exposure to multiple chemicals, the effects of multiple chemicals were assumed to be additive, and the ratios were added together to calculate a ratio sum.

The SRE tables are divided into comparisons for chemicals considered to be outfall- or site-related (top panel) and background-related (bottom panel), and information on other chemicals detected but not quantitatively evaluated (middle panel). For site-related chemicals, the background component is assumed to be equivalent to the threshold or maximum background concentration (MBC) for that chemical as identified in the *Draft Final Basewide Background Soil Investigation* report, dated March 15, 1993. The site-related component is then calculated by subtracting this background component from the maximum detected soil or sediment concentration (MSC). For outfall- or site-related chemicals, the total, background-related, and site-related concentrations were compared with the chemical-specific PRG using the ratios and ratio sum calculations mentioned above. For background-related chemicals, the site-related component was considered to be zero, and the MSC was the only concentration compared to the chemical-specific PRG (i.e., the MSC has only a background component). As a result, for background-related chemicals, the MSC/PRG ratio is equal to the MBC/PRG ratio.

The ratios and ratio sums presented in Tables 11 through 62 were used as the basis for identifying human health (HH) issues and for making recommendations for each outfall. No potential human health impacts were identified, and no further actions were recommended for outfalls for which the sum of the ratios of the maximum site-related chemical concentrations to the corresponding PRGs (MSRC/PRG ratios) was less than or equal to 1. Recommendations for further action at outfalls for which the ratio sum (RS) was greater than 1 also considered:

- The adequacy of site characterization
- TPH toxicity using BTEX and PAH toxicity (not whole-mixture toxicity values)
- Organochlorine pesticides, PCBs and PAHs using a 10^{-4} cancer risk criterion (MSRC/PRG ratio of 100)
- Metals using only risks associated with the incremental concentrations exceeding background
- Exposure potential, including current and projected future land use
- Risks associated with individual and multiple chemicals
- Cancer risks separately from noncancer health effect issues
- Target organ considerations for noncancer health effects.

The risk criterion selected for evaluating the need for further action at outfalls to address organochlorine pesticide, PCB, and PAH concentrations in soil and sediment was a MSRC/PRG ratio of 100. This criterion was selected because:

- It corresponds to cancer risks in the 10^{-4} to 10^{-6} range identified in the National Contingency Plan (NCP, 40 CFR Part 300) as the acceptable post-remediation residual risk range for Superfund sites

- Organochlorine pesticides are often present in developed areas as a result of routine pesticide application and routine activities unrelated to hazardous materials

- PAHs are occur naturally, and are often present in developed areas as a result of routine activities unrelated to hazardous materials

- It corresponds to the lowest PCB cleanup goal for soil (1 mg/kg) identified by EPA for Superfund sites (*EPA, 1990*).

The measured concentrations of background-related chemicals were considered to be naturally occurring and not related to discharges or other activities at the site. Accordingly, possible health effects of these chemicals were considered to be part of the risks inherent in day-to-day living in the region. MBC/PRG and MSC/PRG ratios and ratio sums for background-related chemicals are presented in Tables 11 through 62 to provide a context for risk management decisions at Fort Ord sites.

4.3 Potential Groundwater Impacts

The evaluation of potential impacts to groundwater was qualitative and addressed all site-related chemicals regardless of potential health impacts. Chemicals detected in soil and sediment samples were considered to not represent a threat to groundwater if:

- Chemical concentrations were substantially attenuated in subsurface samples, or

- Chemicals were detected only at low concentrations in soil and have low mobility in soil.

Specific quantitative criteria were not used to characterize the attenuation of chemical concentrations with distance from the outfall and depth below ground surface. Samples were collected from the intervals of 0 to 0.5 feet bgs. and 5 to 5.5 feet bgs in borings at the outfall and 20 feet downgradient from the outfall. Attenuation was considered to be substantial if background levels or concentrations below detection limits could be predicted by projecting the observed attenuation rate over the next two sample intervals (40 feet from the outfall, or 10 feet deeper bgs). If attenuation with distance from the outfall and depth bgs was considered to be substantial, then there was no further soil sampling or additional assessment of potential groundwater impacts.

5.0 RESULTS OF THE DATA EVALUATION

Results of the Phase 1 source area issue evaluation, the SRE, and the potential groundwater impacts evaluation for each sampling location are presented in Tables 11 through 66. Footnotes and acronyms used in Tables 11 through 66 are presented in Table 67.

Various uncertainties are associated with the SRE. Numerous exposure- and effect-related assumptions were used in developing the PRGs, many with very conservative health biases. The uncertainties and limitations these biases place upon this analysis are discussed in greater detail in the *Draft Technical Memorandum, Preliminary Remediation Goals*, dated June 14, 1993. Accordingly, this SRE is subject to the limitations presented in that memorandum.

Because of these uncertainties, the PRGs, MSC/PRG ratios, and ratio sums presented herein do not necessarily represent accurate estimates of actual expected human health risks either now or in the future. Soil and sediment concentrations below the PRGs and location-specific ratio sums less than 1 are unlikely to represent health risks. Soil concentrations greater than the PRGs and ratio sums greater than 1 do not necessarily indicate the presence of unacceptable health risks.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The human health SRE utilized to evaluate the soil and sediment samples obtained for Phase 1 and 2 of this investigation identified five surface water outfalls (Sampling Locations OF-15, OF-25, OF-26, OF-34 and OF-35) that required further characterization of evaluation. All the remaining surface water outfalls sampled under this investigation were determined to require no further action (NoFA).

Two additional storm drain outfalls were identified for Phase 2 sampling during a June 9, 1994 site visit to FAAF with previous employees of the base. These two outfalls (Sampling Locations OF-34 and OF-35) discharge into a vegetated drainage channel west of Buildings 533 and 535 at the western end of FAAF. Sampling at these two outfalls was completed under the Phase 2 Basewide SWOI field activities.

Phase 2 sampling took place on September 28 and 30, 1994. Soil samples were obtained from 10 additional soil borings within and surrounding a concrete channel that lies beneath 2.0 to 3.0 feet of soil and extends approximately 61 feet to the west of Sampling Location OF-15. Concentrations of an unknown hydrocarbon, 1,1,1-TCA, and PCE attenuated with distance from the outfall in the soil samples from within the concrete channel; and attenuated to none detected at a depth of 5.5 feet bgs in samples obtained from soil borings completed around the channel perimeter. Dibromochloromethane and bromoform were detected in a 0.0-foot to 0.5-foot bgs sample from a soil boring above the buried concrete channel. On the basis of these data, it is recommended that the soil above the buried channel at Sampling Location OF-15 be excavated under the IAROD.

Recommendations presented in the Phase I SWOI included further evaluation of the potential impacts to groundwater of a TPH concentration at Sampling Location OF-11 that did not attenuate with depth. During Phase 2, further evaluation of the analytical results determined that the non-attenuated concentration reported at depth was an incorrectly reported surrogate result and was not present in the soil at the outfall. Therefore, no potential impacts to groundwater were identified and no further action at Sampling Location OF-11 was recommended.

The grated inlets to the storm drain in Site 29 and adjacent areas that discharge to off-base outfalls OF-25 and OF-26 will be cleaned by the Army under an operation and maintenance contract. The sediment in the on-base catch basins, manholes, and storm drain lines of outfalls OF-25 and OF-26 will be removed and sampled to assess appropriate disposal options. This work will be completed by the Army.

Two PCBs were detected at levels above PRGs in a soil sample from the soil boring completed adjacent to the outfall at Sampling Location OF-34. No other organics or inorganics detected in the samples obtained at Sampling Location OF-34 were determined to present human health risks. Exposure at the outfall location is expected to be much lower than the calculated residential exposure due to the depth of the sample and non-residential future land use of FAAF. Further characterization of the vertical extent of the PCBs present in the soil at Sampling Location OF-34 will be completed under the IAROD.

Lead and cadmium were detected at levels above PRGs in the 0.0- to 0.5-foot bgs sample from the soil boring completed adjacent to the outfall at Sampling Location OF-35. An unknown petroleum hydrocarbon was also detected at an estimated concentration of 780 mg/kg in the same near-surface sample. Concentrations of these potential contaminants attenuated below human health risk PRGs with depth and distance from the outfall. On the basis of these data, it is recommended that the soil at Sampling Location OF-35 be excavated under the IAROD.