CLEAN

Contract No. N62474-88-D-5086

Contract Task Order 0137
Modification No. 02

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NAVAL AIR STATION, ALAMEDA
ALAMEDA, CALIFORNIA

IMF SITE INTERIM REMOVAL ACTION ENGINEERING EVALUATION/ COST ANALYSIS REPORT

FINAL

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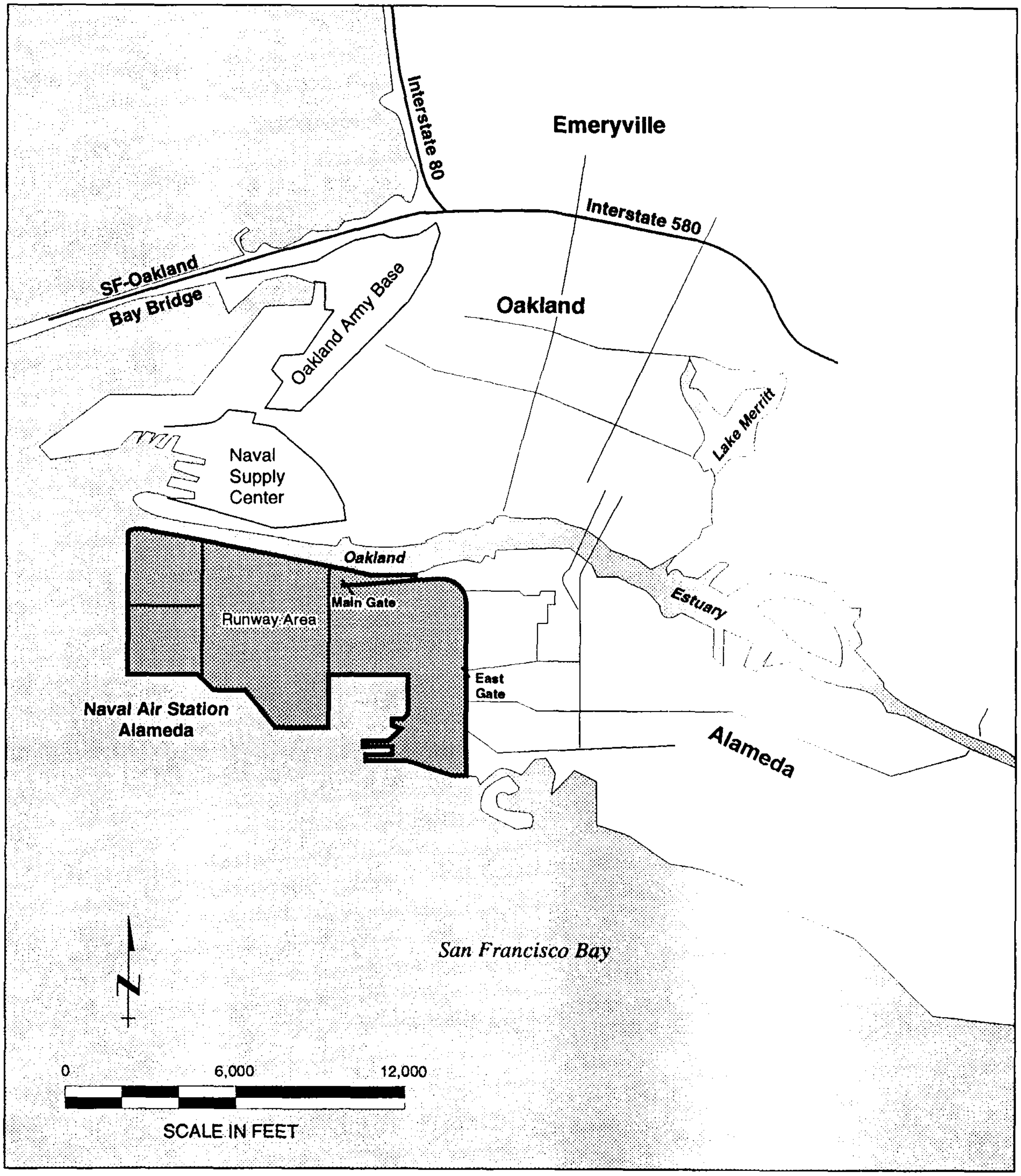
ACRONYMS AND ABBREVIATIONS

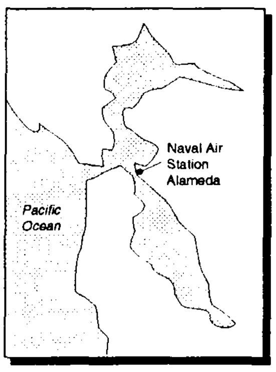
BFI	Browning-Ferris Industries
bgs	Below Ground Surface
Cal-EPA	California Environmental Protection Agency
CCR	California Code of Regulations
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CTO	Contract Task Order
°C	Degrees Celsius
DTSC	Department of Toxic Substances Control
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
HLA	Harding Lawson Associates
IMF	Intermediate Maintenance Facility
LDR	Land Disposal Restrictions
mg/kg	Milligrams per Kilogram
NAS	Naval Air Station
ND	Non Detect
O&M	Operations and Maintenance
OSHA	Occupational Safety and Health Administration
POAM	Plan of Action and Milestones
PRC	PRC Environmental Management, Inc.
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RWQCB	Regional Water Quality Control Board
STLC	Soluble Threshold Limit Concentration
TCLP	Toxic Characteristic Leaching Procedure
TRPH	Total Recoverable Petroleum Hydrocarbons
TTLC	Total Threshold Limit Concentration
U.S.	United States
VOC	Volatile Organic Compound
WESTDIV	Western Division

1.0 INTRODUCTION

PRC Environmental Management, Inc. (PRC) received Contract Task Order (CTO) No. 0137, Modification No. 0002, from the Department of the Navy, Western Division, Naval Facilities Engineering Command (WESTDIV), under Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62474-88-D-5086 on January 28, 1993. This CTO modification directs PRC to prepare documents required for an interim remedial action at the Intermediate Maintenance Facility (IMF) site at the Naval Air Station (NAS) Alameda, California (Figure 1-1). This request was initiated in response to a California Environmental Protection Agency (Cal-EPA), Department of Toxic Substances Control (DTSC) request to address subsurface soils with low pH and high lead levels. WESTDIV requested that PRC review previous site investigation work and develop an engineering evaluation/cost analysis (EE/CA) report for conducting the interim remedial action. PRC's CLEAN contract team member, Montgomery Watson, has primary responsibility for developing the EE/CA report; PRC provides project management and technical oversight. PRC and Montgomery Watson are referred to hereafter as the PRC team.

The scope of work for CTO No. 0137, Modification No. 02, requires the preparation of this EE/CA report for the purpose of outlining the interim remedial actions to be conducted at the IMF site at NAS Alameda. This report also identifies the interim remedial action objectives, screens the general response actions and technologies, develops and evaluates the remediation alternatives, and recommends a preferred alternative to accomplish soil remediation at the IMF site.





NAVAL AIR STATION ALAMEDA
ALAMEDA, CALIFORNIA
REGIONAL LOCATION MAP

FIGURE 1-1

2.0 SITE CHARACTERIZATION AND OBJECTIVES

This section presents a summary of the IMF site at NAS Alameda and its surroundings, the results of previous investigations, the nature and extent of contamination, and the interim remedial action objectives.

2.1 SITE DESCRIPTION AND BACKGROUND

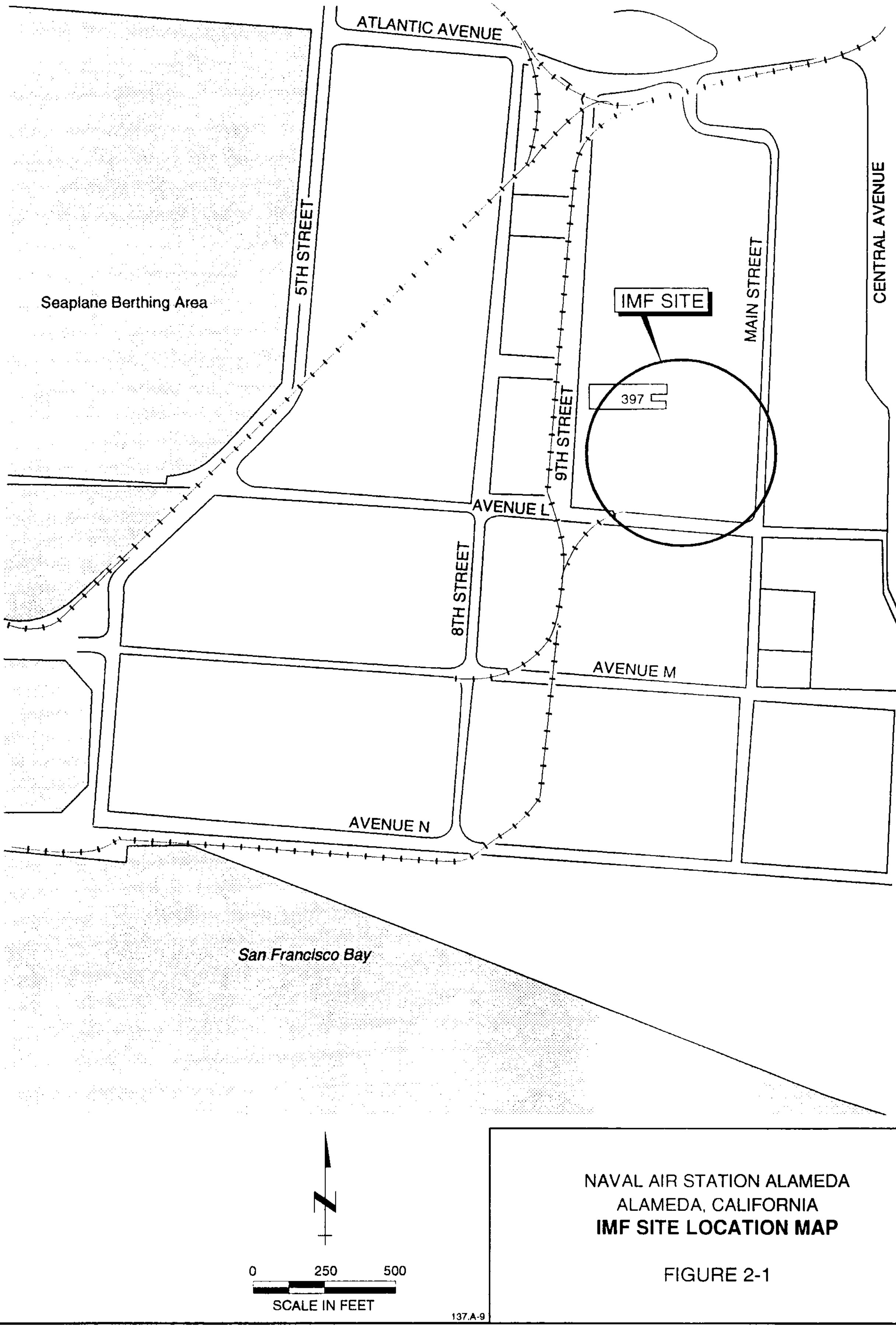
NAS Alameda is located at the west end of the Alameda Island, in Alameda and San Francisco Counties, California as shown on Figure 1-1. Alameda Island lies along the eastern side of San Francisco Bay, adjacent to the city of Oakland. The air station occupies 2,634 acres and is approximately 2 miles long and 1 mile wide. Most of the eastern portion of the air station is developed mainly with offices and industrial facilities, while runways, former landfills, and support facilities occupy the western portion of the station.

Originally a peninsula, the land that is now Alameda Island was isolated from the mainland in 1876 when a channel was cut through the peninsula's tip, linking San Leandro Bay with the main portion of San Francisco Bay. Dredging was conducted to deepen the channel and allow commercial and industrial traffic to and from the island's early industrial sites. These sites included a borax processing plant and the Pacific Coast Oil Refinery.

The U.S. Army acquired the site from the city of Alameda in 1930 and began construction activities in 1931. In 1936, the Navy acquired title to the land and began construction of the air station in response to the military buildup in Europe prior to World War II. After entry of the U.S. into the war in 1941, more land was acquired adjacent to the air station. Following the end of the war, the Navy returned NAS Alameda to its original primary mission of providing support for fleet aviation activities.

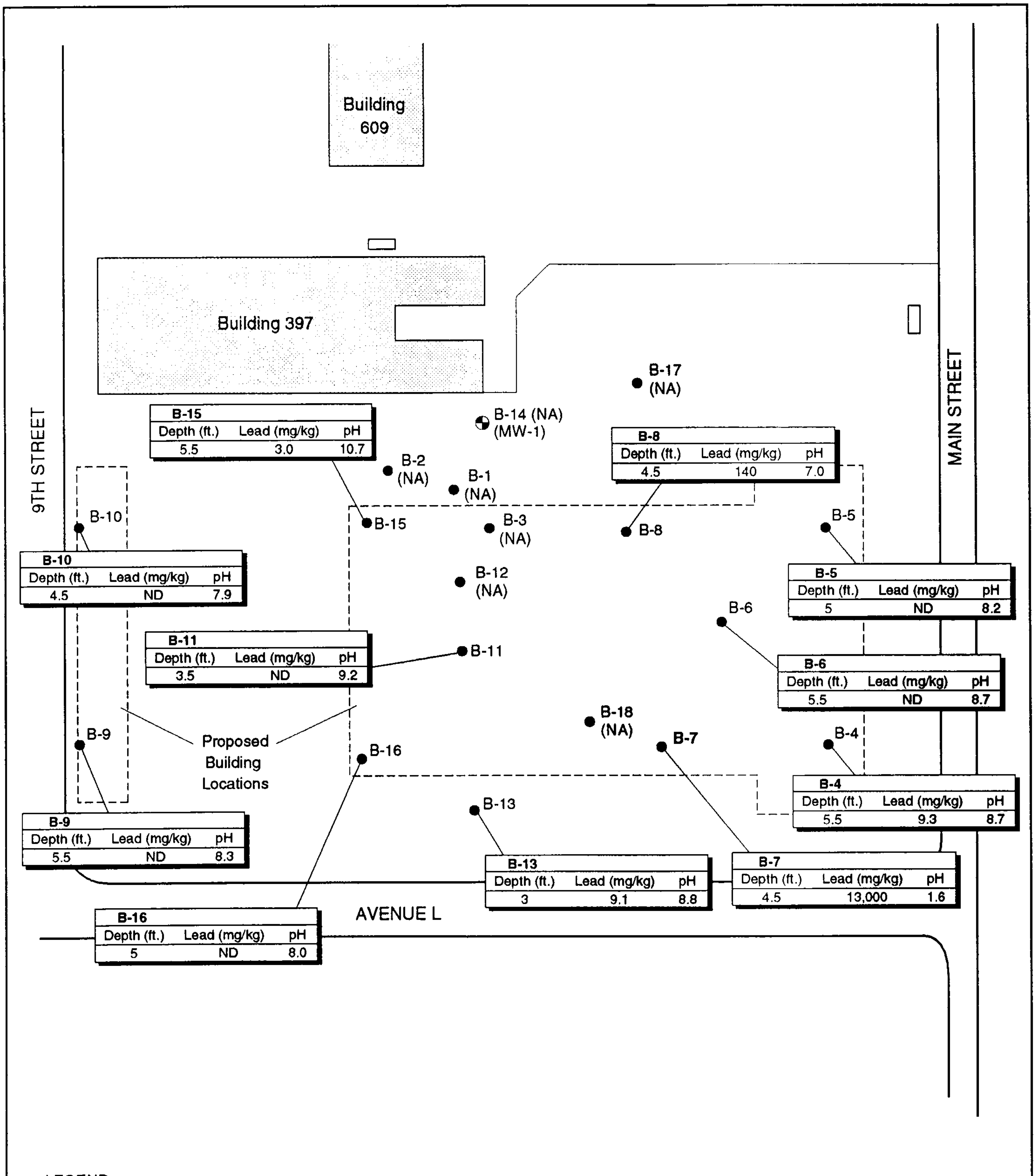
The IMF site at NAS Alameda is located as shown on Figure 2-1. The IMF site lies within the area formerly occupied by the Pacific Coast Oil Refinery which operated from 1879 to 1903. Refinery wastes and asphaltic residues were reportedly disposed of on the refinery property (Canonie 1990). The U.S. Navy surfaced the area in the 1940s, and the later rupture of this surface was attributed to buildup of vapors from the refinery wastes (Canonie 1990). It is reported that the Navy addressed the surface rupture problem by excavating a 30-square-foot area of material and pouring a concrete slab over the area (Canonie 1990).

In 1989, the Navy began construction of the IMF at the site. During construction activities, petroleum odors and stained soil were encountered. Harding Lawson Associates (HLA) was contracted to investigate the extent of contamination present at the site (HLA 1989). In HLA's boring B-7 (Figure 2-2), a soil sample collected from a depth of 4.5 feet below ground surface (bgs) had a pH of 1.6 and contained lead at a concentration of 13,000 milligrams per kilogram (mg/kg). Because HLA's investigation detected soils with low pH and high lead concentrations, the DTSC requested that the Navy perform an interim remedial action addressing soils only in the vicinity of boring B-7. The presence of petroleum hydrocarbons in the site vicinity have been addressed in previous investigations conducted by HLA (1989) and Canonie (1990).



NAVAL AIR STATION ALAMEDA
ALAMEDA, CALIFORNIA
IMF SITE LOCATION MAP

FIGURE 2-1



LEGEND

- Monitoring Well Location
- Soil Boring Location
- ND Concentrations Not Detected
- NA Not Analyzed

0 50 100
SCALE IN FEET

Source: Modified from HLA, 1989

4/93.AL

NAVAL AIR STATION ALAMEDA
ALAMEDA, CALIFORNIA
SOIL TOTAL LEAD AND pH RESULTS
1989 HLA INVESTIGATION
IMF SITE

FIGURE 2-2

2.2 RESULTS OF PREVIOUS INVESTIGATIONS

This section summarizes the analytical results from HLA's soil and groundwater investigation and the subsequent PRC team field investigation at the IMF site. As the interim remedial action for the IMF site is addressing only soil, analytical results for soils only are discussed below.

2.2.1 Harding Lawson Associates Investigation, 1989

The objective of HLA's investigation was to evaluate the presence of hazardous materials in soil and groundwater at the site and consisted of drilling 18 soil borings (B-1 through B-18) as shown on Figure 2-2. Selected soil samples were analyzed for hydrocarbons and lead; pH was also measured.

Results indicated a soil pH of 1.6, and lead concentrations of 13,000 milligrams per kilogram (mg/kg) were detected in a sample collected at 4.5 feet bgs at boring B-7 as presented in Figure 2-2. This sample also contained gasoline, diesel, and oil and grease at 16,000 mg/kg, 76,000 mg/kg, and 120,000 mg/kg, respectively (Figure 2-3). All other soil samples collected from throughout the site had measured pH values ranging from 7.0 to 10.7 and lead concentrations ranging from non-detect (ND) to 140 mg/kg as shown on Figure 2-2.

2.2.2 PRC Team Investigation, 1992

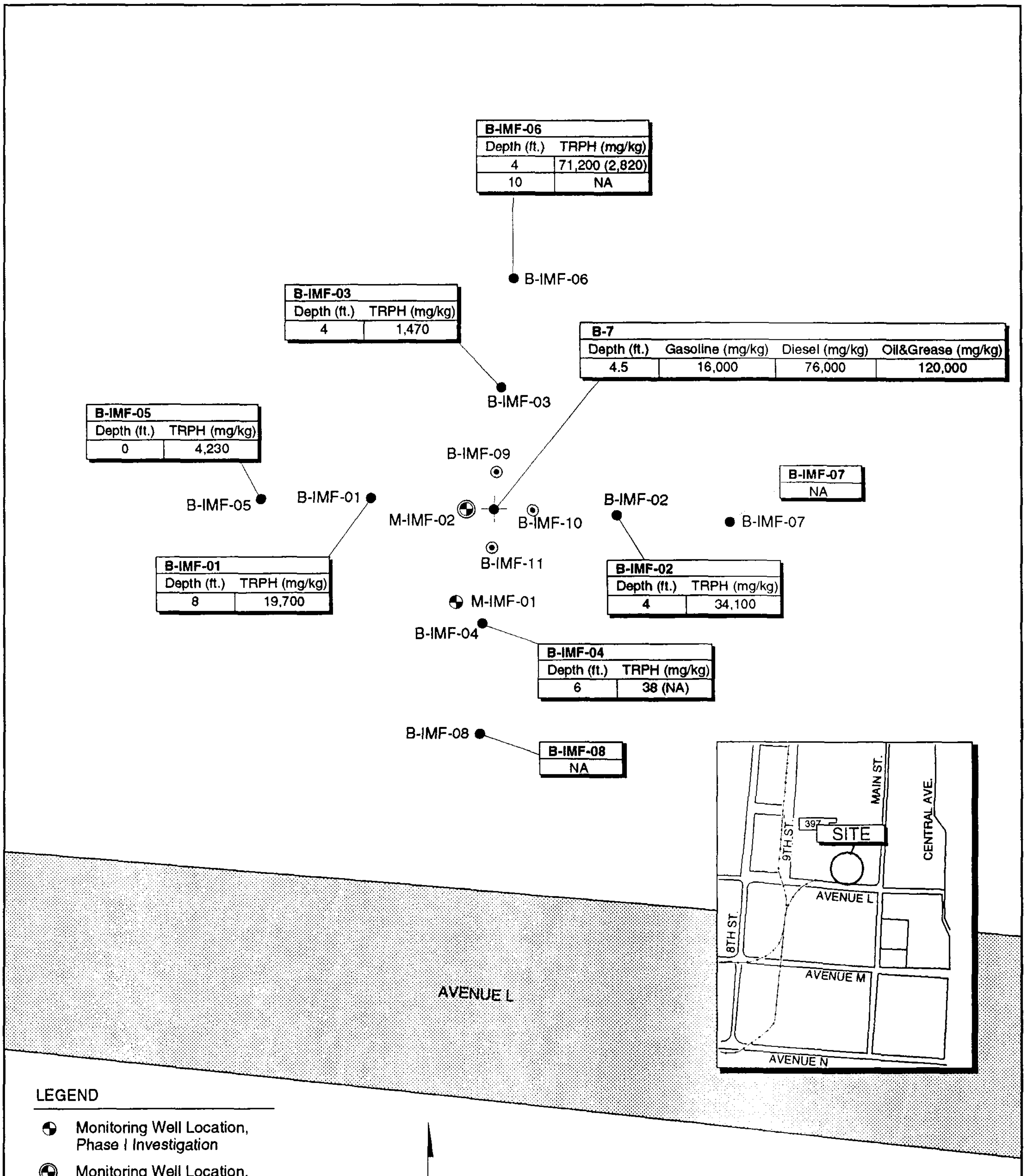
Based on the results of the 1989 HLA investigation, the DTSC requested that the Navy perform an interim remedial action in the vicinity of HLA boring B-7. To further characterize the extent of contamination at the IMF site prior to the interim remedial action, the PRC team performed a field investigation consisting of three separate sampling phases. The purpose of the investigation was to delineate the area surrounding boring B-7 containing soils with low pH and high lead levels.

2.2.2.1 Phase I Investigation

Eight soil borings, B-IMF-01 through B-IMF-08, were drilled to delineate the extent of pH-low, lead-contaminated soils near boring B-7 (Figure 2-3). The borings were drilled to 10 feet bgs, and samples were collected at the surface and at 2-foot intervals. Black, oily soil was found in six of the eight borings. A total of 52 soil samples were measured for laboratory pH. Seven of the 52 samples had laboratory pH values below 7.0 (Figure 2-4). The 8-foot sample from boring B-IMF-01 had a pH of 4.

A total of 18 soil samples were analyzed during Phase I for total lead. However, no soil samples from boring B-IMF-08 were submitted for the analysis of total lead because all field pH readings for boring B-IMF-08 were above a pH of 7.0. Lead concentrations ranged from 3.3 to 602 mg/kg (Figure 2-5), well below the State of California total threshold limit concentration (TTLC) of 1,000 mg/kg. Four samples were analyzed for soluble lead using the Waste Extraction Test (WET); no soluble lead concentrations were detected in excess of the State of California soluble threshold limit concentration (STLC). Three samples were analyzed for soluble lead using the toxicity characteristic leaching potential (TCLP) test; no soluble lead concentrations were detected in excess of the TCLP limit of 5.0 mg/L.

Three soil samples were analyzed for leachable volatile organic compounds (VOCs) based on field screening. The 8-foot sample from boring B-IMF-06 contained 2.9 micrograms per liter (μg/L) of



LEGEND

- Monitoring Well Location, Phase I Investigation
- Monitoring Well Location, Phase III Investigation
- HLA Soil Boring Location
- Soil Boring Location, Phase I Investigation
- Soil Boring Location, Phase III Investigation
- (2,820) Duplicate Analytical Result
- NA Not Analyzed

0 15 30
SCALE IN FEET

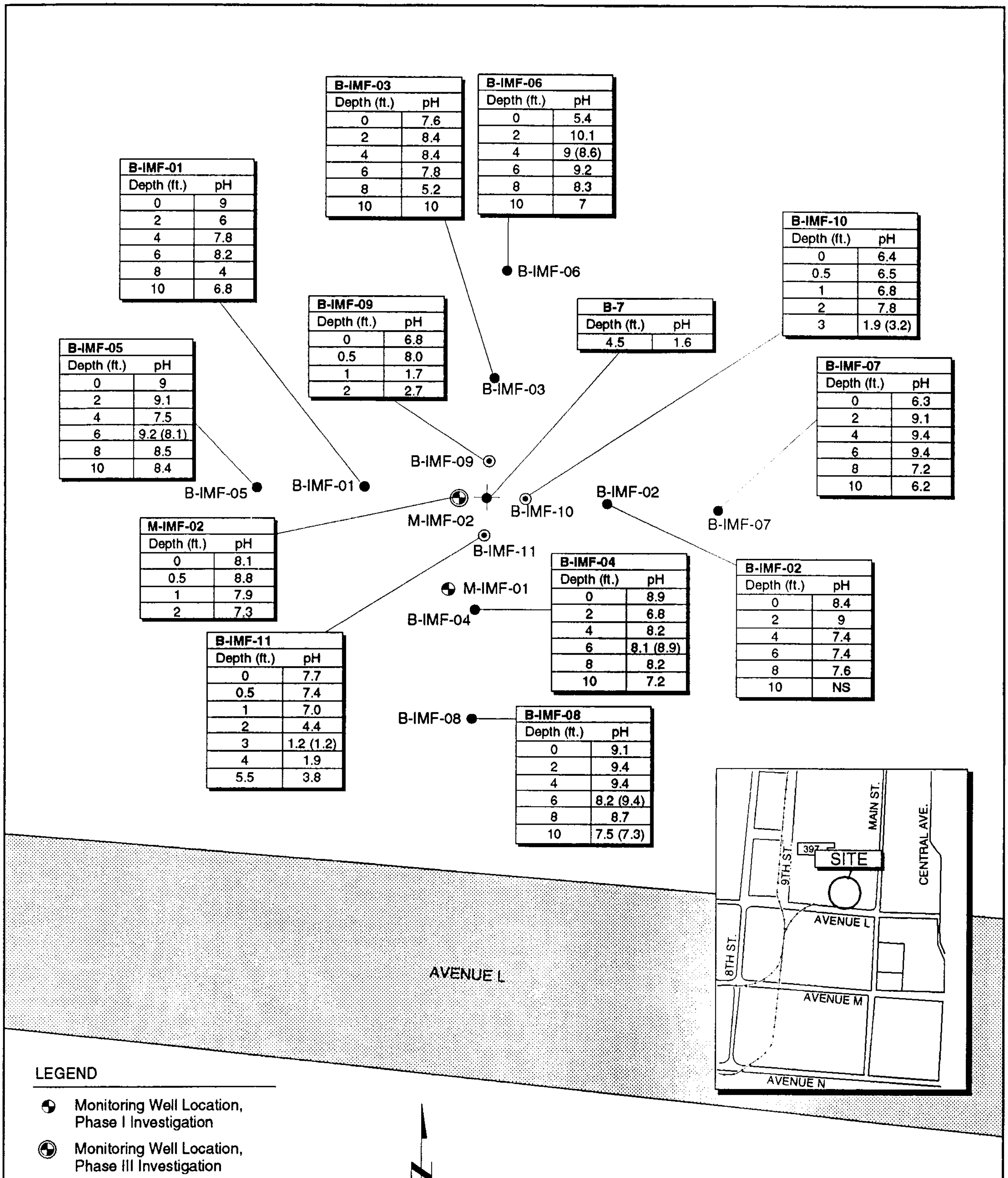
Sources:
Modified from PRC/JMM, 1992;
Modified from HLA, 1989

3/93.137

NAVAL AIR STATION ALAMEDA
ALAMEDA, CALIFORNIA

SOIL PETROLEUM HYDROCARBONS AND OIL AND GREASE RESULTS PREVIOUS INVESTIGATIONS IMF SITE

FIGURE 2-3



B-IMF-01

Depth (ft.)	pH
0	9
2	6
4	7.8
6	8.2
8	4
10	6.8

B-IMF-03

Depth (ft.)	pH
0	7.6
2	8.4
4	8.4
6	7.8
8	5.2
10	10

B-IMF-06

Depth (ft.)	pH
0	5.4
2	10.1
4	9 (8.6)
6	9.2
8	8.3
10	7

B-IMF-10

Depth (ft.)	pH
0	6.4
0.5	6.5
1	6.8
2	7.8
3	1.9 (3.2)

B-IMF-09

Depth (ft.)	pH
0	6.8
0.5	8.0
1	1.7
2	2.7

B-7

Depth (ft.)	pH
4.5	1.6

B-IMF-05

Depth (ft.)	pH
0	9
2	9.1
4	7.5
6	9.2 (8.1)
8	8.5
10	8.4

B-IMF-07

Depth (ft.)	pH
0	6.3
2	9.1
4	9.4
6	9.4
8	7.2
10	6.2

M-IMF-02

Depth (ft.)	pH
0	8.1
0.5	8.8
1	7.9
2	7.3

B-IMF-04

Depth (ft.)	pH
0	8.9
2	6.8
4	8.2
6	8.1 (8.9)
8	8.2
10	7.2

B-IMF-02

Depth (ft.)	pH
0	8.4
2	9
4	7.4
6	7.4
8	7.6
10	NS

B-IMF-11

Depth (ft.)	pH
0	7.7
0.5	7.4
1	7.0
2	4.4
3	1.2 (1.2)
4	1.9
5.5	3.8

B-IMF-08

Depth (ft.)	pH
0	9.1
2	9.4
4	9.4
6	8.2 (9.4)
8	8.7
10	7.5 (7.3)

LEGEND

- Monitoring Well Location, Phase I Investigation
- Monitoring Well Location, Phase III Investigation
- HLA Soil Boring Location
- Soil Boring Location, Phase I Investigation
- Soil Boring Location, Phase III Investigation
- (8.6) Duplicate Analytical Result
- NS Not Submitted to Laboratory

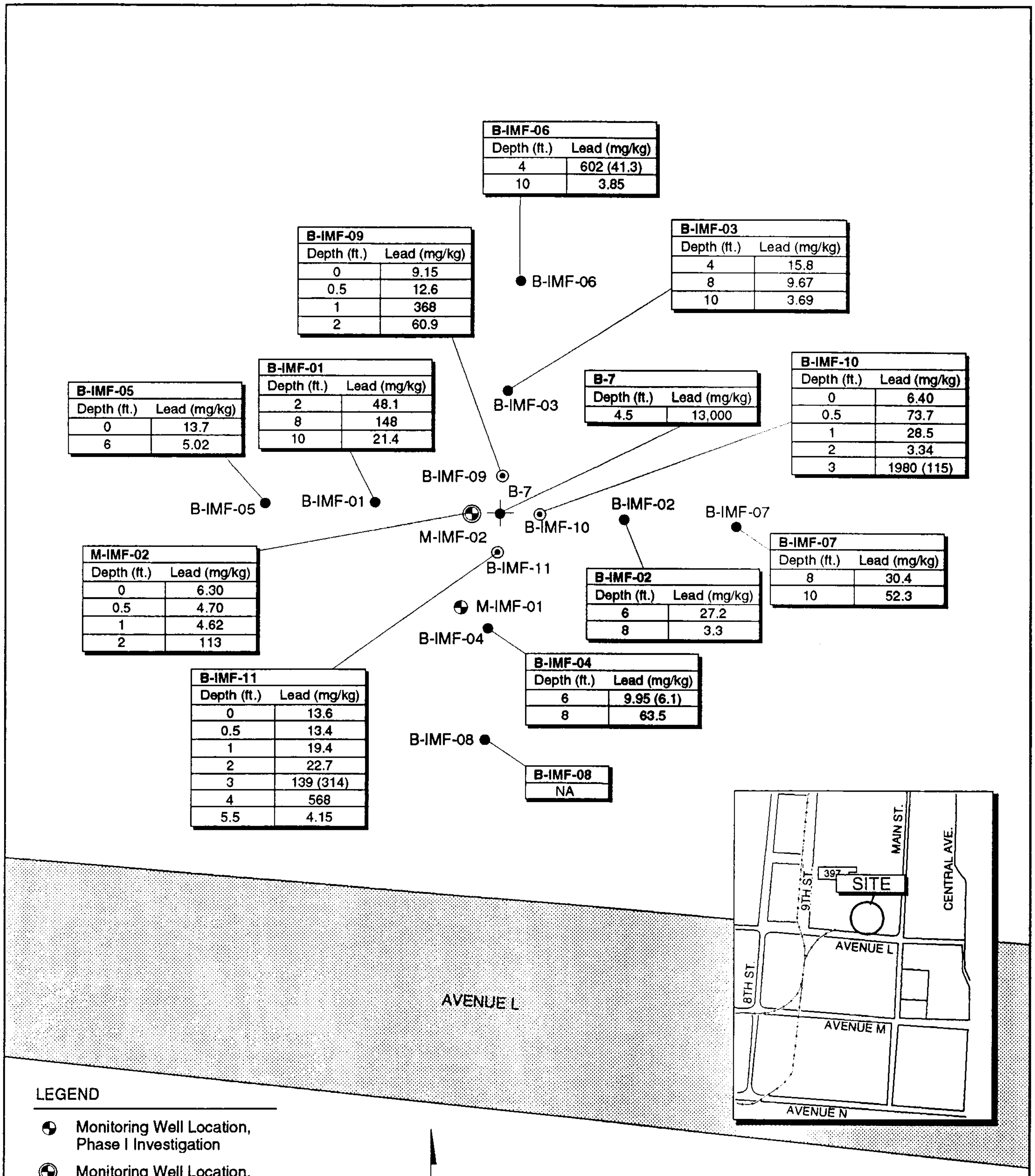
0 15 30
SCALE IN FEET

Sources:
Modified from PRC/JMM, 1992;
Modified from HLA, 1989

NAVAL AIR STATION ALAMEDA
ALAMEDA, CALIFORNIA

SOIL LAB pH RESULTS
PREVIOUS INVESTIGATIONS
IMF SITE

FIGURE 2-4



B-IMF-06

Depth (ft.)	Lead (mg/kg)
4	602 (41.3)
10	3.85

B-IMF-09

Depth (ft.)	Lead (mg/kg)
0	9.15
0.5	12.6
1	368
2	60.9

B-IMF-03

Depth (ft.)	Lead (mg/kg)
4	15.8
8	9.67
10	3.69

B-IMF-05

Depth (ft.)	Lead (mg/kg)
0	13.7
6	5.02

B-IMF-01

Depth (ft.)	Lead (mg/kg)
2	48.1
8	148
10	21.4

B-7

Depth (ft.)	Lead (mg/kg)
4.5	13,000

B-IMF-10

Depth (ft.)	Lead (mg/kg)
0	6.40
0.5	73.7
1	28.5
2	3.34
3	1980 (115)

M-IMF-02

Depth (ft.)	Lead (mg/kg)
0	6.30
0.5	4.70
1	4.62
2	113

B-IMF-02

Depth (ft.)	Lead (mg/kg)
6	27.2
8	3.3

B-IMF-07

Depth (ft.)	Lead (mg/kg)
8	30.4
10	52.3

B-IMF-04

Depth (ft.)	Lead (mg/kg)
6	9.95 (6.1)
8	63.5

B-IMF-11

Depth (ft.)	Lead (mg/kg)
0	13.6
0.5	13.4
1	19.4
2	22.7
3	139 (314)
4	568
5.5	4.15

B-IMF-08

NA

LEGEND

- Monitoring Well Location, Phase I Investigation
- Monitoring Well Location, Phase III Investigation
- HLA Soil Boring Location
- Soil Boring Location, Phase I Investigation
- Soil Boring Location, Phase III Investigation
- (41.3) Duplicate Analytical Result
- NA Not Analyzed

0 15 30
SCALE IN FEET

Sources:
Modified from PRC/JMM, 1992;
Modified from HLA, 1989

3/93.137

NAVAL AIR STATION ALAMEDA
ALAMEDA, CALIFORNIA

SOIL TOTAL LEAD RESULTS
PREVIOUS INVESTIGATIONS
IMF SITE

FIGURE 2-5

leachable benzene and is not in excess of the TCLP limit of 0.5 mg/L for benzene. No other leachable VOCs were identified.

Visual identification of oil stained soil was the criterion used to select samples for analysis of leachable base-neutral and acid extractable organics (BNAs), total recoverable petroleum hydrocarbons (TRPH), and ignitability. Leachable BNAs were not detected. The five samples and one duplicate sample analyzed for TRPH detected concentrations ranging from 37.8 to 71,200 mg/kg (Figure 2-3). No samples were found to be ignitable below 60°C.

2.2.2.2 Phase II Investigation

Due to discrepancies between field pH screening results and laboratory pH results for two soil samples collected during Phase I investigation, the DTSC requested that additional pH sampling was performed. With the exception of one sample, the results of this investigation showed that field and lab pH measurements were generally consistent. Over half of the soil samples collected within 6 feet of boring B-7 had low pH values. The low pH measurements appear to be associated with soils containing a fragmented, black, tar-like or oily material that contains some acidic component.

2.2.2.3 Phase III Investigation

The Phase III investigation focused on the area immediately surrounding boring B-7. As directed by the DTSC, soil and groundwater quality within 10 feet of boring B-7 were characterized to evaluate whether potential impacts to groundwater from soil with low pH and high lead concentrations had occurred in the immediate vicinity (within 5 feet) of boring B-7.

Three borings, B-IMF-09, B-IMF-10, and B-IMF-11, were drilled in the vicinity of boring B-7 (Figure 2-3). A total of 22 samples were collected at approximately 1-foot intervals and sampled for pH and total lead. Tar-like or oily materials were identified in the three borings over intervals of 4.1 feet (B-IMF-09), 5.5 feet (B-IMF-10), and 6.5 feet (B-IMF-11). Thirteen of the twenty-two samples had pH values below 7.0, and the lowest pH value, 1.2, was measured in the 2-foot sample from B-IMF-11. Nine of these 13 samples contained the tar-like, oily material. Total lead concentrations ranged from 3.34 to 1,980 mg/kg. Figures 2-4 and 2-5 show soil pH and total lead results for the Phase III investigation.

2.3 NATURE AND EXTENT OF SOIL REMEDIATION

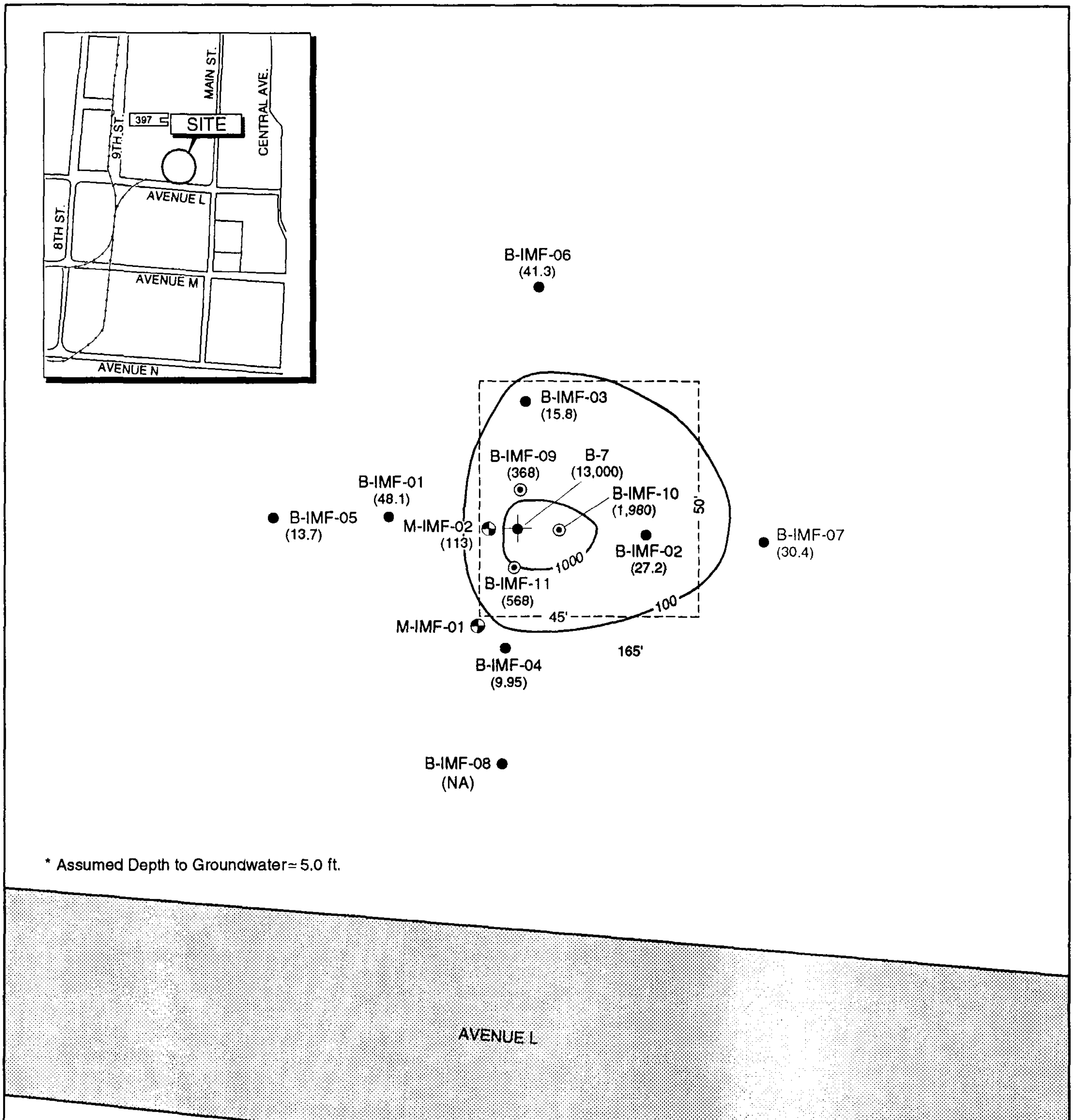
On January 29, 1992, the DTSC requested that a removal action be implemented at the IMF site due to the discovery of subsurface soils with low pH and high lead levels. Following a technical review meeting with the DTSC and RWQCB on February 2, 1993, the Navy agreed to perform a modified approach to the implementation of a Plan of Action and Milestones (POAM) and Engineering Evaluation/Cost Analysis (EE/CA) for low pH and lead in soils at the IMF site. Rather than perform a lengthy and time-consuming POAM and EE/CA, the Navy will perform an interim remedial action that follows a streamlined POAM and EE/CA approach that is acceptable to the DTSC. As agreed to by the DTSC, the Navy will excavate low pH/elevated lead soils from around boring B-7. Alternatives for treatment and/or disposal of the soil will be evaluated as part of the modified approach.

The conditions observed in the vicinity of boring B-7 are limited in extent and are contained within a larger area to be remediated pursuant to the remedial investigation/feasibility study (RI/FS) process. With this in mind, the regulatory agencies and the Navy agreed that the interim soil cleanup goal would be remediation of soil containing greater than 100 mg/kg total lead. The lateral extent of soil containing greater than 100 mg/kg total lead is reflected by an area approximately 45 feet by 50 feet as shown on Figure 2-6. This area also encompasses the pH-low soils. Results of investigations also indicated that the depth to groundwater in the vicinity of boring B-7 ranges from approximately 2.5 to 7 feet bgs, and that the low pH and high lead levels detected in soil were at depths generally less than 5 feet bgs. Therefore, the agreed-upon vertical depth of remediation is 5 feet bgs. This results in an interim soil remediation volume of approximately 400 cubic yards.

Results of previous investigations indicate that soil around boring B-7 may be characterized as hazardous waste based on toxicity and corrosivity according to the Resource Conservation and Recovery Act (RCRA). For the purpose of this interim remedial action, it is assumed that the soil is RCRA hazardous.

2.4 INTERIM REMEDIAL ACTION OBJECTIVES

Site-specific objectives for the interim remedial action at the IMF site are to reduce the potential for subsurface soils with low pH and high lead concentrations to impact groundwater and to mitigate potential exposure to humans and the environment. To address these objectives the Navy, DTSC, and RWQCB have agreed to remediate soils with lead concentrations above approximately 100 mg/kg total lead in the vicinity of HLA boring B-7. The hydrocarbons and the remaining lead concentrations detected in soil and groundwater at the IMF site will be addressed under the NAS Alameda RI/FS program.



LEGEND

- Monitoring Well Location
- HLA Soil Boring Location
- Soil Boring Location, Phase I Investigation
- Soil Boring Location, Phase III Investigation
- ----- Remediate to 100 mg/kg
- 100 Total Lead Concentration, mg/kg
- (41.3) Maximum Total Lead Concentration Detected Within Soil 5 feet bgs in mg/kg
- NA Not Analyzed

0 15 30
SCALE IN FEET

Sources:
Modified from PRC/JMM, 1992;
Modified from HLA, 1989

3/93.137

NAVAL AIR STATION ALAMEDA
ALAMEDA, CALIFORNIA

EXTENT OF SOIL REMEDIATION
IMF SITE

FIGURE 2-6

3.0 IDENTIFICATION AND SCREENING OF GENERAL RESPONSE ACTIONS AND TECHNOLOGIES

To achieve the interim remedial action objectives, site-specific data must be reviewed so that an alternative for interim remedial action can be developed and evaluated. The remedial alternative development and evaluation process proceeds as follows. First, applicable general response actions and technologies are screened with respect to site-specific data. Second, technologies that pass the initial screening are then assembled into alternatives, which are comprehensive interim remedial action plans incorporating one or more specific technologies related to soil remediation. Third, the alternatives are evaluated and compared for the purpose of identifying a preferred alternative. This section identifies the response actions and treatment technologies that were screened. The interim remedial action alternatives are evaluated in Section 4.0.

3.1 IDENTIFICATION AND SCREENING OF GENERAL RESPONSE ACTIONS

General response actions describe those actions that will satisfy the interim remedial action objectives described in Section 2.4. General response actions for the interim remedial action at the IMF site have been identified and are discussed below.

3.1.1 No Action

The no-action response does not entail remediation of soil at or in the vicinity of the site. This action will include only ongoing monitoring and reporting. This general response action is retained for further comparison.

3.1.2 Institutional Actions

These response actions involve only access and/or deed restrictions for the site. Institutional actions, such as perimeter fencing, generally provide minimal protection to human health and the environment. Furthermore, these restrictions would not prevent further groundwater contamination and are not considered permanent soil remediation solutions. Therefore, institutional actions are eliminated from further consideration.

3.1.3 Containment Actions

These actions provide physical containment of chemicals of concern in the affected media to prevent exposure and further migration. Containment actions, such as slurry walls and/or grout curtains, are costly compared to other response actions and provide only limited protection to human health and the environment. Therefore, containment actions are eliminated from further evaluation.

3.1.4 Removal/Treatment Actions

Removal/treatment actions involve physical removal, treatment, and disposal of the contaminated soil. These actions can provide the highest degree of protection of human health and the environment by removing the source of further groundwater contamination. Therefore, these response actions are retained for further consideration.

3.1.5 In Situ Treatment Actions

In situ treatment actions involve treatment of the soil without physical soil removal. Because these actions can provide a high degree of contaminant removal and/or destruction of chemicals, they can also provide a high degree of protection of human health and the environment. However, in situ actions are generally less reliable than removal/treatment actions and are only cost-effective when large volumes of soil require remediation. In situ actions are eliminated from further analysis.

3.2 IDENTIFICATION AND SCREENING OF TREATMENT TECHNOLOGIES

Potentially applicable technology types and process options are compiled for each general response action retained for soil. The term "technology types" refers to general categories of technologies, such as chemical treatment or thermal destruction. The term "technology process options" refers to specific processes within each technology type, such as stabilization/solidification or chemical reduction/oxidation within chemical treatment.

The technology types and process options are screened to retain implementable technologies that can be used in the development of remedial alternatives. The screening is based on the relative effectiveness, technical and institutional implementability, and estimated cost for each technology type and process option. A summary of this screening is presented in Table 3-1. The last two columns of the table indicate whether the process option will be retained for further evaluation, and includes comments regarding elimination of the technology or process option.

3.2.1 No Action

For this general response action, only long-term soil and groundwater monitoring will be required. This action is generally retained to serve as a baseline for comparison with other remedial alternatives during the detailed analysis; therefore, it will be considered for further evaluation.

3.2.2 Removal/Treatment Actions

Removal/treatment actions consist of physical removal of soils followed by 1) disposal at an off-site facility (with or without off-site treatment), 2) on-site treatment followed by on-site disposal, or 3) on-site treatment followed by off-site disposal. The applicable technologies for these options are identified and screened below.

3.2.2.1 Excavation

Excavation in the IMF site area would involve the use of general earthwork equipment. Since the excavation depth is not anticipated to be greater than 5 feet, sloping or shoring would not be required in accordance to California Occupational Safety and Health Administration (CALOSHA) regulations 1540 and 1541. Excavation is easy to implement.

3.2.2.2 Physical Treatment

Physical treatment technologies involve physically separating chemicals of concern from soil. On-site physical treatment processes considered for soils at the IMF site include solvent extraction, soil washing, and aeration. Solvent extraction is effective in separating organics from soil, but is not

TABLE 3-1

GENERAL RESPONSE ACTION AND TECHNOLOGY SCREENING SUMMARY
IMF SITE SOIL
NAS ALAMEDA

General Response Action	Remedial Technology Types	Process Option	Effectiveness	Implementability	Relative Cost	Initial Screening Decision	Comments
No Action	None	None	Low	Good	Low	**Consider**	No action; use as baseline remedial action.
Removal/Treatment	Excavation	General Earthwork Equipment	High	Good	Moderate	**Consider**	Effective and easy to implement.
	Physical	Solvent Extraction	Low	Moderate	High	Eliminate	Not effective for removal of lead; high cost.
		Soil Washing	Moderate	Moderate	High	Eliminate	Not effective for removal of lead; high cost.
		Aeration	Low	Good	Low	Eliminate	Not effective for removal of lead.
	Chemical	Stabilization/Solidification	High	Moderate	Moderate	**Consider**	Effective; reduces lead mobility and raises pH.
		Chemical Reduction/Oxidation	Low	Moderate	High	Eliminate	Not effective for removal of lead or raising pH.
	Biological	Aerobic-Biological Treatment	Low	Good	Moderate	Eliminate	Not effective for removal of inorganics (lead).
		White-Rot Fungus	Low	Moderate	Moderate	Eliminate	Not effective for removal of inorganics (lead).
		Liquid-Solids Contact	Low	Difficult	High	Eliminate	Not effective for removal of inorganics (lead).
	Thermal	Rotary Kiln Incineration	Low	Moderate	Very High	Eliminate	Lead remains in ash; further treatment required.
		Circulating Bed Combustion	Low	Moderate	Very High	Eliminate	Lead remains in ash; further treatment required.
		Thermal Desorption	Low	Moderate	High	Eliminate	Not effective for removal of lead or raising pH.
	Disposal	On-Site Backfill	Moderate	Moderate	Low	**Consider**	Must meet land disposal requirements.
		Class I Facility	High	Good	High	**Consider**	Must meet land disposal requirements.
		Class II Facility	High	Moderate	Moderate	**Consider**	Must meet land disposal requirements.
		Class III Facility	High	Difficult	Low	**Consider**	Must meet land disposal requirements.
		Recycler	High	Moderate	Moderate	**Consider**	Depends on waste stream analysis.

effective for removing heavy metals, such as lead. Therefore, this process option is eliminated from further evaluation.

Soil washing scrubs surficial chemicals from the coarse fraction of soil and separates the untreated fine fraction. The addition of surfactants augments the desorption of hydrophobic constituents from soil particles. This technology is eliminated from further evaluation because it is not effective for treating lead-contaminated soil.

Aeration of excavated soil volatilizes sorbed chemicals of concern. This technology is primarily used on VOCs. Lead is not volatile; thus this treatment technique is eliminated from further consideration.

3.2.2.3 Chemical Treatment

Chemical processes involve the use of chemical agents to alter the structure of a compound or bond with, isolate, or destroy the compound. Chemical technologies considered for soils at the IMF site include stabilization/solidification and chemical reduction/oxidation. Stabilization/solidification processes are commonly used and best suited for soils containing heavy metals, such as lead. In addition, most stabilization/solidification processes are effective in raising the pH of low-pH soils. This treatment technology is retained for further consideration.

With chemical reduction/oxidation, chemicals are injected to destroy or convert the contaminants of concern by oxidation or reduction to less hazardous forms. This technology is generally applied to organic compounds and has not been demonstrated to effectively convert lead to less hazardous forms. Also, pH is not effectively addressed with chemical reduction/oxidation processes. Therefore, this process option is eliminated from further analysis.

3.2.2.4 Biological Treatment

Bioremediation techniques for excavated soils include aerobic and anerobic, white-rot fungus, and liquid-solids contact. Biological treatment uses indigenous or introduced aerobic or anaerobic bacteria to biodegrade organic compounds in soils. Bioremediation is commonly used to degrade petroleum hydrocarbons, but is not effective for treating inorganics, such as lead. In addition, low pH is not conducive to bioremediation. All biological treatment technologies are eliminated from further consideration.

3.2.2.5 Thermal Treatment

Thermal treatment involves conveying the excavated soil to an incinerator for thermal destruction and producing ash as a final product. The ash would be disposed of at an off-site facility. Three types of thermal treatment have been identified: rotary kiln incineration, circulating bed combustion, and thermal desorption. Thermal treatment is generally used to destroy organic compounds. Any heavy metals in treated soils are concentrated in the ash, which may require further treatment. Thermal processes are generally not effective in raising the pH of low-pH soils. In addition, thermal treatment costs are typically very high. Therefore, thermal treatment processes are eliminated from further evaluation.

3.2.2.6 On-Site Disposal

Any excavated soil, whether treated or untreated, will require proper disposal. Chemical analysis would be required at the time of soil excavation to establish whether treatment is necessary pursuant to the land disposal restrictions (LDRs) set forth in the Code of Federal Regulations, Title 40, Part 268 (40 CFR 268) and in the California Code of Regulations, Title 26, Division 22, §66268 (Title 26, Div. 22 CCR 66268). Based on discussions with disposal facilities, the applicable land disposal restrictions require that leachable lead concentrations (based on WET and TCLP analyses) be less than 5.0 milligrams per liter (mg/L), and pH values be between 2 and 12.5. On-site disposal options include backfilling into the excavation. This option is considered feasible and is retained for further consideration.

3.2.2.7 Off-Site Disposal

Proper disposal of excavated soil off site must conform to the appropriate LDRs as discussed above. Based on discussions with various treatment/disposal facilities, a stabilization/solidification process is used to pretreat soils containing lead if the leachable lead concentration exceeds the LDR. Furthermore, Chemical Waste Management Class I treatment/disposal facility representatives stated that treating low pH soils is relatively straightforward and not a major concern. The effectiveness of stabilization in meeting the treatment standards is subject to treatability study evaluation prior to acceptance.

Class I disposal facilities often are capable of treating a variety of hazardous wastes at their facilities, and therefore may accept both hazardous, as defined by 40 CFR 268 and Title 26, Div. 22 CCR 66268, and nonhazardous waste for disposal. This option is retained for further evaluation.

Class II and III disposal facilities provide limited or no waste treatment services. These disposal facilities generally accept soil waste that is considered nonhazardous and may accept treated hazardous waste for disposal. The Class II or III facility disposal option appears feasible and is retained for further consideration.

Recycling facilities treat soils to generate a nonhazardous product that can be used as a road mix or ground cover for landfill sites. Recycling facilities generally accept nonhazardous wastes and may accept hazardous wastes. This option is retained for further analysis.

4.0 DEVELOPMENT AND EVALUATION OF INTERIM REMEDIAL ACTION ALTERNATIVES

The interim remedial action alternatives developed from the technologies and process options retained in Section 3.2 are described below. These remediation alternatives are assembled to meet the interim remedial action objectives established for the IMF site and will be further evaluated to provide the basis for selecting a preferred remedial alternative.

4.1 DEVELOPMENT OF INTERIM REMEDIAL ACTION ALTERNATIVES

The following demonstrated and potentially applicable technologies or process options for remediation of soils at the IMF site have been retained from the screening of general response actions and technologies:

- No Action
- Removal/Treatment Actions
  - Excavation
  - On-Site Stabilization
  - On-Site Disposal
  - Off-Site Disposal
- Class I Disposal
- Class II or III Disposal
- Recycler

Since these technologies or process options do not individually satisfy the interim remedial action objectives, they must be assembled into remedial alternatives. Certain technologies may be necessarily associated with other technologies. For example, depending on the concentration of constituents in the excavated soils and the applicability of LDRs, excavated soils may require treatment before disposal. Based on the results of the technologies screening, the following specific interim remedial action alternatives have been assembled for remediating soils at the IMF site:

Alternative 1: No Action

Includes periodic inspection and monitoring of groundwater as it may potentially be affected by existing vadose-zone soil contamination.

Alternative 2: Excavation/On-Site Stabilization/On-Site Disposal

Removes soil containing concentrations of total lead greater than 100 mg/kg; stabilizes leachable lead concentrations and raises pH in excavated soil through on-site treatment by stabilization; disposes treated soil on site by backfilling into the excavation.

Alternative 3: Excavation/On-Site Stabilization/Class II or III Disposal

Removes soil containing concentrations of total lead greater than 100 mg/kg; stabilizes leachable lead concentrations and raises pH in excavated soil through on-site treatment by stabilization; disposes treated soil at a Class II or III facility.

Alternative 4: Excavation/Class I Disposal with or without Treatment

Removes soil containing concentrations of total lead greater than 100 mg/kg; disposes soil at a Class I facility with or without treatment for lead and pH in soil through off-site stabilization.

Alternative 5: Excavation/Recycler

Removes soil containing concentrations of total lead greater than 100 mg/kg; recycles soil at a recycling facility to produce a nonhazardous product.

These five alternatives are evaluated in detail in terms of implementability, effectiveness, and cost in the following section.

4.2 EVALUATION OF INTERIM REMEDIAL ACTION ALTERNATIVES

A detailed evaluation includes definition of each alternative with respect to the area of affected soil, the technologies used and any associated performance requirements and the assumptions used in establishing costs for each alternative. A comparative analysis among the alternatives is presented in Section 4.3.

4.2.1 Evaluation Criteria

The identified interim remedial action alternatives are evaluated based on three criteria: 1) effectiveness; 2) implementability; and 3) estimated costs, including capital and operation and maintenance (O&M) costs, as described below.

<u>Effectiveness.</u> Effectiveness is a measure of how well 1) the interim remedial action alternative handles the estimated areas or volumes of media and meets the remedial action objectives, and 2) the alternative minimizes potential impacts to human health and the environment during implementation.

<u>Implementability.</u> Implementability encompasses both the technical and the administrative feasibility of applying a remedial technology. Technical implementability is used to eliminate those technologies that are clearly impractical at a site. In many cases, treatability studies may be required prior to full-scale operation. Administrative implementability may include permitting and off-site disposal feasibility.

<u>Cost.</u> The capital and O&M costs are estimated based on information obtained by vendors and by treatment/disposal facility representatives. As recommended by the U.S. Environmental Protection Agency (USEPA) Remedial Action Costing Procedures Manual, this accuracy has been defined as a final equipment and O&M cost that will fall within the range of +50 percent to -30 percent of the estimated cost. In preparing the estimated present-worth capital and O&M costs, a project life of 10

TABLE 4-1

PRESENT WORTH COST ESTIMATE SUMMARY
IMF SITE SOIL
NAS ALAMEDA

Alternative No.	Alternative Description	Estimated Capital Cost	Estimated Present Worth O&M Cost	Total Present Worth [a]
1	No Action	$0	$0	$0
2	Excavation On-Site Stabilization On-Site Disposal	$291,000	$211,000	$502,000
3a	Excavation On-Site Stabilization Class II Disposal	$380,000	$0	$380,000
3b	Excavation On-Site Stabilization Class III Disposal	$333,000	$0	$333,000
4a	Excavation Class I Disposal with pretreatment	$506,000	$0	$506,000
4b	Excavation Class I Disposal without pretreatment	$340,000	$0	$340,000
5	Excavation Recycler	$322,000	$0	$322,000

Notes:
[a]Present worth analysis assumes project life of 10 years and a discount rate of 3%.

All costs are rounded to the nearest one thousand dollars.
Groundwater monitoring costs of wells currently located on the IMF site are part of the ongoing NAS Alameda RI/FS and are not included in any of these alternatives.
Present worth operations and maintenance cost for Alternative 2 includes groundwater monitoring for two new wells for on-site disposal monitoring purposes.
See Appendix A for detailed costs.

years is assumed with a discount rate of 3 percent. Table 4-1 summarizes the estimated capital, O&M, and present worth costs for each alternative.

4.2.2 Analysis of Interim Remedial Action Alternatives

The analysis of each interim remedial action alternative is organized in the following manner. First, a detailed description of the alternative is presented, including any necessary assumptions regarding its conceptual design and operational parameters. Subsequently, each alternative is evaluated based on its relative effectiveness, implementability, and estimated cost.

4.2.2.1 Alternative 1: No Action

Description. This interim remedial action alternative is retained for detailed analysis to provide a basis for comparison with other alternatives. For this alternative, no remedial activities for soil would be implemented in the IMF site. The no-action alternative would include monitoring of nearby downgradient wells. However, because monitoring (including on-site monitoring wells) will be carried out as part of the current ongoing NAS Alameda RI/FS, the estimated cost for monitoring is not included in this alternative.

Effectiveness. Interim remedial action objectives would not be achieved through naturally occurring remedial processes, such as biodegradation, because these processes are not effective for treating lead or pH. In addition, lead and acidity detected in the soils may migrate from soil into groundwater due to the lack of containment of chemicals in the vadose-zone soil. The no-action alternative would not be effective in reducing risk to public health and the environment in the short term. Long-term effectiveness and permanence would be considered high after the IMF site is addressed as part of the RI/FS and remediated under the remedial design/remedial action (RD/RA) phase.

Implementability. The no-action alternative is easily implementable.

Cost. There are no capital or O&M costs associated with the no-action alternative. Groundwater quality would be monitored on a routine basis to assure the long-term effectiveness of the no-action alternative. However, these costs are assumed to be included in the ongoing NAS Alameda RI/FS.

4.2.2.2 Alternative 2: Excavation/On-Site Stabilization/On-Site Disposal

Description. This alternative consists of excavation of soil from the IMF site boring B-7 vicinity as shown in Figure 2-6, and on-site treatment of soil by stabilization to immobilize lead concentrations to meet TCLP and STLC land disposal requirements. Treated soils would be disposed of on site by backfilling the excavated area. Excavation, on-site treatment, and on-site disposal details are described below.

Excavation. For this site, excavation and hauling of soils would be achieved using conventional earthwork equipment such as a backhoe, dozers, and trucks. Few obstructions to excavation are likely during the implementation of remedial activities at the IMF site boring B-7 area. Activities associated with soil excavation would include the following:

- Mobilization and Site Preparation. Mobilization consists of all activities associated with mobilizing equipment to the IMF site and preparing staging areas. Site preparation activities include clearing vegetation, decommissioning utilities, abandoning all monitoring wells located within the excavated area, setting up the on-site stabilization area, and performing the preliminary earthwork necessary for excavation. Site preparation work would also include construction of a temporary chain-link fence, including gates, around the proposed excavation area to prevent unauthorized access to the work area.

- Sloping. Sloping or shoring would not be required as discussed in Section 3.2.2.1.

- Excavation. Excavation of soil at the source area would be initiated using a backhoe or other earthwork equipment. Soil would be removed from the excavation and temporarily stockpiled on visqueen at an adjacent area. The soil would be subsequently transferred and stockpiled at a designated area for on-site stabilization activities.

- Confirmation Sampling. Confirmation sampling would not be required. The excavation limits for interim remedial action in the vicinity of boring B-7 were established by agreement with regulatory agencies (Section 2.3), with the remaining soils to be evaluated under the RI/FS process.

- Risk Assessment Characterization. Upon completion of excavation, soil core samples would be obtained at each of the walls, and at the bottom of the excavation. These samples would be analyzed for RI/FS risk assessment purposes. It is assumed that sampling would include collecting one sample per 100 square feet of excavation.

- Backfill and Compaction. When the excavation is completed, the excavated area would typically be backfilled with the pretreated excavated soil. After the backfill and compaction is completed, the interim remedial action for the IMF site would be complete.

On-Site Stabilization. Stabilization is a commonly used method for treating lead in soil. In addition, most stabilization processes are effective in raising the pH of low-pH soils. On-site locations would be needed to stockpile and treat soil. The purpose of the stabilization would be to immobilize the lead and raise the pH in soil by mixing the soil with chemical agents. The effectiveness of treatment would require verification by a treatability study that should be performed before field work. The objectives of the treatability study are to evaluate 1) the effectiveness of this treatment process in meeting the treatment goal; 2) stabilization agents; 3) the optimum dosage and curing time; and 4) the final condition of treated soil volume and mass increase. No post-stabilization treatment of the soils is assumed to be required.

On-Site Disposal. Disposal of soil on site consists of backfilling the treated soil into the excavation. On-site disposal must be acceptable to regulatory agencies and the community, in addition to meeting the appropriate state and federal land disposal restrictions. Also, on-site disposal would require installing additional groundwater monitoring wells to monitor the potential leaching of the treated backfill. Obtaining regulatory and community acceptance of disposal on site may be difficult.

Effectiveness. By removing and treating soils containing lead above 100 mg/kg from the IMF site boring B-7 vicinity, the toxicity and acidity of the soil would be reduced. However, backfilling the treated soil into the excavation would reduce but not eliminate the potential for any future releases to groundwater. Therefore, continued monitoring of leaching and conditions of the backfill would be required. The short-term effectiveness is considered high because the excavation, treatment, and backfilling of the soil can be completed within a relatively short period of time. However, implementation of this alternative may only provide a moderate degree of protection to both human health and the environment on a long-term basis. Because the waste would be disposed of on site, the liability risk associated with implementing Alternative 2 is minimal.

Implementability. The excavation aspect of this alternative is implementable. In addition, IMF site characteristics, such as the absence of building structures, concrete, and vegetation, are favorable for excavation activities. Stabilization of lead in soil is a commonly applied technology and could be easily implemented on site. However, soil stabilization processes often result in an end-product with increased volume that may not be completely backfilled. Soil disposal on site may require site grading modifications to satisfy stringent state and federal landfill requirements and may also be subject to RCRA permitting regulations. Furthermore, on-site disposal of the treated soils may not be acceptable to the regulatory agencies or the community. Overall, this alternative is anticipated to be difficult to implement.

Cost. Table 4-1 presents the estimated capital and O&M costs for this alternative. The capital cost for Alternative 2 is approximately $291,000. The estimated present worth O&M cost for this alternative is associated with the additional well installations and annual monitoring of leachate in the vicinity of the on-site disposal area and is approximately $211,000. The annual O&M costs assume that IMF site inspections would be performed on a quarterly basis and results would be presented in quarterly reports. Details of the capital cost and annual O&M costs are included in Appendix A.

The total present worth for Alternative 2 is $502,000. The estimated present-worth capital and O&M costs are $291,000 and $211,000, respectively.

4.2.2.3 Alternative 3: Excavation/On-Site Stabilization/Class II or III Disposal

Description. This alternative is the same as Alternative 2 except that treated soils would be disposed of off site at a Class II or III disposal facility.

Excavation. Excavation activities for this alternative would be as described in Section 4.2.2.2, except that the excavation would be backfilled with clean fill.

On-Site Stabilization. On-site stabilization activities for this alternative would be as described in Section 4.2.2.2. It is assumed that all the excavated soil would require treatment by stabilization before disposal.

Class II or III Disposal. The stabilized soil would be transported and disposed of as a nonhazardous waste at a Class II or III disposal facility in accordance with appropriate state and federal land disposal restrictions. It is assumed that no post-stabilization treatment of the soils would be required. In general, a Class II disposal facility would be permitted to accept a greater range of waste types and concentrations than a Class III facility. Waste acceptance at a Class II or III disposal facility is also generally dependent on satisfying the disposal facility's waste acceptance requirements, which may be more stringent compared with a Class I facility.

Effectiveness. By removing and treating soils containing lead above 100 mg/kg from the IMF site boring B-7 vicinity, the potential for any future releases to groundwater would be effectively eliminated. Excavated soil would be replaced with clean material and the toxicity and acidity of excavated soil would be reduced by on-site stabilization. Because the excavation and disposal of the soil can be completed within a relatively short period of time, the short-term effectiveness is considered high. Implementation of this alternative would provide a high degree of long-term protection to both human health and the environment. The potential long-term liability risks affiliated with waste disposal at a Class II or III facility are greater than compared with disposal at a Class I facility.

Implementability. Although the excavation and on-site stabilization activities for this alternative are implementable, as discussed in Section 4.2.2.2, disposal may be more difficult to implement. Disposal of soil at a Class II disposal facility is implementable depending on the analytical results from the treated soils. Class II acceptance criteria are generally more stringent than Class I facility requirements. Class III disposal may be more difficult to implement because based on discussions with Class III facility representatives from a Browning-Ferris Industries (BFI) Class III facility at Livermore, California, their facility may not accept stabilized hazardous waste. Both Class II and III facilities representatives from a Liquid Waste Management, Inc. Class II facility at McKittrick, California and from BFI indicated that acceptance of stabilized waste would be evaluated on a case basis.

Cost. Table 4-1 presents the estimated capital and O&M costs for two versions of this alternative: a) excavation/on-site stabilization/Class II disposal, and b) excavation/on-site stabilization/ Class III disposal. The capital costs for Alternative 3 with Class II disposal and with Class III disposal are approximately $380,000 and $333,000, respectively. There are no O&M costs for either of these alternatives. Groundwater monitoring costs are considered to be included in the ongoing NAS Alameda RI/FS. Details of the costs for this alternative are included in Appendix A.

The estimated present worth cost for this alternative with Class II disposal is $380,000, and $333,000 for this alternative with Class III disposal (Table 4-1). The costs would all be incurred in the first year.

4.2.2.4 Alternative 4: Excavation/Class I Disposal with or without Treatment

Description. This alternative consists of soil excavation from the boring B-7 vicinity at the IMF site. Soils would be transported and disposed of off site at a Class I facility with or without prior treatment.

Excavation. Excavation activities for this alternative would be as described in Section 4.2.2.2, except that soil would be removed from the excavation area and temporarily stockpiled, then transferred to an area designated for loading onto trucks for transport to a Class I disposal facility. The excavation would be backfilled with clean fill.

Class I Disposal. All excavated soil is assumed to be transported and disposed of at a Class I disposal facility in accordance with appropriate state and federal land disposal regulations. Although disposal facility representatives have indicated that treatment of soil containing lead is a relatively straightforward procedure, a Class I facility would require an accurate waste profile or lab analytical testing results before accepting waste for disposal with or without treatment. Class I facility personnel have indicated that low pH values are not a concern. It is assumed that no post-stabilization treatment of the soils would be required. Liability risks associated with soil disposal at a Class I facility are generally less than compared with Class II or III or recycling facilities.

Effectiveness. By removing soils with high lead and low pH, the potential for future releases to groundwater would be permanently eliminated. By treating soil at the Class I facility, by stabilization if required, the effective toxicity and acidity of the soil and mobility of lead would be reduced to meet their disposal standards. The remedial action objectives would be achieved over a short period of time. This alternative would also be effective over the short term. As with Alternative 3, long-term protection to human health and the environment would be attained.

Implementability. The excavation and on-site stabilization activities for this alternative are implementable, as discussed in Section 4.2.2.2. Disposal of soil at a Class I facility with or without treatment is easy to implement.

Cost. For costing purposes, two versions of this alternative have been developed: a) excavation and Class I disposal with treatment, and b) excavation and Class I disposal without treatment. Details of the capital and O&M costs are provided in Table 4-1. The capital cost for soil excavation and Class I disposal with treatment is approximately $506,000 see Table 4-1. The estimated capital cost for excavation and Class I disposal without treatment is $340,000. There are no O&M costs for either of these alternatives. Groundwater monitoring costs are considered to be included in the ongoing NAS Alameda RI/FS. Appendix A includes the capital and O&M costs for these alternatives in detail.

The present worth cost for this alternative is $506,000 for Class I disposal with treatment and $340,000 for disposal without treatment (Table 4-1). These costs would all be incurred in the first year.

4.2.2.5 Alternative 5: Excavation/Recycler

Description. This alternative consists of soil excavation from the boring B-7 vicinity at the IMF site. Soils would be transported off site for recycling at a recycling facility.

Excavation. Excavation activities for this alternative are as described in Section 4.2.2.2, except that soil removed from the excavation area and temporarily stockpiled would be subsequently transferred and stockpiled at an area designated for loading into trucks for transport to a recycling facility.

Recycler. For costing purposes, all excavated soil is assumed to be transported to and recycled at a recycling facility as hazardous waste. The recycling facility would mix the waste with admixtures to bind and encapsulate heavy metals. The nonhazardous product generated can be used as a road mix or ground cover for landfill sites. According to Gibson Environmental representatives, sending waste to their recycling facility is not subject to federal, state, or local disposal fees because the waste is not disposed of as waste, and, to the extent that Gibson disposes of any wastes from its operations, Gibson is responsible for all disposal fees associated with such material. Mr. Matt McKerron of the DTSC concurred that recycling facilities eliminate federal, state, or local disposal fees, but emphasized that waste recycling does not necessarily eliminate the liability of the generator.

Effectiveness. By removing soil containing lead and low pH from the IMF site, the potential for future releases to groundwater would be effectively eliminated. The remedial action objectives would be achieved over a short period of time. This alternative would also be effective in a short period of time. As with the other excavation alternatives, long-term protection to human health and the environment would be attained. However, potential liability risks do exist especially if the recycling facility does not adequately treat the material before reuse.

Implementability. The excavation activities for this alternative are implementable, as discussed in Section 4.2.2.2. Recycling of excavated soil from the NAS Alameda IMF site may be difficult to implement because the recycling facility will not accept waste with pH less than 2 and greater than 12.5. In addition, the recycling facility would evaluate the waste toxicity on a case basis before acceptance. The potential for long-term liability is also significant if this alternative is implemented.

Cost. As presented in Table 4-1, the capital cost for this alternative is approximately $322,000. There are no significant O&M costs for this alternative. Groundwater monitoring costs are considered to be included in the ongoing NAS Alameda RI/FS. Details of the capital and O&M costs are provided in Appendix A.

The present worth cost for this alternative is $322,000 (Table 4-1). The costs would all be incurred in the first year.

4.3 COMPARATIVE ANALYSIS OF INTERIM REMEDIAL ACTION ALTERNATIVES

This section presents a comparative analysis of the five alternatives retained for detailed evaluation. The objective of the comparative analysis is to assess the relative performance of each alternative with respect to the evaluation criteria (Section 4.1). To facilitate this analysis, Table 4-2 has been developed to summarize the relative merits of each alternative with respect to effectiveness, implementability, and cost. Details of the comparative analysis of alternatives are discussed below.

Five interim remedial action alternatives (1, 2, 3, 4, and 5) were retained for detailed analysis. As shown in Table 4-2, Alternatives 3, 4, and 5 are similar in terms of the level of protection to human health and the environment. Alternatives 1 and 2 are eliminated because they do not satisfy the interim remedial action objectives.

Alternatives 3, 4, and 5 would reduce the toxicity and mobility of lead present in soil by ex situ stabilization technologies, along with increasing the soil pH. All three alternatives are effective, but Alternative 5 may be difficult to implement, because the recycling facility may not accept soils from the IMF site based on corrosivity and toxicity. The recycler would require that waste pH be greater than 2 and less than 12.5 before acceptance. Toxicity would be evaluated on a case basis. Because of high liability for this alternative compared to Alternatives 3 and 4, at relatively similar cost to implement, Alternative 5 is eliminated.

Of the two remaining alternatives, Alternative 3 is potentially less expensive to implement than Alternative 4. However, Alternative 3 has a greater liability risk to the generator. A Class II or III disposal facility is generally less financially stable than a Class I facility and thus more likely to encounter future economic difficulties that result in the closure of the disposal facility. In addition, Class I disposal facilities operate under more stringent regulations. Disposing of soil to a Class I disposal facility minimizes potential future liability to the Navy. The liability issue represents a long-term benefit of Alternative 4 that largely outweighs any immediate cost savings. In addition,

TABLE 4-2

REMEDIAL ALTERNATIVES COMPARISON SUMMARY
IMF SITE SOIL
NAS ALAMEDA

Remedial Alternative	Effectiveness	Implementability	Total Present Cost
Alternative 1 No Action	Does not provide adequate protection to human health and the environment. Removal action objectives are not attained with this alternative. Soil source would continue to impact groundwater. Natural remedial processes would result in little or no remediation over a long period of time.	Alternative is implementable.	$0
Alternative 2 Excavation/On-Site Stabilization/ On-Site Disposal	Provides moderate protection to human health and the environment. Removal action objectives are likely to be achieved with this alternative. Treated soil that is backfilled may impact the shallow groundwater over a long period of time.	Alternative may be relatively difficult to implement. On-site stabilization would require permitting. Effectiveness of treatment requires verification by treatability study. Regulatory and community unlikely to accept on-site disposal. On-site disposal may require site modifications.	$502,000
Alternative 3 Excavation/On-Site Stabilization/ Class II or III Disposal	Provides adequate protection to human health and the environment. Removal action objectives are achieved with this alternative. Because soils would be permanently removed from the site, this alternative is highly effective in eliminating impacts to groundwater.	Alternative is implementable. On-site stabilization would require permitting. Effectiveness of treatment requires verification by treatability study. Class II or III disposal requires satisfying federal and state land disposal restrictions and facility acceptance criteria.	$380,000 (Class II facility) or $333,000 (Class III facility)
Alternative 4 Excavation/Class I Disposal with or without pretreatment	Provides adequate protection to human health and the environment. Removal action objectives are achieved with this alternative. Because soils would be permanently removed from the site, this alternative is highly effective in eliminating impacts to groundwater.	Alternative is implementable. Effectiveness of treatment, if necessary, requires verification by treatability study. Class I disposal facility likely to accept and dispose of waste with or without treatment in accordance with federal and state land disposal restrictions.	$506,000 (with treatment) or $340,000 (without treatment)
Alternative 5 Excavation/Recycler	Provides adequate protection to human health and the environment. Removal action objectives are achieved with this alternative. Because soils would be permanently removed from the site, this alternative is highly effective in eliminating impacts to groundwater.	Alternative is implementable. Recycling of waste requires satisfying facility acceptance criteria. Recycler may accept Toxic Characteristic Leaching Procedure waste soils, but pH must be greater than 2 and less than 12.5. Recycling facility evaluates waste toxicity on a case basis.	$322,000

Class II or III disposal facilities may not accept stabilized hazardous waste. Therefore, Alternative 3 is eliminated.

Based on the evaluation of interim remedial action alternatives, Alternative 4 is the preferred alternative for remediation of soils at the IMF site. Soil disposal at a Class I facility with or without treatment is the most implementable alternative for treatment (if required) and disposal of soils with high lead and low pH concentrations. Alternative 4 also presents a low liability risk to the generator.

5.0 RESPONSE TO COMMENTS FROM REGULATORY AGENCIES

The DTSC and the RWQCB have reviewed the draft IMF Site Interim Remedial Action EE/CA Report and provided the following comments for the Navy to address.

Comment No. 1:	**The remediation goal for the Interim Remedial Action is 100 ppm lead. Confirmation sampling must occur at the perimeter and bottom of the excavation to ensure that this level is reached. If the 100 ppm level is not reached what will be the Navy's response?**
Response:	The purpose of this report is to identify and evaluate potential EE/CA for conducting the interim removal action at the IMF Site. A detailed confirmation sampling plan will be prepared and submitted to the regulatory agencies for review prior to implementing the preferred alternative. The confirmation sampling plan will be included in the implementation work plan to be prepared by the PRC team.
Comment No. 2:	**The DTSC and the RWQCB are especially concerned that the 100 ppm level will not be obtained at 5 feet below ground surface. Boring B-7 has lead contamination of 13,000 ppm at 4.5 feet.**
Response:	The implementation work plan will include a proposed approach to address this concern.
Comment No. 3:	**Any chosen alternative must consider the impact of the action to future remedial alternatives. Will the addition of clean soil in the excavation significantly add to the amount of soil to be remediated in the future? Has the Navy explored options other than filling the excavation with clean dirt?**
Response:	The implementation work plan will include a proposed approach to address this concern.
Comment No. 4:	**In Alternative 5, the report states that Gibson will not accept soil with a pH of less than 2 or greater than 12.5. Has the Navy considered pretreating soil by neutralization, if the soil is found to be below a pH of 2.**
Response:	For Alternative 5, soils that are deemed acceptable by Gibson will be disposed of at the recycling facility. Soil found to be below a pH of 2 will be transported off site and treated/ disposed of at a Class I facility, as opposed to pretreating the soil on site by neutralization. This is the more cost effective option.

6.0 REFERENCES

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APPENDIX A - DETAILED COST ANALYSES
(13 pages)

TABLE A-1

PRELIMINARY CAPITAL COST ESTIMATE OF REMOVAL ACTION ALTERNATIVE 2
EXCAVATION/ON-SITE STABILIZATION/ON-SITE DISPOSAL
NAS ALAMEDA
IMF SITE
(Sheet 1 of 2)

Item No.	Item/Description	Unit	Unit Cost	Quantity	Subtotal [1]	Total
	Removal Design Activities					
1	Plan and Specification Preparation [a]	lump sum	$25,000	1	$25,000	
2	Bid Preparation and Evaluation	lump sum	$15,000	1	$15,000	
3	Permitting [b]	lump sum	$15,000	1	$15,000	
	TOTAL					$55,000
	Removal Action Activities					
4	**Well Abandonment**	each	$500	2	$1,000	
	TOTAL					$1,000
5	**Soil Excavation**					
5a	Engineering Oversight [c]	hour	$130	170	$22,100	
5b	Mobilization & Demobilization	lump sum	$3,000	1	$3,000	
5c	Site Preparation	lump sum	$1,000	1	$1,000	
5d	Temporary Fence	linear foot	$3	400	$1,200	
5e	Excavation [d]	ton	$30	730	$21,900	
5f	Soil Dewatering [e]	bank cubic yard	$13	NA		
5g	Imported Fill		(see on-site disposal)			
5h	Backfilling & Compaction		(see on-site disposal)			
	TOTAL					$49,200
6	**On-Site Stabilization** [f]					
6a	Engineering Oversight	hour	$60	48	$2,900	
6b	Mobilization	lump sum	$10,000	1	$10,000	
6c	Treatability Study	lump sum	$5,000	1	$5,000	
6d	Stabilization Treatment	ton	$60	730	$43,800	
	TOTAL					$61,700

TABLE A-1

PRELIMINARY CAPITAL COST ESTIMATE OF REMOVAL ACTION ALTERNATIVE 2
EXCAVATION/ON-SITE STABILIZATION/ON-SITE DISPOSAL
NAS ALAMEDA
IMF SITE
(Sheet 2 of 2)

Item No.	Item/Description	Unit	Unit Cost	Quantity	Subtotal [l]	Total
7	Post Excavation Sampling					
7a	Sampling					
	Personnel	hour	$60	32	$1,900	
	Sampling Material	lump sum	$500	1	$500	
7b	Analyses (assumes 1 sample per 100 square feet, 28-day turn around for lead, TPH, and pH analyses)	sample	$400	32	$12,800	
	TOTAL					$15,200
8	**Well Replacement** [g] (assumes 10 feet deep)	each	$1,000	4	$4,000	
	TOTAL					$4,000
9	**On-Site Disposal** [h]					
9a	Backfilling & Compaction [i]	ton	$30	730	$21,900	
	TOTAL					$21,900
10	Closure Report [j]	hour	$70	120	$8,400	
	TOTAL					$8,400
	SUBTOTAL					$216,400
	Contingency (30%)					$64,900
	Project Administration					$10,000
	TOTAL CAPITAL COST [k]					**$291,000**

Assumptions:
[a] Three drawings and 20-page technical specifications.
[b] On-site stabilization unit will have a transportable treatment unit (TTU) permit.
[c] Two-person crew (one senior and one professional), two weeks, 12-hour days.
[d] Area to be excavated is approximately 11,300 cu. feet and 5 feet deep; 135 pounds per cubic foot soil, or 1.83 tons per cubic yard.
[e] Soil dewatering is not necessary.
[f] Includes transportation, mobilization, equipment, labor, materials, treatability study, and demobilization; all the soil excavated will require stabilizatior
[g] Replace two previous wells plus two new wells to monitor leaching of on-site disposal.
[h] No major on-site modifications to meet federal and state disposal regulations (e.g., installing a clay foundation).
[i] Treated soil has negligible volume increase and can be backfilled on site.
[j] 25-page report
[k] Total capital cost is rounded to the nearest one thousand dollars.
[l] Individual costs are rounded to the nearest one hundred dollars.

TABLE A-2

PRELIMINARY O&M COST ESTIMATE OF REMOVAL ACTION ALTERNATIVE 2
EXCAVATION/ON-SITE STABILIZATION/ON-SITE DISPOSAL
IMF SITE
NAS ALAMEDA

Item/Description	Unit	Unit Cost	Quantity	Total [f]
Groundwater Monitoring [a]				
Quarterly Sampling and Analysis				
Labor (assumes one professional, 8-hour day per quarterly sampling)	hour	$60	32	$1,900
Laboratory Analyses (assumes 1 sample per well, 28-day turn around for lead, TPH, and pH analyses)	sample	$500	4	$2,000
Quarterly Report [b]	each	$2,500	4	$10,000
Cap Repair/Replacement [c]	square foot	$2	2250	$4,500
SUBTOTAL				$18,400
Contingency (30%)				$5,500
TOTAL ANNUAL O&M COST [d]				**$24,000**
PRESENT-WORTH O&M COST [d,e]				**$211,000**

Assumptions:
[a] On-Site Disposal requires installing 2 new groundwater monitoring wells.
[b] 3-page report.
[c] Annual Cap Repair/Replacement cost is 5% of remediated area.
[d] Annual and present-worth O&M costs are rounded to the nearest one thousand dollars.
[e] Present worth O&M cost: project life of 10 years, discount rate of 3%.
[f] Individual costs are rounded to the nearest one hundred dollars.

TABLE A-3a

PRELIMINARY CAPITAL COST ESTIMATE OF REMOVAL ACTION ALTERNATIVE 3a
EXCAVATION/ON-SITE TREATMENT/CLASS II DISPOSAL
NAS ALAMEDA
IMF SITE
(Sheet 1 of 2)

Item No.	Item/Description	Unit	Unit Cost	Quantity	Subtotal [j]	Total
	Removal Design Activities					
1	Plan and Specification Preparation [a]	lump sum	$25,000	1	$25,000	
2	Bid Preparation and Evaluation	lump sum	$15,000	1	$15,000	
3	Permitting [b]	lump sum	$15,000	1	$15,000	
	TOTAL					$55,000
	Removal Action Activities					
4	**Well Abandonment**	each	$500	2	$1,000	
	TOTAL					$1,000
5	**Soil Excavation**					
5a	Engineering Oversight [c]	hour	$130	170	$22,100	
5b	Mobilization & Demobilization	lump sum	$3,000	1	$3,000	
5c	Site Preparation	lump sum	$1,000	1	$1,000	
5d	Temporary Fence	linear foot	$3	400	$1,200	
5e	Excavation [d]	ton	$30	730	$21,900	
5f	Soil Dewatering [e]	bank cubic yard	$13	NA		
5g	Imported Fill	ton	$6	730	$4,400	
5h	Backfilling & Compaction	ton	$30	730	$21,900	
	TOTAL					$75,500
6	**On-Site Stabilization** [f]					
6a	Engineering Oversight	hour	$60	48	$2,900	
6b	Mobilization	lump sum	$10,000	1	$10,000	
6c	Treatability Study	lump sum	$5,000	1	$5,000	
6d	Stabilization Treatment	ton	$60	730	$43,800	
						$61,700

TABLE A-3a

PRELIMINARY CAPITAL COST ESTIMATE OF REMOVAL ACTION ALTERNATIVE 3a
EXCAVATION/ON-SITE TREATMENT/CLASS II DISPOSAL
NAS ALAMEDA
IMF SITE
(Sheet 2 of 2)

Item No.	Item/Description	Unit	Unit Cost	Quantity	Subtotal [j]	Total
7	Post Excavation Sampling					
7a	Sampling					
	Personnel	hour	$60	32	$1,900	
	Sampling Material	lump sum	$500	1	$500	
7b	Analyses (assumes 1 sample per 100 square feet, 14 day turn around for lead, TPH, and pH analyses)	sample	$400	32	$12,800	
	TOTAL					$15,200
8	**Well Replacement** (assumes 10 feet deep)	each	$1,000	2	$2,000	
	TOTAL					$2,000
9	Class II Facility Disposal [g]					
9a	Field Sampling	hour	$60	10	$600	
9b	Pre-Disposal Lab Analytical Testing/ Waste Profile (assumes 1 sample per 100 cubic yards)	sample	$400	4	$1,600	
9c	Transportation (assumes 20-cu.-yd. end dump, round trip)	truck load	$890	22	$19,600	
9d	Disposal	ton	$60	730	$43,800	
	TOTAL					$65,600
10	Closure Report [h]	hour	$70	120	$8,400	
	TOTAL					$8,400
	SUBTOTAL					$284,400
	Contingency (30%)					$85,300
	Project Administration					$10,000
	TOTAL CAPITAL COST [i]					**$380,000**

Assumptions:
[a] Three drawings and 20-page technical specifications
[b] On-site stabilization unit will have a transportable treatment unit (TTU) permit.
[c] Two-person crew (one senior and one professional), two weeks, 12-hour days.
[d] Area to be excavated is approximately 11,300 cu. feet and 5 feet deep; 135 pounds per cubic foot soil, or 1.83 tons per cubic yard.
[e] Soil dewatering is not necessary
[f] Includes transportation, mobilization, equipment, labor, materials, treatability study, and demobilization; all the excavated soil will require stabilizatio
[g] Disposal at McKittrick Class II Disposal Facility, McKittrick, CA.
[h] 25-page report.
[i] Total capital cost is rounded to the nearest one thousand dollars.
[j] Individual costs are rounded to the nearest one hundred dollars.

TABLE A-3b

PRELIMINARY CAPITAL COST ESTIMATE OF REMOVAL ACTION ALTERNATIVE 3b
EXCAVATION-SITE TREATMENT/CLASS III DISPOSAL
IMF SITE
NAS ALAMEDA
(Sheet 1 of 2)

Item No.	Item/Description	Unit	Unit Cost	Quantity	Subtotal [j]	Total
	Removal Design Activities					
1	Plan and Specification Preparation [a]	lump sum	$25,000	1	$25,000	
2	Bid Preparation and Evaluation	lump sum	$15,000	1	$15,000	
3	Permitting [b]	lump sum	$15,000	1	$15,000	
	TOTAL					$55,000
	Removal Action Activities					
4	**Well Abandonment**	each	$500	2	$1,000	
	TOTAL					$1,000
5	**Soil Excavation**					
5a	Engineering Oversight [c]	hour	$130	170	$22,100	
5b	Mobilization & Demobilization	lump sum	$3,000	1	$3,000	
5c	Site Preparation	lump sum	$1,000	1	$1,000	
5d	Temporary Fence	linear foot	$3	400	$1,200	
5e	Excavation [d]	ton	$30	730	$21,900	
5f	Soil Dewatering [e]	bank cubic yard	$13	NA		
5g	Imported Fill	ton	$6	730	$4,400	
5h	Backfilling & Compaction	ton	$30	730	$21,900	
	TOTAL					$75,500
6	**On-Site Stabilization** [f]					
6a	Engineering Oversight	hour	$60	48	$2,900	
6b	Mobilization	lump sum	$10,000	1	$10,000	
6c	Treatability Study	lump sum	$5,000	1	$5,000	
6d	Stabilization Treatment	ton	$60	730	$43,800	
						$61,700

TABLE A-3b

PRELIMINARY CAPITAL COST ESTIMATE OF REMOVAL ACTION ALTERNATIVE 3b
EXCAVATION-SITE TREATMENT/CLASS III DISPOSAL
IMF SITE
NAS ALAMEDA
(Sheet 2 of 2)

Item No.	Item/Description	Unit	Unit Cost	Quantity	Subtotal [j]	Total
7	Post Excavation Sampling					
7a	Sampling					
	Personnel	hour	$60	32	$1,900	
	Sampling Material	lump sum	$500	1	$500	
7b	Analyses (assumes 1 sample per 100 square feet, 14 day turn around for lead, TPH, and pH analyses)	sample	$400	32	$12,800	
	TOTAL					$15,200
8	**Well Replacement** (assumes 10 feet deep)	each	$1,000	2	$2,000	
	TOTAL					$2,000
9	Class III Facility Disposal [g]					
9a	Field Sampling	hour	$60	10	$600	
9b	Pre-Disposal Lab Analytical Testing/ Waste Profile (assumes 1 sample per 100 cubic yards)	sample	$400	4	$1,600	
9c	Transportation (assumes 20-cu.-yd. end dump, round trip)	truck load	$850	22	$18,700	
9d	Disposal	cubic yard	$22	400	$8,800	
	TOTAL					$29,700
10	Closure Report [h]	hour	$70	120	$8,400	
	TOTAL					$8,400
	SUBTOTAL					$248,500
	Contingency (30%)					$74,600
	Project Administration					$10,000
	TOTAL CAPITAL COST [i]					**$333,000**

Assumptions:
[a] Three drawings and 20-page technical specifications.
[b] On-site stabilization unit will have a transportable treatment unit (TTU) permit.
[c] Two-person crew (one senior and one professional, two weeks, 12-hour days.
[d] Area to be excavated is approximately 11,300 cu. feet and 5 feet deep; 135 pounds per cubic foot soil, or 1.83 tons per cubic yard.
[e] Soil dewatering is not necessary.
[f] Includes transportation, mobilization, equipment, labor, materials, treatability study, and demobilization; all the excavated soil will require stabilization
[g] Disposal at McKittrick Class II Disposal Facility, McKittrick, CA.
[h] 25-page report.
[i] Total capital cost is rounded to the nearest one thousand dollars.
[j] Individual costs are rounded to the nearest one hundred dollars.

TABLE A-4a

PRELIMINARY CAPITAL COST ESTIMATE OF REMOVAL ACTION ALTERNATIVE 4a
EXCAVATION/CLASS I DISPOSAL WITH PRETREATMENT
IMF SITE
NAS ALAMEDA
(Sheet 1 of 2)

Item No.	Item/Description	Unit	Unit Cost	Quantity	Subtotal [i]	Total
	Removal Design Activities					
1	Plan and Specification Preparation [a]	lump sum	$25,000	1	$25,000	
2	Bid Preparation and Evaluation	lump sum	$15,000	1	$15,000	
3	Permitting	lump sum	$10,000	1	$10,000	
	TOTAL					$50,000
	Removal Action Activities					
4	**Well Abandonment**	each	$500	2	$1,000	
	TOTAL					$1,000
5	**Soil Excavation**					
5a	Engineering Oversight [b]	hour	$130	170	$22,100	
5b	Mobilization & Demobilization	lump sum	$3,000	1	$3,000	
5c	Site Preparation	lump sum	$1,000	1	$1,000	
5d	Temporary Fence	linear foot	$3	400	$1,200	
5e	Excavation [c]	ton	$30	730	$21,900	
5f	Soil Dewatering [d]	bank cubic yard	$13	NA		
5g	Imported Fill	ton	$6	730	$4,400	
5h	Backfilling & Compaction	ton	$30	730	$21,900	
	TOTAL					$75,500
6	**Post Excavation Sampling**					
6a	Sampling					
	Personnel	hour	$60	32	$1,900	
	Sampling Material	lump sum	$500	1	$500	
6b	Analyses (assumes 1 sample per 100 square feet, 14-day turn around for lead, TPH, and pH analyses)	sample	$400	32	$12,800	
	TOTAL					$15,200
7	**Well Replacement** (assumes 10 feet deep)	each	$1,000	2	$2,000	
	TOTAL					$2,000

TABLE A-4a

PRELIMINARY CAPITAL COST ESTIMATE OF REMOVAL ACTION ALTERNATIVE 4a
EXCAVATION/CLASS I DISPOSAL WITH PRETREATMENT
IMF SITE
NAS ALAMEDA
(Sheet 2 of 2)

Item No.	Item/Description	Unit	Unit Cost	Quantity	Subtotal [i]	Total
8	Class I Facility Disposal [e]					
8a	Field Sampling	hour	$60	10	$600	
8b	Pre-Disposal Lab Analytical Testing/ Waste Profile	lump sum	$500	1	$500	
8c	Transportation (assumes 20-cu.-yd. end dump, round trip)	truck load	$797	22	$17,500	
8d	Disposal [f]	ton	$298	730	$217,500	
	TOTAL					$236,100
9	Closure Report [g]	hour	$70	20	$1,400	
	TOTAL					$1,400
	SUBTOTAL					$381,200
	Contingency (30%)					$114,400
	Project Administration					$10,000
	TOTAL CAPITAL COST [h]					**$506,000**

Assumptions:
[a] Three drawings and 20-page technical specifications.
[b] Two-person crew (one senior and one professional), two weeks, 12-hour days.
[c] Area to be excavated is approximately 11,300 cu. feet and 5 feet deep; 135 pounds per cubic foot soil, or 1.83 tons per cubic yard.
[d] Soil dewatering is not necessary.
[e] Disposal at Chemical Waste Management's Kettleman Hills Class I Disposal Facility.
[f] All the excavated soil will require treatment; cost includes 10% county tax and $45/ton federal tax.
[g] 25-page report.
[h] Total capital cost is rounded to the nearest one thousand dollars.
[i] Individual costs are rounded to the nearest one hundred dollars.

TABLE A-4b

PRELIMINARY CAPITAL COST ESTIMATE OF REMOVAL ACTION ALTERNATIVE 4b
EXCAVATION/CLASS I DISPOSAL WITHOUT PRETREATMENT
IMF SITE
NAS ALAMEDA
(Sheet 1 of 2)

Item No.	Item/Description	Unit	Unit Cost	Quantity	Subtotal [i]	Total
	Removal Design Activities					
1	Plan and Specification Preparation[a]	lump sum	$25,000	1	$25,000	
2	Bid Preparation and Evaluation	lump sum	$15,000	1	$15,000	
3	Permitting	lump sum	$10,000	1	$10,000	
	TOTAL					$50,000
	Removal Action Activities					
4	**Well Abandonment**	each	$500	2	$1,000	
	TOTAL					$1,000
5	**Soil Excavation**					
5a	Engineering Oversight [b]	hour	$130	170	$22,100	
5b	Mobilization & Demobilization	lump sum	$3,000	1	$3,000	
5c	Site Preparation	lump sum	$1,000	1	$1,000	
5d	Temporary Fence	linear foot	$3	400	$1,200	
5e	Excavation[c]	ton	$30	730	$21,900	
5f	Soil Dewatering [d]	bank cubic yard	$13	NA		
5g	Imported Fill	ton	$6	730	$4,400	
5h	Backfilling & Compaction	ton	$30	730	$21,900	
	TOTAL					$75,500
6	**Post Excavation Sampling**					
6a	Sampling					
	Personnel	hour	$60	32	$1,900	
	Sampling Material	lump sum	$500	1	$500	
6b	Analyses (assumes 1 sample per 100 square feet, 14-day turn around for lead, TPH, and pH analyses)	sample	$400	32	$12,800	
	TOTAL					$15,200
7	**Well Replacement** (assumes 10 feet deep)	each	$1,000	2	$2,000	
	TOTAL					$2,000

TABLE A-4b

PRELIMINARY CAPITAL COST ESTIMATE OF REMOVAL ACTION ALTERNATIVE 4b
EXCAVATION/CLASS I DISPOSAL WITHOUT PRETREATMENT
IMF SITE
NAS ALAMEDA
(Sheet 2 of 2)

Item No.	Item/Description	Unit	Unit Cost	Quantity	Subtotal [i]	Total
8	Class I Facility Disposal [e]					
8a	Field Sampling	hour	$60	10	$600	
8b	Pre-Disposal Lab Analytical Testing/ Waste Profile	lump sum	$300	1	$300	
8c	Transportation (assumes 20-cu.-yd. end dump, round trip)	truck load	$797	22	$17,500	
8d	Disposal [f]	ton	$124	730	$90,500	
	TOTAL					$108,900
9	Closure Report [g]	hour	$70	20	$1,400	
	TOTAL					$1,400
	SUBTOTAL					$254,000
	Contingency (30%)					$76,200
	Project Administration					$10,000
	TOTAL CAPITAL COST [h]					**$340,000**

Assumptions:
[a] Three drawings and 20-page technical specifications.
[b] Two-person crew (one senior and one professional), two weeks, 12-hour days.
[c] Area to be excavated is approximately 11,300 cu. feet and 5 feet deep; 135 pounds per cubic foot soil, or 1.83 tons per cubic yard.
[d] Soil dewatering is not necessary.
[e] Disposal at Chemical Waste Management's Kettleman Hills Class I Disposal Facility.
[f] All the excavated soil will require no pretreatment; cost includes 10% county tax.
[g] 25-page report.
[h] Total capital cost is rounded to the nearest one thousand dollars.
[i] Individual costs are rounded to the nearest one hundred dollars.

TABLE A-5

PRELIMINARY CAPITAL COST ESTIMATE OF REMOVAL ACTION ALTERNATIVE 5
EXCAVATION/RECYCLER
IMF SITE
NAS ALAMEDA
(Sheet 1 of 2)

Item No.	Item/Description	Unit	Unit Cost	Quantity	Subtotal[h]	Total
	Removal Design Activities					
1	Plan and Specification Preparation[a]	lump sum	$25,000	1	$25,000	
2	Bid Preparation and Evaluation	lump sum	$15,000	1	$15,000	
3	Permitting	lump sum	$10,000	1	$10,000	
	TOTAL					$50,000
	Removal Action Activities					
4	**Well Abandonment**	each	$500	2	$1,000	
	TOTAL					$1,000
5	**Soil Excavation**					
5a	Engineering Oversight[b]	hour	$130	170	$22,100	
5a	Mobilization & Demobilization	lump sum	$3,000	1	$3,000	
5b	Site Preparation	lump sum	$1,000	1	$1,000	
5c	Temporary Fence	linear foot	$3	400	$1,200	
5e	Excavation[c]	ton	$30	730	$21,900	
5f	Soil Dewatering[d]	bank cubic yard	$13	NA		
5g	Imported Fill	ton	$6	730	$4,380	
5h	Backfilling & Compaction	ton	$30	730	$21,900	
	TOTAL					$75,500
6	**Post Excavation Sampling**					
6a	Sampling					
	Personnel	hour	$60	32	$1,900	
	Sampling Material	lump sum	$500	1	$500	
6b	Analyses (assumes 1 sample per 100 square feet, 14-day turn around for lead, TPH, and pH analyses)	sample	$400	32	$12,800	
	TOTAL					$15,200

TABLE A-5

PRELIMINARY CAPITAL COST ESTIMATE OF REMOVAL ACTION ALTERNATIVE 5
EXCAVATION/RECYCLER
IMF SITE
NAS ALAMEDA
(Sheet 2 of 2)

Item No.	Item/Description	Unit	Unit Cost	Quantity	Subtotal[h]	Total
7	**Well Replacement** (assumes 10 feet deep)	each	$1,000	2	$2,000	
	TOTAL					$2,000
8	**Recycling Facility**[e]					
8a	Field Sampling	hour	$60	10	$600	
8b	Pre-Disposal Lab Analytical Testing/ Waste Profile (assumes 1 sample per 100 cubic yards)	sample	$400	4	$1,600	
8c	Transportation (assumes 20-cu.-yd. end dump, round trip)	truck load	$890	22	$19,600	
8d	Recycling	ton	$100	730	$73,000	
	TOTAL					$94,800
9	**Closure Report**[f]	hour	$70	20	$1,400	
	TOTAL					$1,400
	SUBTOTAL					$239,900
	Contingency (30%)					$72,000
	Project Administration					$10,000
	TOTAL CAPITAL COST[g]					**$322,000**

Assumptions:
[a] Three drawings and 20-page technical specifications.
[b] Two-person crew (one senior and one professional), two weeks, 12-hour days.
[c] Area to be excavated is approximately 11,300 cu. feet and 5 feet deep; 135 pound per cubic foot soil, or 1.83 tons per cubic yard
[d] Soil dewatering is not necessary.
[e] Soil recycled at Gibson Environmental Recycling Facility.
[f] 25-page report.
[g] Total capital cost is rounded to the nearest one thousand dollars.
[h] Individual costs are rounded to the nearest one hundred dollars.