AECRU Contract Number N68711-00-D-0005
Delivery Order 0035

# Installation Restoration Site 12 Chemical- and Solid-Waste-Contaminated Soil Engineering Evaluation and Cost Analysis

## Naval Station Treasure Island San Francisco, California

**DS.A035.10059**

**September 18, 2002**

Prepared for

DEPARTMENT OF THE NAVY
Southwest Division
Naval Facilities Engineering Command
San Diego, California

Prepared by

TETRA TECH EM INC.
1230 Columbia Street, Suite 1000
San Diego, CA 92101
(619) 525-7188

Victor Early, R.G., C.E.G.
Project Manager

REGISTERED GEOLOGIST
VICTOR EARLY
No. 2204
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

## CONTENTS

**CONTENTS (Continued)**

**CONTENTS (Continued)**



**Appendix**

## FIGURES



## TABLES

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| 40 CFR | Title 40 of the Code of Federal Regulations |
| AOC | Area of concern |
| ARAR | Applicable or relevant and appropriate requirement |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| BAAQMD | Bay Area Air Quality Management District |
| BAP | Benzo(a)pyrene |
| BCT | BRAC Cleanup Team |
| bgs | Below ground surface |
| BRAC | Base Realignment and Closure |
| Ca-HSC | California Health and Safety Code |
| Cal/EPA | California Environmental Protection Agency |
| CCR | California Code of Regulations |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| COC | Chemical of concern |
| CS | Cleanup standard |
| CSM | Conceptual site model |
| DTSC | Cal/EPA Department of Toxic Substances Control |
| EE/CA | Engineering evaluation and cost analysis |
| EO | Executive Order |
| EPA | U.S. Environmental Protection Agency |
| FS | Feasibility study |
| FSY | Former storage yard |
| ft | Foot or feet |
| IC | Institutional control |
| IR | Installation Restoration |
| IT | International Technology Corporation |
| µg/dL | Micrograms per deciliter |
| mg/kg | Milligrams per kilogram |
| NAVSTA TI | Naval Station Treasure Island |
| Navy | Department of the Navy |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |
| NFEC | Naval Facilities Engineering Command |

## ACRONYMS AND ABBREVIATIONS (CONTINUED)

| | |
|---|---|
| NPDES | National Pollutant Discharge Elimination System |
| NTCRA | Nontime-critical removal action |
| O&M | Operations and maintenance |
| PA/SI | Preliminary assessment/site inspection |
| PAH | Polycyclic aromatic hydrocarbons |
| PCB | Polychlorinated biphenyl |
| PRA | Preliminary risk assessment |
| PRC | PRC Environmental Management, Inc. |
| PRG | Preliminary remediation goal |
| RAO | Remedial action objective |
| RAP | Remedial action plan |
| RAWP | Removal action work plan |
| RCRA | Resource Conservation and Recovery Act |
| RI | Remedial investigation |
| RS Means | R.S. Means Company, Inc. |
| SFRA | San Francisco Redevelopment Agency |
| SI | Site inspection |
| Site 12 | IR Site 12 |
| SWDA | Solid waste disposal area |
| TBC | To be considered |
| TCRA | Time-critical removal action |
| Tetra Tech | Tetra Tech EM Inc. |
| TI | Treasure Island |
| TIHDI | Treasure Island Homeless Development Initiative |
| TPH | Total petroleum hydrocarbons |
| $UCL_{95}$ | 95th Percentile of the upper Confidence limit on the arithmetic mean |
| VOC | Volatile organic compound |
| YBI | Yerba Buena Island |
| $yd^3$ | Cubic yard |

# EXECUTIVE SUMMARY

This Engineering Evaluation and Cost Analysis (EE/CA) report summarizes the EE/CA process, characterizes the site, identifies removal action objectives, describes and analyzes removal action alternatives, and provides a comparative analysis of the alternatives for the housing area at the former Naval Station on Treasure Island. This report was prepared in accordance with current U.S. Environmental Protection Agency and Department of the Navy guidance documents for a non-time-critical removal action.

## SITE BACKGROUND

The Treasure Island housing area (Site 12) is located on the northwestern portion of the island. Site 12 is also known as the "old bunker area" because, from the 1940s to the 1960s, ammunition was stored in bunkers in the area. Based on previous reports and historical information, four solid waste disposal areas have been identified within Site 12. Solid waste material included wood, glass, metals, and petroleum products, with some of the material burned for disposal. The primary chemicals of concern within these disposal areas are lead, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs).

Beginning in the 1960s, bunkers were removed from Site 12 and the area was graded for construction of Navy housing. Grading and site preparation for construction of the housing units included mixing and spreading of the solid waste material with fill and near-surface soil, both within and outside of the known waste disposal areas. The grading process scattered the waste material throughout the housing area in a variable and unpredictable manner.

## REMOVAL ACTION OBJECTIVES

The presence of chemicals and solid waste in soil at Site 12 might create an exposure risk for current and future residents. The potential threat of exposure to human health at Site 12 does not warrant an emergency or time-critical removal action (TCRA). The planned removal action for the chemical- and solid-waste-contaminated soil remaining at known solid waste disposal areas (SWDA) and potentially present in backyards at Site 12 is nontime-critical, because the risk until the removal action is taken is relatively low.

The proposed removal action will be undertaken under the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Title 40 of the Code of Federal Regulations, Part 300), CERCLA, and Ca-HSC Section 25323. All of these regulations define removal actions as the cleanup or removal of released hazardous substances, actions to monitor the threat of release of hazardous substances, and actions to mitigate or prevent damage to public health or welfare or the environment.

Based on CERCLA and the NCP, the removal action objectives are to: (1) promote overall protection of human health and the environment, and (2) restrict the potential for a resident to contact chemical- or solid-waste-contaminated soil near the ground surface within Site 12.

## Removal Action Alternatives

There are two areas addressed by remedial alternatives presented in this EE/CA: (1) common areas and backyards within the known solid waste disposal areas, and (2) backyards in the housing area, outside the known disposal areas. Four removal action alternatives were developed to address potential health risks associated with chemical- and solid-waste-contaminated soil <u>within</u> known solid waste disposal areas, and eight removal action alternatives were developed to address the potential health risks in backyards <u>outside</u> of the known disposal areas:

| EE/CA Alternatives | Within Known Solid Waste Disposal Areas | |
|---|---|---|
| | Backyards | Common Areas |
| 1A, 2A, 3A, and 4A | Addressed | Addressed |

| EE/CA Alternatives | Outside of Known Solid Waste Disposal Areas | |
|---|---|---|
| | Backyards | Common Areas |
| 1B, 2B, 3B, 4B, 5B, 6B, 7B, and 8B | Addressed | Not addressed, but part of the remedial investigation/feasibility study program |

Common areas outside of the known solid waste disposal areas are not included in this EE/CA; however, they will be investigated as part of the remedial investigation program for Site 12. The remedial investigation will evaluate the results of the investigation of common areas and will provide the basis for evaluating potential human health risks and for developing any necessary remedial actions for these areas.

## Comparative Analysis Of Removal Action Alternatives

A comparative analysis of chemical- and solid-waste-contaminated soil removal actions was conducted to evaluate the relative performance of each alternative. Each alternative was evaluated considering the NCP criteria of overall protectiveness of human health; compliance with applicable or relevant and appropriate requirements; long-term effectiveness; reduction of mobility, toxicity, or volume through treatment; short-term effectiveness; implementability; and cost.

A comparative analysis of the costs of the alternatives for common areas and backyards <u>within</u> the known solid waste disposal areas is presented in the table below:

| Alternative | Description | Cost Opinion (in millions) |
|---|---|---|
| 1A | Cap Backyards (poured-in-place) and Excavate Common Areas to 2 Ft bgs in Known SWDAs | $4.4 |
| 2A | Cap Backyards (Precast Pavers) and Excavate Common Areas to 2 Ft bgs in Known SWDAs | $4.6 |
| 3A | Excavate Backyards to 2 Ft bgs and Common Areas to 2 Ft bgs in Known SWDAs | $4.6 |
| 4A | Excavate Backyards to 4' and Common Areas to 2 Ft bgs in Known SWDAs | $5.3 |

Each alternative for the known solid waste disposal areas would: (1) restrict the potential (exposure pathway) for a resident to contact soil contaminants (protective of human health), (2) be implementable, and (3) comply with applicable or relevant and appropriate requirements. Backyard excavation alternatives would reduce the on-site volume of hazardous material and would be more permanent, but also would be more disruptive than concrete capping alternatives. Alternative 1A costs the least, Alternatives 2A and 3A have similar costs, and Alternative 4A costs the most.

A comparative analysis of the costs of the alternatives for backyards outside of the known solid waste disposal areas is presented in the table below:

| | | | Cost Opinion (in millions) | | |
|---|---|---|---|---|---|
| Alternative | Description | Number of Backyards | Investigation of Backyards | Remediation | Total |
| 1B | Cap Backyards (poured-in-place) | 685 | NA | $4.6 | $4.6 |
| 2B | Cap Backyards (precast pavers) | 685 | NA | 8.2 | $8.2 |
| 3B | Excavate Backyards to 2 Ft bgs | 685 | NA | $8.5 | $8.5 |
| 4B | Excavate Backyards to 4 Ft bgs | 685 | NA | $14.6 | $14.6 |
| 5B | Investigate/Cap (poured-in-place) Backyards | 685 (533 remediated) | $19.6 | $3.6 | $23.2 |
| 6B | Investigate/Cap (precast pavers) Backyards | 685 (533 remediated) | $19.6 | $6.3 | $25.9 |
| 7B | Investigate/Excavate Backyards to 2 Ft bgs | 685 (533 remediated) | $19.6 | $6.9 | $26.5 |
| 8B | Investigate/Excavate Backyards to 4 Ft bgs | 685 (533 remediated) | $19.6 | $10.8 | $30.4 |

Similar to the first set of alternatives, Alternatives 1B, 2B, 3B, and 4B for backyards outside of the known solid waste disposal areas would: (1) restrict the potential (exposure pathway) for a resident to contact soil contaminants (protective of human health), (2) be implementable, and (3) comply with applicable or relevant and appropriate requirements. Backyard excavation alternatives would reduce the on-site volume of hazardous material and would be more permanent, but also would be more disruptive than concrete capping alternatives. Of the first four alternatives, Alternative 1B costs the least, Alternatives 2B and 3B have similar costs, and Alternative 4B costs the most.

Alternatives 5B, 6B, 7B, and 8B would include conducting a field investigation in each backyard to determine if a removal action is necessary. Based on predictions from a statistical evaluation of the current data set, a large proportion of the backyards would require a removal action to be health-protective. In addition, some uncertainty would remain in backyards that were investigated but not remedied due to the high degree of variability in both contaminant location and concentration. As a group, Alternatives 5B, 6B, 7B, and 8B would provide less certainty of achieving health protection, and be more disruptive, and more costly than Alternatives 1B, 2B, 3B, and 4B.

Before the Navy chooses a preferred alternative, regulatory and public input is necessary. The public will have an opportunity to review and comment on the EE/CA during public comment period. State and community acceptance will be evaluated after the public comment period.

## REGULATORY AND PUBLIC PARTICIPATION

In addition to the 30-day public comment period from September 20 to October 21, 2002, the Navy will hold a public meeting to present the EE/CA and solicit comments from residents of Treasure Island and other interested members of the public. Comments by California regulatory agencies and the community will be evaluated with other required selection criteria after the 30-day public comment period for the EE/CA. The Navy will identify the alternatives selected for the removal action decision in an action memorandum, which also will discuss all comments received during the public comment period on the EE/CA. A 30-day public notice period will occur for the action memorandum.

# 1.0 INTRODUCTION

This EE/CA addresses Installation Restoration (IR) Site 12 (Site 12) at Naval Station Treasure Island (NAVSTA TI), San Francisco, California (see Figure 1-1). Site 12 is located on the northwestern portion of Treasure Island (TI) and occupies about 93 acres of the island. Site 12 is a flat area, characterized by lawns (common areas), paved roads, and about 900 housing units and associated backyards.

## 1.1 DESCRIPTION OF THE NONTIME-CRITICAL REMOVAL ACTION AUTHORITY AND THE PURPOSE OF THE ENGINEERING EVALUATION/COST ANALYSIS

The purpose of a NTCRA is to conduct action that reduces a threat to human health or the environment. The purpose of this Engineering Evaluation/Cost Analysis (EE/CA) is to develop, compare, and evaluate removal action alternatives for a planned nontime-critical removal action (NTCRA). The planned removal action is intended to be consistent with the final remedy for Site 12. The final remedy will be selected through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigation (RI) and feasibility study (FS) process.

CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Title 40 of the Code of Federal Regulations [40 CFR] Part 300) define removal actions to include the following:

> The cleanup or removal of released hazardous substances from the environment, such actions as may necessarily be taken in the event of the threat of release of hazardous substance into the environment, such action as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances, the disposal of removal material, or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release.

This EE/CA evaluates proposed removal action alternatives that are intended to reduce the likelihood of human exposure to chemical- and solid-waste-contaminated soil in a residential area at Treasure Island.

The U.S. Environmental Protection Agency (EPA) has classified removal actions into three types, based on the circumstances surrounding the release or threat of release:

- An emergency removal action, where on-site cleanup activities are initiated within hours of the verification of a release or threat of a release and on-site cleanup activities are completed within 30 days
- A time-critical removal action (TCRA), where based on the site evaluation, a period of six months or less exists before on-site removal activities must be initiated

- A NTCRA, where the on-site action will be taken more than 6 months after commencement of the planning period

The potential threat of exposure to human health at Site 12 does not warrant an emergency or TCRA. The planned removal action for the chemical- and solid-waste-contaminated soil remaining at known solid waste disposal areas (SWDA) and potentially present in backyards at Site 12 is nontime-critical, because the risk until the removal action is taken is relatively low.

In addition to this EE/CA, the California Health and Safety Code (Ca-HSC) specifically requires preparation of documentation for planned removal actions. The type of documentation required depends on the projected cost of the removal action. The Ca-HSC requires development of a remedial action plan (RAP) for removal actions that cost $1 million or more or a removal action work plan (RAWP) for removal actions projected to cost less than $1 million. Further, the Ca-HSC authorizes the California Environmental Protection Agency (Cal/EPA), Department of Toxic Substances Control (DTSC), to waive RAP requirements in favor of a RAWP for removal actions taken in response to an imminent or substantial endangerment determination. DTSC also may waive RAP requirements of Ca-HSC Sections 25356.1(d)(1) through (6) if a RAWP document is prepared that meets the requirements of Ca-HSC Section 25356.1(h)(3).

This EE/CA for a NTCRA at Site 12 addresses the implementability, effectiveness, and costs of the removal action alternatives, along with applicable regulatory requirements. The Navy is the lead agency for Site 12 removal actions. As the lead agency, the Navy has the authority to select the alternative, considering public and regulatory comments. The Navy is working in cooperation with DTSC, EPA, the California Integrated Waste Management Board, and the Regional Water Quality Control Board to implement this removal action.

## 1.2 SCOPE OF THE ENGINEERING EVALUATION/COST ANALYSIS

Site 12 has been divided into two separate areas for the purposes of this planned removal action. The first area includes locations that are considered to be known SWDAs. These SWDAs were identified through evaluation of historical site data (aerial photographs, reports, and construction drawings) and site investigation (trenching, borings, inspection, and sample collection). The known SWDAs were discovered during the initial portion of the RI of Site 12 in 1997 and during later field investigation in 1999. The known SWDAs are shown in Figures 1-2 to 1-6. They include 60 backyards and about 3 acres of common area and are located along the northern and western portions of Site 12, as well as in Bigelow Court, in the central portion of the site. Within the known SWDAs, this EE/CA addresses common landscaped areas between and around the buildings, referred to as “common areas”. Although paved roadways, driveways, and primary sidewalks are also part of the overall common area, they are not included in this EE/CA. Residential structures within the known SWDAs are primarily unoccupied, with the exception of Buildings 1211, 1213, 1235, and 1237.

The second area in the proposed removal action consists of all residential backyards that are outside of the known SWDAs, except those backyards that were excavated previously. A fence currently encloses each backyard in the 1100-, 1200-, and 1300-series buildings. The 1400-series backyards currently are unfenced. Residential buildings outside of the known SWDAs are primarily occupied. This second area also is shown in Figures 1-2 to 1-6.

Removal action alternatives for the first area are developed and evaluated independently of alternatives for the second area. Common areas outside of the known SWDAs are excluded from this EE/CA, and they will be further investigated as part of the RI program for Site 12. The RI and FS process will evaluate the results of the further investigation and will provide the basis for evaluating potential human health risks and developing any necessary remedial alternatives for these common areas.

Figures 1-2 through 1-6 and the table below summarize which common areas and backyards within Site 12 are included in this EE/CA.

**Areas Included in The EE/CA**

| Area | Within Known Solid Waste Disposal Areas | Outside of Known Solid Waste Disposal Areas |
|---|---|---|
| Common Areas | Included in EE/CA | Not included, but part of the remedial investigation/feasibility study program |
| Backyards | Included in EE/CA | Included in the EE/CA* |

Notes:

* Except backyards that were excavated previously

## 1.3 DESCRIPTION OF THE SITE HISTORY AND CONCEPTUAL MODEL

When Treasure Island (TI) originally was constructed, for the 1939-40 Golden Gate International Exposition, most of the Site 12 area was used as a parking lot for the exposition. After the Navy took over in late 1940 and until the 1960s, the area was used for bunker storage of munitions and other materials, vehicle equipment and storage, recreational playing fields, and disposal and burning of waste. These operations resulted in the release of lead, polychlorinated biphenyls (PCB), and polycyclic aromatic hydrocarbons (PAH) into the surface soils of Site 12. Based on information to date, the primary areas of release are the known SWDAs (See Figures 1-2 through 1-6). As part of the construction of residential housing units beginning in 1967, construction specifications (see Appendix C) for the residential units instructed the contractor to prepare the site by mixing the solid waste with fill material. The mixing, spreading, and grading of the solid waste/fill mixture occurred both within and outside of the known SWDAs and resulted in a random distribution of solid waste, lead, PAH, and PCB contamination in soil. In addition, possible chemical releases or waste disposal may have occurred outside of the known SWDAs. The random and scattered distribution of waste and debris results from grading and uncontrolled disposal practices. Figure 1-7 was developed to graphically depict the conceptual site model (CSM). This figure conceptually shows the historical features that relate to the release and distribution of solid waste and hazardous substances in Site 12. The CSM was developed from review of historical aerial photographs and construction documents.

## 1.4 LIMITED SUCCESS OF SITE CHARACTERIZATION OUTSIDE OF THE SOLID WASTE DISPOSAL AREAS RESULTING FROM THE RANDOM AND VARIABLE NATURE OF CONTAMINATION

Based on the sampling data available at the time and the known historic uses of the Site 12 property, the Navy initially found the property suitable to lease in 1997. Subsequently, the Navy completed several phases of site investigation (most recently in March 2002) in an attempt to characterize the nature and extent of any soil contaminants. While each phase has identified new areas of concern, some areas of Site 12 never yielded sample results that caused any concern.. The results of the investigations to date for lead, PCBs, and PAHs are shown in figures in Appendix A.

Initial investigation activities (RI Phase I in 1992 and Phase IIB in 1995) focused primarily on total petroleum hydrocarbons (TPH) and metals. Results from the sampling revealed areas contaminated with metals and TPH. Further investigation occurred in 1996 and 1997 (PRC Environmental Management, Inc. [PRC] 1997). The additional investigations were targeted in suspected burn pit areas and on a grid pattern across Site 12. The results of the additional investigation revealed areas with elevated lead and TPH contamination. Potential risk from TPH is considered to be low and will be further evaluated in the RI.

Based on the investigations conducted before 1999, the contamination was localized and the number and location of samples was adequate to characterize the contamination. During a removal action in a debris area near Buildings 1207 and 1209 in June 1999, the Navy discovered that the debris area was larger than previously concluded when using a direct-push drill. As a result, additional investigation activities were planned to address areas where only direct-push data existed. The additional investigation included trenching, rather than direct-push drill sampling. Another phase of investigation in the Halyburton Court in 1999 revealed contamination resulting from a release of PCBs. Since no information regarding the release of PCBs was known, the discovery of the PCB release was unexpected.

In the summer of 2001, the Navy conducted additional sampling in backyards and common areas. The results of this investigation revealed new and unexpected areas that contained PCBs, PAHs, and lead, distributed in a random and variable manner. Detected contaminant concentrations were above action levels for the site. During confirmation soil sampling (conducted in October 2001) for a follow-on removal action in the front common area adjacent to Building 1254, PCB contamination was documented to be discontinuous, both vertically and horizontally, within an area the size of about 400 $ft^2$. This variability and randomness within the 400 $ft^2$ area was consistent with previous investigation results.

The subsequent investigation activities and results indicated that contamination and the potential areas of release were scattered and unpredictable. In addition, it was discovered that during the time of housing construction, the contractor had been instructed to mix the existing rubbish with clean fill for use as subgrade for the site. This likely helped create the random and heterogeneous distribution of the waste, both within and away from the original source areas. In the areas outside of the SWDAs, the location(s) of hazardous materials cannot be reliably predicted. In addition, after contaminated areas have been identified, chemical concentrations are variable over short distances. Site data consistently show spatial and concentration variability, even within areas of 400 $ft^2$. The distribution of hazardous substances has not resulted from natural or predictable processes (for example, migration of a spill that is controlled by site topography, geology, or drainage features), and as a result, adequate characterization has not been achieved by investigations to date.

Because of the heterogeneous nature of the contaminants, it is not possible to predict where contamination may be found or be encountered by a person. Additional sampling to date has not significantly lowered the overall uncertainty about the distribution of contaminants within Site 12.

## 1.5 POTENTIAL THREATS TO HUMAN HEALTH FROM SITE CONTAMINANTS

Initially, the Navy developed soil action levels for lead, PCBs, and PAHs, based upon a residential exposure scenario (see Appendix G). Based on the Navy-developed action levels, the following is a preliminary risk evaluation to determine whether a removal action is warranted.

### 1.5.1 Lead Contamination

Concentrations of lead in near-surface soil exceed the action level of 400 milligrams per kilogram (mg/kg) for residential scenarios, indicating a possible risk to human health. Lead contamination in soil exists primarily within the known SWDAs, and to a lesser extent, is scattered outside of the known SWDAs.

### 1.5.2 Polychlorinated Biphenyl and Polycyclic Aromatic Hydrocarbon Contamination

PCBs are present in near-surface soils within Site 12 at concentrations above the action level of 1 mg/kg. PAHs are also present in near-surface soils within Site 12 at concentrations that exceed the action level of 0.62 mg/kg, indicating a possible risk to human health. PCB and PAH contamination in soil exists primarily within the known SWDAs, and to a lesser extent, is scattered in the areas outside of the known SWDAs.

In residential backyards, the Navy recognized a higher potential exposure level than in common areas. The higher potential level of exposure in backyards resulted from residents (adults and children) possibly digging and gardening. Without active remedies and monitoring measures, residents might come into contact with contaminants in near-surface soils through the activities listed previously.

The Navy concluded that a NTCRA for chemical- and solid-waste-contaminated soil potentially present in backyards and in known SWDAs in Site 12 should be taken to significantly reduce the risk of potential human exposure to hazardous substances. This decision was based on the site history, limited success of site investigations in isolating the locations of contaminants, and the presence potential threats to human health at Site 12.

## 1.6 PLANNED REMOVAL ACTION TO ACHIEVE HIGH LEVEL OF PROTECTION FOR HUMAN HEALTH

CERCLA and the NCP define removal actions to include actions that may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release. For Site 12, the site history, and investigation results show that distribution of hazardous substances is random. In the presence of such uncertainty and because of the occupancy of many housing units in Site 12, the Navy has concluded that a NTCRA is necessary to significantly reduce the risk of potential human exposure to hazardous substances in Site 12.

Four removal action alternatives were developed and evaluated for the known SWDAs, and eight removal action alternatives were developed and evaluated for the backyards outside of the known SWDAs. In evaluating the alternatives, the Navy considered the overall effectiveness, implementability, and cost.

The Navy recognizes that some backyards may not contain hazardous materials that pose a threat to human health. Because there is a high degree of uncertainty as to which yards do not pose an unacceptable risk based on the current data set, the Navy has decided to take a prudent approach regarding protection of human health by conducting a removal action in all of the backyards of Site 12.

The public is encouraged to review and comment on the proposed removal activities described in this EE/CA. This document may be reviewed at the following locations:

Navy Detachment
410 Palm Avenue
Building 1, Room 161
San Francisco, CA 94130
(415) 743-4704

San Francisco Public Library
Government Publications Section
100 Larkin Street
San Francisco, CA 94102
(415) 557-4400

# 2.0 SITE DESCRIPTION AND BACKGROUND

This section summarizes background information from previous reports, including the draft RI Report (Tetra Tech 1999b). In addition, a detailed review of the historical aerial photographs was conducted and is summarized in the following sections. In many cases, the aerial photographs were stereo-pairs, which revealed three-dimensional features such as depressions or mounds on the ground surface. Selected aerial photographs that show historical features are presented in Appendix D.

## 2.1 SITE DESCRIPTION AND BACKGROUND

The following sections summarize: (1) site location and historic operations, (2) surrounding land use and proposed reuse, (3) site geology and hydrogeology, (4) regional ecology, and (5) climate and meteorology.

### 2.1.1 Site Location and Historic Operations

NAVSTA TI lies in San Francisco Bay, midway between San Francisco and Oakland, California. The facility consists of two contiguous islands. The northern island, TI, encompasses about 403 acres, and the southern island, Yerba Buena Island (YBI), encompasses about 147 acres. TI is a manmade island constructed of sediment dredged from the San Francisco Bay; YBI is a natural island. In 1993, NAVSTA TI was designated for closure under the Base Realignment and Closure (BRAC) Act of 1990. The base was closed on September 30, 1997, and is being transferred to the City and County of San Francisco for reuse.

Site 12 (see Figure 1-2), the old bunker area, is located on the northwestern portion of TI and occupies about 93 acres of the island. Site 12 is currently the TI housing area. Site 12 is a flat area, consisting of grassy lawns, paved roads, and residential housing units with backyards.

Throughout the 1940s, 1950s, and 1960s, ammunition was stored in bunkers located around Site 12. As early as 1945, 9 large ammunition bunkers and 12 smaller bunkers were visible along the northern end of TI. These bunkers were constructed in 1944 as reinforced concrete structures covered by sand, with a chert rock and clay surface. A backfilled blast wall, the same height as the bunkers, existed along the open side of the structures. Soil trenching and boring activities performed before the 1965 housing foundation excavations indicated that the areas between and around the bunkers were used for solid waste disposal. Both trench-type disposal units and general SWDAs were constructed and used for the disposal of materials such as loose rubbish, bottles, wire rope, paper, and steel drums. These areas have been combined into four identified SWDAs, currently known as SWDA A&B, SWDA 1207/1209, SWDA 1231/1233, and SWDA Bigelow Court. Figures 1-2, 1-3, 1-4, 1-5, and 1-6 show each of these areas. Disposal of household waste, construction debris, incinerator ash, and sandblast grit is suspected to have also occurred in these areas. The household waste and portions of the construction debris would have been burned or degraded with air exposure over the years. Photographs of debris encountered in the investigation are shown in Appendix B.

From review of the aerial photographs, the first noticeable debris disposal areas at Site 12 were located at what is now known as SWDA A&B and SWDA 1207/1209. Aerial photographs were used to identify debris disposal areas on the island (EPA 1995). Site investigations were then performed to confirm or deny the presence of debris or specific chemicals of concern (COC). In a 1945 aerial photograph, container facilities (possibly used for storage) were in a storage yard south of the ammunition bunkers. Storage containers sporadically moved into an extension of the storage yard over the years. Transformers may have been present at the storage yard, and PCBs likely were present in the transformer insulating oils.

Aerial photographs indicated that into the late 1940s, SWDAs continued to expand. Burn pits or stained areas were visible periodically throughout Site 12. In 1950, the area between the northeastern ammunition bunkers was developed into a waste disposal area, now known as SWDA 1231/1233. Three known SWDAs (A&B, 1207/1209, and 1231/1233) were adjacent to the shoreline and located along the shoreline perimeter of Site 12. In the 1958 aerial photograph, EPA identified a waste incinerator (1995) around SWDA 1231/1233. Waste and debris likely were incinerated in this area, and the residue probably was scattered throughout the area prior to construction of the housing. SWDA Bigelow court was identified during sampling activities in 2001 (IT 2002).

During most of the 1950s, debris disposal areas remained visible in aerial photographs, but changed in tone and size. Various stained areas appeared sporadically throughout Site 12 over the years. Earthwork practices and bulldozing could have been used to separate, grade, and downsize areas that collected too much debris, even before housing construction took place in the 1960s. Aerial photographs clearly show SWDA A&B changing in shape and size over the years. Smaller debris mounds located in earlier photographs are not present in later photographs.

In the 1963 aerial photograph, a large, dark area, about 1,200 feet in length, appeared directly north of the storage yard. This large, dark area was less visible in 1966, when housing construction first started, possibly because of earthwork operations. The earthwork plans and specifications (see Appendix C) identified this area as a "Rubbish Disposal Area" and the specifications stated, "Where rubbish is found, mix with soil to reduce localized concentrations of rubbish".

Aerial photographs show that as housing construction began, the ammunition bunkers were simultaneously removed and the area eventually was graded. During the grading, some of the solid waste material around the bunkers likely was spread over a moderately larger local area in an unknown fashion. This material included wood, glass, metals, and petroleum products, some of which had been burned as part of the disposal process.

Figure 1-7 was developed to conceptually display site features and history before and up to construction of the housing. The basis for development of this figure was analysis of the historical photographs and review of construction drawings for the housing development.

### 2.1.2 Surrounding Land Use and Proposed Reuse

As of this date, the San Francisco Redevelopment Agency (SFRA) has not developed a final reuse plan for NAVSTA TI. The proposed reuse for Site 12 identified in the Draft NAVSTA TI Reuse Plan (SFRA 1996) is for residential/open space/publicly oriented uses. The surrounding land use includes a public school and various commercial/industrial uses.

### 2.1.3 Site Geology and Hydrogeology

Soils encountered in borings advanced to depths up to 15 feet below ground surface (bgs) consist primarily of tan to grayish-brown, fine- to coarse-grained, loose sands, with some shell fragments and gravel. Solid waste, such as glass, ceramics, brick fragments, unspecified metal objects, shoe soles, film canisters, a paint bucket, a metal ladder, and a metal drum, were encountered in borings and trenches during previous investigations. Solid waste was encountered most commonly from 2 to 5 feet bgs in borings located near the northern and northwestern shorelines, in the vicinity of the SWDAs. Glass was by far the most frequently encountered type of solid waste. In addition to the SWDAs, solid waste has been found in other areas of Site 12, including near Buildings 1254 and 1219.

According to monitoring well and Hydropunch® boring logs drilled during the Phase IIB RI (PRC 1997), the estimated depth to groundwater during drilling at Site 12 ranged from about 2.5 to 7.5 feet bgs. The water table is unconfined. Groundwater generally flows in a radial pattern from the center of TI to the shoreline. Perched groundwater conditions above the shallow water table exist locally because of the presence of relatively impermeable silt and clay lenses. Groundwater recharge occurs primarily from precipitation infiltration; with some contribution from irrigation and leaking storm drains (PRC 1993). Previous investigations at TI have revealed tidally induced water table fluctuations of as much as 4.5 feet immediately adjacent to the TI seawall and as much as 2.25 feet at a distance of about 50 feet from the seawall (Harding Lawson Associates 1985).

### 2.1.4 Regional Ecology

NAVSTA TI is a component of the San Francisco Bay estuary. An estuary is the lower, wide portion of a river, usually partially enclosed, and is where fresh water mixes with salt water. This area comprises the largest embayment on the Pacific Coast of the United States. San Francisco Bay is composed of many varied habitats, including deep waters, wetlands, and upland areas, which provide important staging and wintering areas for migratory waterfowl and shorebird populations of the Pacific Flyway (San Francisco Estuary Project 1992).

### 2.1.5 Climate and Meteorology

The climate at NAVSTA TI is dominated by the Pacific Ocean, which produces a maritime climate characterized by little temperature variation. The average annual temperature is 56 to 58 degrees Fahrenheit, with an annual frost-free period ranging from 300 to 330 days.

The prevailing wind direction for the San Francisco Bay Area is from the northwest. Wind speed is less than 6 miles per hour for more than 50 percent of the time and exceeds 12 miles per hour for approximately 10 percent of the time. The strongest winds are associated with winter storms. In the winter, winds from the north and east sometimes bring low temperatures to the San Francisco Bay Area. Westerly winds predominate during the summer, when cool marine air flows east toward the warm Central Valley region of California. These winds are strongest in the late afternoon and early evening.

The average annual precipitation is about 25 to 30 inches. Approximately 90 percent of the annual precipitation occurs from November to April. Localized showers are infrequent, and storms are moderate in duration and intensity. Mean annual evaporation is 48 inches. The greatest evaporation occurs during July.

Relative humidity during the winter is approximately 50 to 60 percent during the day, increasing to approximately 80 to 90 percent at night. Humidity decreases in spring; however, by summer, it increases, particularly at night or in the morning, when frequent fogs occur. Humidity is lowest in the fall, ranging from approximately 50 percent during the day to 70 percent at night (Navy 1987).

## 2.2 PREVIOUS REMOVAL ACTIONS, INVESTIGATIONS, AND ACTIVITIES

This section summarizes removal actions and investigations previously conducted at Site 12.

### 2.2.1 Previous Removal Actions

Four removal actions have occurred at Site 12. The first removal was conducted in the vicinity of Buildings 1207 and 1209, between the months of June and August 1999. Sufficient contamination to warrant a cleanup remedy had not been identified at SWDA A&B, and SWDA 1231/1233 had not yet been identified. The removal was for lead at Buildings 1207/1209, where there appeared to be a hot spot in a former burn pit area. About 2,200 cubic yards ($yd^3$) of soil were excavated and replaced with clean fill. The Navy determined that a TCRA was necessary around these buildings to prevent possible exposure to contaminants. Other constituents, such as antimony, arsenic, and copper, as well as organic compounds, such as dioxins and TPH, also were removed; however, these constituents were not detected above preliminary remediation goals (PRG) and were not determined to pose an unacceptable risk to human health or the environment (Tetra Tech 1999a).

The second removal action was conducted in the vicinity of Building 1133, which is within SWDA A&B, in November 1999. Because of the imminent residential occupation of the Mason Court area, which included Building 1133, the Navy conducted a TCRA of lead-contaminated soil. About 3,100 $yd^3$ of soil was excavated and replaced with clean fill. In conjunction with lead-contaminated soil, other constituents such as TPH and inorganic compounds such as aluminum and copper, also were removed. The other constituents were detected at concentrations that would not by themselves warrant a removal action or pose an unacceptable risk to human health or the environment (Tetra Tech 1999c).

The third removal was conducted in the area of Halyburton and Bigelow Courts in July 2000. Historical records and aerial photographs helped identify this section of Site 12 as the Former Storage Yard (FSY) area of concern (AOC). The investigation in the FSY in the spring of 2000 led to a decision to conduct a removal action for PCBs (and a small quantity of PAHs). This was performed as a TCRA during Summer 2000 in order to be completed before the opening of school in late August 2000. Most of the removal was in Halyburton Court, with additional removal on the eastern side of Bigelow Court and a small spot between Buildings 1411 and 1413 in Flounder Court. To date, this has been the largest removal on Site 12; about 11,300 $yd^3$ of contaminated soil were excavated and replaced with clean fill. Soils in the FSY AOC contained concentrations of PCBs in excess of the 1.0-mg/kg action level and PAHs in excess of the 0.620-mg/kg, benzo(a)pyrene (BAP) equivalent site-specific action level. The Site 12 boundary was expanded to include the FSY.

The fourth removal action was conducted in the areas of Buildings 1252, 1254, 1246, 1248, and 1413 in October and November 2001. These areas were identified during an investigation program conducted by International Technology Corporation (IT) for the Navy (IT 2002). The COCs near the Building 1254 area were PCBs in soil, and near the remaining buildings, elevated PAHs in soil were found to be present. During excavation of the PCB-contaminated soil near Building 1254, it was noted that the contaminated soil was discontinuous and fragmented and appeared to have been moved around by previous grading operations. The removal action was extended laterally until cleanup goals were met and verified by confirmation sampling.

In October 2000, the Navy met with DTSC and agreed to develop a plan for interim measures in the areas around the three known SWDAs (A&B, 1207/1209, and 1231/1233), also taking into account the detections at Buildings 1211 and 1235. Interim measures were to consist of fencing and signage of vacant known debris areas and additional trenching and sampling of occupied buildings outside of fenced areas to ensure that hazardous substances did not affect occupied areas. Vacant buildings within known SWDAs were fenced off in early January 2001. Interim trenching and sampling was conducted in March through May 2001. As a result of the sampling, an additional 12 backyards among Buildings 1213, 1235, and 1237 required interim-measure ground cover (sod or concrete pavers). The ground cover was necessary to prevent possible exposure by a resident to soil until a more permanent remedy is selected.

### 2.2.2 Previous Investigations

The Navy has conducted numerous investigations at Site 12 over the last several years. This section presents a chronological summary of site investigation activities.

**<u>1988</u>**

Site 12 was designated the "Old Bunker Area" in the 1988 preliminary assessment/site inspection (PA/SI) (Dames and Moore 1988). Site 12 was originally defined as the area primarily north of the elementary school, which is where the ammunition bunkers were located. No sampling was conducted for the PA/SI, but Site 12 was recommended for the RI phase because of the presence of housing and the potential for soil and groundwater contamination if the refuse was not completely removed during construction.

**1990 to 1997**

Because no PA/SI sampling was conducted and the housing was occupied, a preliminary risk assessment (PRA) of human health was conducted in 1991, prior to the initial RI sampling. The PRA was based on analytical results from grab samples of surface soil from common areas, including playgrounds and tot lots, throughout the housing area. No significant detections of hazardous substances were reported, and no further action was taken. During the RI, the site boundary was expanded to include a leg along the southwestern shoreline. The leg included an area south to Building 1306, but did not include the last three of the 1300-series buildings (1301, 1303, and 1305). The leg was added to account for a rubbish disposal area (later to be known as SWDA A&B) that was outside of the bunker area. None of the 200 residences of the 1400-series housing were included in this revised site boundary. The focus at that time was not on whether housing buildings were in or out of the site boundary but on what the boundary should be, based on the historical information known at that time.

**1999**

The spring 1999 removal action at Buildings 1207/1209 led to the identification of a mass of burn pit material in this area. The Navy conducted additional investigations at other locations where buried material might exist. Because the original direct-push borings at Buildings 1207/1209 provided little clue as to the quantity of burn pit material, the NAVSTA TI BRAC Cleanup Team (BCT) made a decision to switch from direct-push borings to trenching. Subsequent trenching during the summer of 1999 identified three additional areas impacted by debris (Area A; Area B, including Building 1133; and Area 1231/1233). A separate investigation also was conducted in Fall 1999, just outside of the Site 12 boundary, as it then existed, in an area designated as the FSY, which had not been investigated previously. The investigation was conducted with typical direct-push borings, because it targeted potential chemical releases from the FSY. At the time of the investigation, there was no historical information to indicate that any chemical releases had occurred and the BCT had little expectation that contamination was present, so it was primarily a due-diligence site investigation. However, the results revealed a significant release of PCBs and some elevated detections of PAHs, primarily in the Halyburton Court Area, but also extending into the Bigelow Court Area.

During the winter break in the 1999 school year, limited trenching was conducted in a portion of the TI Elementary School schoolyard, where an historical photograph showed an area of possible disturbed soil. Only a few items of trace debris were identified. No chemical sampling was conducted in accordance with the approach agreed upon by the BCT at that time. The TI Elementary School is bordered on three sides by the housing area.

**2000**

In early August 2000, a resident reported to DTSC that debris was apparent in the backyard at a shallow depth. As a result of discussions between the Navy and DTSC, the yard was "pothole" sampled. PCBs were detected at two locations in the backyard at concentrations above the PRG but less than the 1.0-mg/kg action level. In addition, some inert concrete and metal debris were observed. As a result of the sampling, the Navy decided to collect samples in the backyards of Buildings 1205 and 1211 in late August 2000. There were no significant detections in the backyards of Building 1205, but there were varied detections of lead, PCBs, and PAHs above the screening criteria in the four Building 1211 backyards that were sampled (two of the six backyards were not accessible and were not sampled). Based on discussions with DTSC and a meeting with the Building 1211 residents, it was decided to place an interim ground cover of sod in all of the Building1211 backyards slated for occupation.

In June 2000, the Navy collected soil gas samples from 70 locations within Site 12. The purpose of the shallow soil gas survey was to investigate the potential of volatile organic compound (VOC) and methane generation and migration within SWDA A&B and to determine the nature and extent of VOCs and methane suspected during field screening in previous intrusive investigations of Site 12. As a result of the investigation, it was determined that VOCs were present at concentrations that exceeded screening criteria in only one location, near Building 1323. However, methane was detected at numerous locations in the SWDAs as well as the Northpoint Drive and Gateview Avenue area. Further investigation, with the goal of determining the extent of contamination, was planned for 2001.

As a result of the 1999 investigation in the FSY, the Navy collected air samples from within the units of Building 1100 in Halyburton Court to monitor for the presence of PCBs. Building 1100 was the building closest to the highest PCB concentrations detected during the investigation. PCBs were detected in four units (1100A, B, C, and D). Further investigation of indoor air in all buildings within the FSY continued through the summer of 2002.

**2001**

The Navy conducted trenching and sampling at 11 buildings that were scheduled for leasing (Buildings 1117, 1246, 1248, 1252, 1254, 1401, 1408, 1410, 1411, 1412, and 1413). The Navy subsequently decided to include an additional 4 buildings (1101, 1103, 1105, and 1107) in the trenching and sampling program, because they were scheduled for future housing leases as well.

Trenching and sampling began in June 2001. The sampling results identified three additional hotspots: two were outside of any previously known area of contaminant detection (Buildings 1254, 1246, and 1248), and the third was adjacent to the PCB removal action in the FSY (Bigelow Court), which was beyond the area where the PCB release appeared to end (based on removal confirmation samples).

In May 2001, based on results from the June 2000 soil gas investigation, the Navy collected step-out soil gas samples in the SWDAs as well as the Northpoint Drive and Gateview Avenue area. The results of this investigation showed the extent of the VOC contamination near Building 1323 and limited the area of known methane contamination. Upon review of the data, it became apparent that methane detections correlated closely with natural gas pipelines in both the SWDAs and the Northpoint Drive and Gateview Avenue area. As a result, the Navy prepared a plan to inspect and cap the natural gas pipelines, where possible, and resample these locations.

**2002**

In January 2002, based on results from previous soil gas investigations, the Navy capped the natural gas pipeline in the SWDA, allowed any remaining gas in the pipe to dissipate, and then resampled locations along the line. The result of this investigation was that in the majority of the locations, methane was no longer present at concentrations exceeding the screening criterion. Two locations, near Buildings 1319 and 1321, continued to produce results exceeding the screening criterion. The extent of methane contamination in these areas is defined, and further action is being evaluated.

## 2.3 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

Based on the results of previous and current investigations, chemical- and solid-waste-contaminated soil has been identified in the four known SWDAs and in other areas of Site 12. In some cases, contaminated soil has been removed and the discussion below takes this into account.

The four known SWDAs were shown in Figures 1-2 through 1-6 as SWDAs A&B, 1207/1209, 1231/1233, and Bigelow Court. Solid waste, lead, PCB, and PAH sampling showed localized contamination in soil within the known SWDAs. The known SWDAs were identified from historical photographs as well as site investigation data. Although extensive metals sampling in soil was conducted throughout Site 12, high concentrations of lead, above the EPA PRG of 400 mg/kg, were located predominantly in identified SWDAs. Occasional concentrations of PAHs in excess of the BAP equivalent of 0.62 mg/kg were found in SWDAs 1231/1233, A&B, and Bigelow Court. The BAP equivalent method is described in Office of Environmental Health Hazard Assessment guidance (1999).

A series of figures included in Appendix A show the sporadic distribution of known contamination at different locations and depths throughout Site 12. These figures provide sampling locations and concentrations of lead, PCBs, and PAHs above action levels in soil from the ground surface to 2 feet bgs and from 2 to 4 feet bgs. As shown in the figures, contaminants that exceed action levels are located primarily within and adjacent to the known SWDAs and adjacent to prior removal action locations.

In areas of Site 12 outside of known SWDAs, test pit investigations have shown that solid wastes are scattered widely and with little correlation to areas of disposal. The heterogeneous nature of solid waste at Site 12, shown in Figure 1-7 and in Appendix B (photographs), was the result of early construction practices and disposal area operations on the island. Housing construction specifications dating from 1967 and 1968, shown in Appendix C, clearly note that the grading and mixing of waste material with soil throughout the site was accepted and practiced as a means of disposing of unwanted material. Filling, grading, and general earthwork occurring before and during construction of residential buildings had an effect on the nature and extent of solid waste at Site 12.

Outside of the known SWDAs, concentrations of lead, PCBs, and PAHs in soil do not follow any pattern associated with dispersal from a known source. Rather, sampled concentrations in soils above action levels generally occurred at random locations and were highly variable in concentration. A statistical analysis of the site data was conducted to develop a sampling design that would adequately characterize the soil within a backyard (see Appendix H). The main objectives of the sampling design were that: (1) the design should have a reasonable assurance of detecting some predetermined threshold level of debris (based on either the presence or absence of different types of debris or estimates of their densities), (2) the size of the largest unsampled area within a backyard be reasonably small (no greater than 4 feet, based on the diameter of an area of soil that a child could be exposed to), and (3) a sufficient number of samples be collected in order to be able to reliably compare the mean concentration of contaminants within individual backyards to a set of appropriate cleanup standards (CS). Based on the statistical analysis, a total of 144 samples from three depth intervals would be necessary to adequately characterize the soil in a backyard.

Pesticides generally were detected at random locations throughout Site 12 and do not appear to be associated with a specific source. Because of the apparent lack of a specific source of the pesticides at Site 12, a 95th percentile of the upper confidence limit on the arithmetic mean ($UCL_{95}$) was calculated for each constituent detected. The $UCL_{95}$ for each pesticide was less than the corresponding PRG (Tetra Tech 1999b).

## 2.4 RISK EVALUATION

A formal, quantitative risk assessment has not yet been performed for Site 12. The following three steps were completed to evaluate risk for the EE/CA:

(1) The Navy developed soil action levels for lead, PAHs, and PCBs in the common areas within the known SWDAs. The action levels were developed to aid in protecting against excessive exposure to chemicals in soil. The action levels will be used during excavation of the common areas to establish the lateral boundaries of the excavation. Action levels for soil in the back yards were not developed because the Navy has decided that a removal action will occur throughout every backyard.

(2) The Navy conducted a risk screening evaluation to assess the need for a removal action. Based on the risk screening results, the Navy concluded that a NTCRA was necessary to address contaminated soil remaining at known SWDAs (see Figures 1-2 to 1-6) and within all backyards at Site 12.

(3) The Navy conducted a qualitative risk evaluation to assess the protectiveness of alternatives such as removing soil and backfilling with clean soil vs. placement of a hard physical barrier. Additional details about the risk screening evaluations are presented in Sections 2.4.1 through 2.4.4.

### 2.4.1 Soil Action Levels for Lead, PAHs, and PCBs

Risk-based action levels were developed for lead, PAHs, and PCBs in soils within the common areas in the known SWDAs at Site 12. The Navy developed site-specific exposure parameters to develop site-specific action levels for soil in the common areas. The Site 12-specific action levels are summarized in the following table. A detailed description of the derivation of the action levels is presented in Appendix G.

| COC | Action level (mg/kg) | Basis | Health Endpoint |
|---|---|---|---|
| Lead | 400 | Region 9 PRG | Blood-lead level less than 10 µg/dL |
| PAHs (B[a]P equivalents) | 0.62 | Site-specific | Corresponds to a cancer risk of $4.2 \times 10^{-6}$. The hazard quotient less is than 0.1 |
| PCBs | 1.0 | ARAR | Corresponds to a cancer risk of $1.9 \times 10^{-6}$. The hazard quotient is 0.5. |

### 2.4.2 Risk Screening Evaluation

The Navy conducted a risk screening evaluation to assess the health effects associated with exposure to contaminated soil at Site 12. The evaluation included all of Site 12 (approximately 93 acres) and considered the heterogeneous distribution of soils contaminated with solid waste and chemicals. As discussed in Section 2.3, previous investigations at Site 12 showed that in areas outside the known SWDAs, contaminants were present at random locations at variable concentrations. That is, contamination within these areas did not appear to be associated with a specific source. Because the contamination did not originate from a specific source and was scattered from grading operations, a discernable spatial pattern was not present.

The initial screening-level assessment compared contaminant concentrations associated with individual sampling locations to EPA Region 9 residential PRGs (EPA 2000). PRGs are the concentrations of chemicals in soil that correspond to either a cancer risk of $1 \times 10^{-6}$ (for carcinogens) or a hazard index of 1 (for noncarcinogens), with the exception of lead. The PRG for lead corresponds to a blood-lead concentration of 10 micrograms per deciliter (µg/dL), the level of concern. Screening the sampling results, initially, against PRGs is a standard practice to identify potential areas of concern. The following chemicals were identified as COCs on the basis of these comparisons.

- Lead. Concentrations of lead in near-surface soil exceeded the PRG of 400 mg/kg for residential scenarios (EPA 2000) in areas of Site 12. The RI reports (PRC 1997; Tetra Tech 1999b), indicate that concentrations of lead in soil exceeded the PRG within and near known SWDAs at Site 12. In addition, several rounds of soil investigations and the recent interim-measures sampling results (IT 2002) have been conducted at Site 12; the results of these subsequent investigations also indicate that elevated concentrations of lead are present in and near the known SWDAs.

- PAHs and PCBs. A review of the analytical data (see Section 2.3) indicates that PAHs and PCBs are present in and near the known SWDAs in near-surface soils at concentrations above residential PRGs.

Subsequent investigation results showed that lead, PAHs and PCBs were also scattered by preconstruction grading in soil outside the SWDAs. Some limited disposal may also have occurred outside the SWDAs. These scattered substances are not located in one particular area, and the locations and concentrations of these substances do not occur in a clear pattern.

#### 2.4.3 Evaluation of the Protectiveness of a Soil Cover or Hard Physical Barrier

The Navy conducted a qualitative risk evaluation to assess the protectiveness of removing the top 2 feet of soil in the common areas and backfilling with 2 feet of clean soil. In the backyards, the Navy evaluated the protectiveness of removing the top 2 feet of soil, the top 4 feet of soil, and the placement of a hard physical barrier at the ground surface, all of which are components of the remedial alternatives described in Section 4.0. The qualitative risk evaluation is described in the following sections.

##### 2.4.3.1 Potential Receptors

Potential receptors at Site 12 were identified as residents (adults and children) in occupied housing units, future residents (adults and children), recreational users of the common areas, and workers installing or servicing underground utilities. Residents might be exposed to the contaminated soil or encounter physical hazards from solid waste in the backyards of the housing units or in common areas covered by grass and landscaping. Utility workers might encounter contaminated soil or solid waste while installing or servicing underground utilities.

##### 2.4.3.2 Exposure Pathways

Exposure pathways describe the mechanisms by which exposure to chemicals can occur. According to EPA (1989), an exposure pathway is complete if there is: (1) a source and mechanism of release (such as hazardous materials being disposed of on the ground), (2) a retention or transport medium (such as soil), (3) a point of human contact with the contaminated medium (such as contaminated soil in the backyards or common areas), and (4) an exposure route (such as ingestion) by which contact can occur. All four of these components must be present for an exposure pathway to be considered complete and for exposure to COCs to occur.

If any component is missing, the pathway is considered to be incomplete and exposure to COCs does not occur.

The expected uses of backyards and common areas include light recreational activities (as described below) by residents and visitors and as walking paths between apartment units. Light recreational activities for children include unstructured play and informal games such as catch, Frisbee, and soccer. Expected activities of adults include participating in children's games, jogging, and supervising young children. The child and adult residents participating in these activities might be exposed to soil through the following pathways:

- Incidental ingestion of soil
- Dermal contact with soil
- Inhalation of particulates released from soil to ambient air

Soils at the immediate surface (within the top 1 to 2 inches) could be contacted through these exposure pathways. For the soil ingestion pathway, the primary mechanism of exposure is through the transfer of soil on the hands to the mouth (EPA 1997). During recreational activities, the hands would contact only soils at the immediate surface. Similarly, for the dermal contact pathway, hands and other body parts would contact only soils at the surface. Finally, the underlying basis of the particulate emission factor used to estimate release of soil particles to ambient air is that fugitive dusts are emitted only from soil particles present in the top 1 to 2 inches of soil and subject to wind erosion or generated as a result of human activities (Cowherd and Others 1985). The mechanisms of soil contact in these pathways are such that only soil at the immediate surface would be contacted.

Two potential exposure pathways that are sometimes associated with residential exposure to soils are inhalation of VOCs released from soils to ambient air and ingestion of homegrown produce. Both potential pathways were considered to be incomplete for Site 12. Inhalation of VOCs released from soil was considered to be incomplete because of the low volatility of PAHs and PCBs (inorganic lead is not volatile) and the rapid dilution and dispersion of any chemicals released to outdoor air. (The physical-chemical properties of the COCs are discussed in the following section.) In backyards, the surface would either be capped or excavated so that ingestion of homegrown produce also is considered an incomplete exposure pathway.

### 2.4.4 Fate and Transport Properties of the Chemicals of Concern

Information on the physical and chemical properties that affect the mobility of Site 12 COCs is summarized below. Only information that generally pertains to the proposed remedies is discussed.

- Lead. Lead in soil is generally insoluble, except under acidic conditions. Groundwater conditions at Site 12 are not acidic, and lead has not been detected in groundwater during groundwater monitoring events at Site 12 (Tetra Tech 2002). In addition to having low solubility, lead binds electrostatically to soil and is strongly sorbed to organic matter in soil, limiting its transport in soil (Fetter 1993). Based on this information, lead at Site 12 is expected to be immobile in undisturbed soils. Lead could be mobilized through wind erosion or surface water transport of affected soil.

- PAHs. PAHs as a group generally have low water solubility and sorb strongly to organic carbon in soil and sediment. PAHs are classified as immobile compounds (Fetter 1988). PAHs have not been detected in groundwater during groundwater monitoring events at Site 12 (Tetra Tech 2002). Although PAHs generally occur as a complex mixture of compounds, the properties that control their fate and transport are generally related to their molecular weights. Although PAHs with the highest molecular weights are the most toxic of the group, they are also the least soluble and have the highest soil sorption coefficients. Because PAHs are strongly sorbed to soil and are essentially insoluble in water, they are mobilized only through wind erosion or surface water transport of the affected soil. As a class, PAHs have low vapor pressures, with volatility tending to increase with decreasing molecular weight. Sorption is the primary process governing the fate of PAHs released to soil, so that only very low levels of PAHs are released through volatilization from soils to ambient (outdoor) air (Agency for Toxic Substances and Disease Registry [ATSDR] 1995).

- PCBs. PCBs are extremely stable compounds that have high thermal stability and resist degradation in both acidic and alkaline environments. Like PAHs, PCBs sorb strongly to organic carbon in soil and sediment and have very low solubility in water. PCBs also are classified as immobile compounds (Fetter 1988). PCBs have not been detected in groundwater during historic and recent groundwater monitoring events in Site 12 (Tetra Tech 2002). PCBs are strongly sorbed to soil and are essentially insoluble in water. These characteristics result in a possibility that PCBs could be mobilized through wind erosion or surface water transport of the affected soil. As a class, PCBs have low vapor pressures, with volatility tending to increase with decreasing levels of chlorination. Sorption is the primary process governing the fate of PCB congeners released to soil, so that only very low levels of PCBs are released through volatization from soils to ambient (outdoor) air (ATSDR 2000).

### 2.4.5 Ecological Risk Evaluation

Family housing units and pavement cover about 60 percent of Site 12. Landscaped lawns cover the remaining 40 percent of the site. Lawns, in general, provide poor habitat, and landscaped areas are planted with largely non-native species, to which few animals have adapted. Disturbance from vehicular traffic and general human presence also reduces the quality of the habitat to wildlife species at this site.

Because of the low-quality habitat of the site, few, if any, receptors of concern use the area. Receptors using this area, such as pigeons, European starlings, house sparrows, and house mice, are not native to the United States and are not receptors of concern. Avian receptors native to California potentially using Site 12 are mourning dove (*Zenaida macroura*), house finch (*Carpodacus mexicanus*), northern mockingbird (*Mimus polyglottos*), and Stellar's jay (*Cyanocitta stelleri*) (PRC 1996e). Small mammals native to California that may occur are the ground squirrel (*Spermophilus beecheyi*), deer mouse (*Peromyscus maniculatus*), and bats (*Order Chiroptera*).

Potential terrestrial exposure pathways include dermal contact with, and indirect ingestion of, contaminated soil. Receptors of concern that have been identified at other portions of NAVSTA TI, the deer mouse (*Peromyscus maniculatus*), American kestrel (*Falco sparverius*), and peregrine falcon (*Falco peregrinus anatum*), have not been observed to spend time at Site 12 and are not likely to use the poor habitat offered by the site. Although the pathways are expected to be complete in landscaped areas, receptors of concern have not been observed to frequent the area. Adequate habitat is available for receptors of concern within the larger and higher-quality habitat in the undeveloped areas of YBI.

Lead, PCBs, and PAHs may enter the food chain through direct contact and ingestion of terrestrial fauna by foraging animals or plant uptake and subsequent ingestion by wildlife. Although lead is toxic by ingestion and accumulates within animal tissues, the low quality of wildlife habitat at Site 12 makes it unlikely that any terrestrial receptors would be threatened by contamination. Lead, PCBs, and PAHs are not considered contaminants that would have a negative ecological impact at the site.

# 3.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

This section discusses: (1) the statutory framework, (2) determination of removal scope, (3) determination of removal schedule, (4) applicable or relevant and appropriate requirements (ARAR), and (5) the removal action objectives (RAO) for the planned removal action at Site 12.

## 3.1 STATUTORY FRAMEWORK

This removal action is being taken pursuant to CERCLA and the NCP, under the delegated authority of the Office of the President of the United States, by Executive Order (EO) 12580. This EO provides the Navy with authorization to conduct removal actions. The removal action is nontime–critical, because no immediate risk exists to human health. The public comment period for this EE/CA will provide the opportunity for public input to the cleanup process.

The Navy is the lead agency for the removal action. As the lead agency, the Navy has the authority to select the removal action methodology, while considering public and regulatory participation. The Naval Facilities Engineering Command, Southwest Division, is the regional manager of the Navy's CERCLA program.

This EE/CA complies with the requirements of CERCLA and the Superfund Amendment and Reauthorization Act of 1986; the NCP at 40 CFR Part 300; Defense Environmental Restoration Program at Title 10 of U.S. Code Section 2701, and subsequent sections; and EO 12580. This EE/CA is being prepared under 40 CFR Part 300.415(b)(2). In addition, the Navy will conduct the removal action in compliance with CERCLA.

Chemical- and solid-waste contaminated soil at Site 12 potentially contains lead, PCBs, PAHs (chemicals), and debris (solid waste). Within the known SWDAs at Site 12, lead, PCBs, and PAHs were detected at levels exceeding site-specific cleanup criteria. The debris found in the various test pits throughout Site 12 consisted of glass, metal, and wood.

Residential exposure to chemical-containing soils exposed by erosion, excavation, and other activities by occupants in common areas and backyards could create a potential hazard. The proposed removal action is intended to reduce the threat of human exposure to chemical- and solid-waste-contaminated soil at Site 12.

The proposed removal action will address the threats posed by the following conditions at Site 12, pursuant to the NCP:

> **Actual or potential exposure of nearby human populations to hazardous substances, pollutants, or contaminants (40 CFR Part 300.415(b)(2)i).** People residing or working at the site may be exposed through excavation, erosion, or other intrusive activities, to soil contaminated with lead, PCBs, and PAHs through direct contact or incidental ingestion. Lead, PCBs, and PAHs are hazardous substances known to pose a threat to human health.

**High levels of hazardous substances, pollutants, or contaminants in soil largely at or near the surface that may migrate (40 CFR Part 300.415(b)(2)iv).** Lead, PCB, and PAH concentrations exceeding residential PRGs and site-specific action levels (EPA 1999) are present in soil at and near the surface of the site. This lead, PCB, and PAH contamination may adversely affect public health and welfare if it is not removed or isolated.

## 3.2 DETERMINATION OF REMOVAL SCOPE

The removal action is intended to restrict the pathway for residential human exposure to hazardous substances in soil at Site 12. This action is intended to serve as the final removal action for residential human health risks associated with the known SWDAs and backyards within Site 12. The common areas outside of the known SWDAs are excluded from this EE/CA and will be further investigated as part of the IR Program for Site 12. The RI/FS process will evaluate the results of the further investigation, and the investigation will provide the basis for evaluating potential human health risks and developing any necessary remedial actions for the common areas.

## 3.3 DETERMINATION OF REMOVAL SCHEDULE

This EE/CA identifies and evaluates removal alternatives for Site 12. This EE/CA will be available for public review and comment for 30 days. The Navy will review the comments and, where appropriate, incorporate responses to public and regulatory agency comments into the action memorandum.

It is anticipated that the removal action and site restoration activities will be completed within 12 to 18 months after award of the removal contract.

## 3.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The NCP states, "Removal actions . . . shall to the extent practicable considering the exigencies of the situation, attain applicable or relevant and appropriate requirements under Federal environmental or state environmental or facility citing laws" (40 CFR Part 300.415[i]).

An evaluation of ARARs for this EE/CA can be found in Appendix E. The following sections provide an overview of the ARARs process and a summary of those ARARs that potentially affect RAOs and alternatives.

### 3.4.1 Applicable or Relevant and Appropriate Requirements Overview

The identification of ARARs is a site-specific determination and involves a two-part analysis. First, a determination is made about whether a given requirement is applicable. Second, if it is not applicable, a determination is made about whether it is relevant and appropriate. A requirement is deemed applicable if the specific terms of the law or regulation directly address the COC, remedial action, or place involved at the site. If the jurisdictional prerequisites of the law or regulation are not met, a legal requirement may nonetheless be relevant and appropriate if the site's circumstances are sufficiently similar to circumstances in which the law otherwise applies and it is well suited to site conditions.

A requirement must be substantive to constitute an ARAR for activities conducted on site. Procedural or administrative requirements, such as permits and reporting requirements, are not ARARs.

As the lead federal agency, the Navy has the primary responsibility for identification of federal ARARs at TI. As the lead state agency, DTSC has the responsibility for identifying state ARARs. For a state requirement to qualify as an ARAR, the requirement must be: (1) a state law, (2) promulgated, (3) a substantive requirement, (4) from an environmental or facility siting law, (5) more stringent than the federal requirement, (6) identified in a timely manner, and (7) consistently applied. ARARs and to-be-considered (TBC) criteria are generally divided into three categories: chemical-, location-, and action-specific. TBC means that an environmental standard, requirement, criteria, or limitation is not legally applicable or relevant and appropriate, but is nevertheless useful information "TBC" in developing remedial alternatives. ARARs and TBCs affecting RAOs and alternatives are discussed in the following section.

### 3.4.2 Applicable or Relevant and Appropriate Requirements and To Be Considered Criteria Affecting Removal Action Objectives and Alternatives

Chemical-specific ARARs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in establishment of numerical cleanup values. These values establish the acceptable amount or concentration of a chemical found in, or discharged to, the ambient environment that is protective of human health or ecological receptors. The only potential chemical-specific ARARs are those requirements applicable to identification and land disposal of hazardous waste. If the removal action generates contaminated media that meets the definition of a Resource Conservation and Recovery Act (RCRA) hazardous waste, then RCRA waste management requirements may be applicable. The RCRA requirements at 22 California Code of Regulations (CCR) Sections 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100 are potential ARARs, because they define RCRA hazardous waste.

The Navy identified potential chemical-specific TBCs for lead for human receptors. The EPA Region 9 risk-based PRG for lead in residential soil, 400 mg/kg (EPA 1999), has been accepted by the Navy and DTSC as the cleanup goal for lead concentrations for prior Site 12 removal actions and will be used in this removal action.

Location-specific ARARs are restrictions placed on concentrations of hazardous substances or the conduct of activities as a result of the characteristics of the site or its immediate environment. The only location-specific ARAR identified for this removal action is the Coastal Zone Management Act.

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities selected and suggest how a selected removal alternative should be achieved. These action-specific requirements do not, in themselves, determine the removal alternative; rather, they indicate how a selected alternative must be conducted. Therefore, because action-specific ARARs depend on the action selected, they are identified after an alternative has been selected.

For excavation, the following requirements may be action-specific ARARs. If based on the hazardous waste determination under the federal chemical-specific ARARs discussion, waste are determined to be hazardous, the substantive requirements of 22 CCR Section 66262.34 (pertaining to hazardous waste accumulation) would be applicable. These requirements also may be relevant and appropriate if the waste does not meet the definition of a hazardous waste, but is similar to a RCRA waste. Any on-site management activities for hazardous waste generated by the removal action must meet the appropriate, substantive RCRA requirements codified in 22 CCR, Division 4.5, Chapter 14. However, as long as excavated material remains inside of the area of contamination, the material is not newly generated and would not be subject to RCRA generator, treatment, or other waste management requirements. If excavated material is moved outside of the area of contamination, the substantive RCRA requirements of 22 CCR for managing hazardous waste (including land disposal restrictions) would be applicable. Bay Area Air Quality Management District (BAAQMD) Regulations 6-301, 6-302, and 6-305 and Regulation 8, Rule 40, which specify standards for particulates and visible emissions for excavations, are potential ARARs for excavation activities. In addition, Regulation 8, Rule 40 sets forth standards for maintaining, covering, and stockpiling soil and is an ARAR.

National Pollutant Discharge Elimination System (NPDES) Permit Requirements. The State Water Resources Control Board and the Regional Water Resources Control Board can issue general permits in accordance with the Clean Water Act for discharges to surface water. CERCLA response actions are not subject to permit requirements as provided under CERCLA Section 121(e) (42 U.S.C.Section 9621[e]). The Navy will comply with the substantive effluent limitations of appropriate NPDES requirements. Therefore the substantive provisions of requirements under NPDES are TBCs for this response action.

Action-specific ARARs for capping of backyards include portions of 27 CCR that relate to intermediate cover of SWDAs (27 CCR Section 20700(a)-(d)); dust control (27 CCR Section 20800); drainage (27 CCR Section 20820(a)(1)-(3)); litter (27 CCR 20830); gas (27 CCR Section 20919); final cover (27 CCR Section 21140(a)-(c)(1)-(3)); final grading (27 CCR Section 21142(a)-(b)(1)-(2)); slope stability (27 CCR Section 21145(a)-(b)); postclosure drainage (27 CCR Section 21150(a)-(c)); and postclosure land use (27 CCR Section 21180(a)-(c)).

## 3.5 REMOVAL ACTION OBJECTIVES

RAOs are site-specific qualitative or quantitative goals that define the extent of cleanup required for a removal action. Based on CERCLA and the NCP, RAOs are as follows:

- Promote overall protection of human health and the environment.
- Restrict the potential for a resident to contact chemical- or solid-waste-contaminated soil near the ground surface within Site 12.

For this Site 12 EE/CA, the following criteria are considered to be action levels for excavation of common areas within known SWDAs:

- Lead – the EPA Region 9 risk-based PRG for lead in residential soil (400 mg/kg) will be used as the action level. The EPA Region 9 risk-based PRG for lead in residential soil (400 mg/kg) has been accepted by the Navy and DTSC as the preliminary cleanup goal for average lead concentrations for previous Site 12 removal actions.
- PCBs – concentration in soil of 1 mg/kg (site-specific criterion)
- PAHs – concentration in soil at the BAP equivalent concentration of 0.62 mg/kg (site-specific criterion)
- Solid-waste-contaminated soil – visual observations will be used to verify that solid-waste-contaminated soil is removed laterally.

## 4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Based on the objectives presented in Section 3.5, twelve alternatives have been developed for the removal action at Site 12. For the backyards, the alternatives generally fall into three categories; capping, excavation, and investigation followed by an action if necessary. For the common areas within the known SWDAs, excavation was the only alternative evaluated.

Beginning with this section, the EE/CA is divided into two parts, corresponding to the following areas of Site 12: (1) the known SWDAs and (2) the backyards outside of the known SWDAs. Selection and evaluation of the alternatives for each part are conducted independently. The following tables list the removal action areas addressed by each group of alternatives.

### Areas Addressed By Each Engineering Evaluation/Cost Analysis Alternative

| EE/CA Alternatives | Within Known Solid Waste Disposal Areas | |
|---|---|---|
| | Backyards | Common Areas |
| 1A, 2A, 3A, and 4A | Addressed | Addressed |

| EE/CA Alternatives | Outside of Known Solid Waste Disposal Areas | |
|---|---|---|
| | Backyards | Common Areas |
| 1B, 2B, 3B, 4B, 5B, 6B, 7B, and 8B | Addressed | Not addressed, but part of the remedial investigation/feasibility study program |

Alternatives 1A through 4A address common and backyard areas of the known SWDAs only. For the remainder of Site 12, outside of the known SWDAs, Alternatives 1B through 8B were developed to address potential risks in backyards.

Potential risks associated with common areas outside of the known SWDAs are not addressed in this EE/CA and will be further investigated as part of the RI program for Site 12. The results of the further investigation will provide the basis for evaluating potential human health risks and developing any necessary remedial actions for these areas.

Because many of the alternatives include common components (excavation, off-site disposal, restoration, and postclosure monitoring), the common components are discussed once before the discussion of specific alternatives. If portions of these components vary from alternative to alternative, the variance is discussed in the analysis of each alternative.

The 12 alternatives are described in the following sections and are evaluated based on their effectiveness, implementability, and cost. To evaluate effectiveness, each alternative is evaluated against five criteria (40 CFR Part 300.430): (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, or volume; and (5) short-term effectiveness. Evaluation of the implementability of each alternative considers the technical feasibility and commercial availability of the remedy. Public and regulatory (Cal/EPA) acceptance will be evaluated in an action memorandum following the public comment period.

Cost opinions for each removal action, including direct and indirect costs, were completed using the R.S. Means Company, Inc., environmental remediation cost data estimating books (2000a, 2000b). The cost opinion was based upon estimates for direct capital costs and indirect costs (markups). Annual operations and maintenance (O&M) costs for a 30-year period were included for each of the alternatives. Direct capital costs include labor, equipment, material, and waste disposal costs. Indirect costs include construction management staff, office overhead, general and administration, home office expenses, design, administrative costs, insurance, contingency allowances, and profit. The accuracy goal of the cost opinion is plus 50 to minus 30 percent.

## 4.1 BACKYARDS AND COMMON AREAS WITHIN KNOWN SOLID WASTE DISPOSAL AREAS

Common areas to be addressed in the removal action include about 3 acres of landscaped and open areas between and around the buildings. In addition, 60 backyards are included in the planned removal action for this area. Figures 1-2 through 1-6 showed these areas. Excavation of common areas, off-site disposal of excavated material, site restoration, backfill, and postclosure monitoring are common components to all alternatives in the known SWDAs. Common components are discussed separately in the following sections. Site-specific details of these components are discussed in the sections on each individual alternative.

### Excavation

Initially, nearby residents would be notified of the planned excavation and the site would be secured with temporary fencing. Pre-excavation grades and conditions would be documented, and underground utility clearance surveying would be conducted. In addition, the contractor would set up an exclusion zone, decontamination area, and general work areas for the excavation, hauling, loading, and weighing of the soil and solid waste.

The Navy is proposing to remove the top 2 feet of soil in common areas and backfill excavated areas with clean soil. As part of this alternative, interim restrictions would be implemented to address excavated soils removed during future intrusive activities that could occur in common areas (for example, during repair of utility lines), and appropriate mechanisms would be put in place to prohibit soil-intrusive activities such as digging or gardening below depths of 2 feet by residents. Ultimately, institutional controls (IC) would be necessary to prevent long-term exposure to underlying soil in common areas. A 2-foot cover for common areas (combined with ICs) was identified as being protective of human health on the basis of a qualitative risk evaluation (see Section 2.4) that considered the potential exposure pathways identified for child and adult receptors exposed to soils and the fate and transport properties of the COCs. Placement of 2 feet of clean soil cover over contaminated soils is protective of human health, as long as the following two conditions are met: (1) the soil cover remains uncontaminated and (2) remaining contaminated subsurface soils (at depths greater than 2 feet) are not brought to the surface. These conditions can be maintained by ensuring that residents are prohibited from engaging in any type of activity that would involve disturbance of more than the first few inches of soil. Also, a visible, geotextile marker would be placed at a depth of 2 feet. Interim restrictions, followed by ICs, would be in place to address excavated soils removed during necessary maintenance activities associated with landscaping or maintenance of the areas (for example, utility maintenance).

The thickness of the protective layer also depends on the applicable purposes of the protective layer. For the common areas in Site 12, the reasonable thickness is 2 feet, based on the following purposes of the protective layer as identified in federal (40 CFR Part 258) and state requirements (27 CCR Section 21140):

1. Prevent Erosion. A minimum of 6 inches of soil is needed to maintain plant growth and impede water and wind erosion.
2. Consider the Unique Characteristics of Small Communities. At TI, residents use common areas for recreational purposes. A 6-inch layer of soil equates to many of the normal gardening and maintenance activities associated with plant growth in common areas. Excavations beyond 6 inches, to a depth of 2 feet, are possible for planting shrubs and other plants. Excavations beyond 2 feet are possible for larger trees or other intrusive activities such as laying pipes and other utilities underground. Excavations beyond 2 feet in depth and corresponding risk scenarios will be addressed as part of the final remedial action in the RI/FS program for Site 12.
3. Be Protective of Human Health and the Environment. The minimum vegetative soil/top layer recommended by EPA is 2 feet for landfills and surface impoundments (1989).

Based on the above considerations, a 2-foot-thick soil cover would provide adequate long-term protection for a resident or other recreational user.

The estimated lateral extent of the common area excavation for each known SWDA was shown on Figures 1-2 through 1-6. The actual lateral extent of the common area excavation would be set by the presence of chemical and physical hazards in the sidewalls, as determined by confirmation sampling. The vertical extent of excavation in the common areas would be 2 feet bgs. Most underground utilities are deeper than 2 feet bgs; therefore, interference with utilities is expected to be minimal during excavation of common areas. Measures would be implemented to ensure that contact with utilities is avoided. Excavated material would consist of solid waste, chemically contaminated soil, and clean soil. Excavation near buildings or structure foundations (residential building foundations are shallow systems) would be sloped away from the foundations (1:1) to prevent loss of foundation support.

Removal areas would be excavated mechanically using standard construction equipment (such as excavators). In common areas, screening-level sampling would be conducted to assess whether additional lateral excavation is required. After excavations are complete, final confirmation sidewall samples would be collected and analyzed to verify adequate soil removal. Confirmation sampling and inspection would be conducted in accordance with the construction oversight work plan. No confirmation sampling is planned for work occurring in backyards, because each entire backyard would be either capped or excavated.

#### Off-site Disposal

Excavated soil would be sampled and analyzed to determine its waste classification. Excavated material then would be loaded and hauled to a permitted off-site disposal facility, in accordance with the EPA offsite disposal policy.

#### Protective Layer (Backfill) and Site Restoration

For common areas and backyard alternatives that involve excavation and off-site disposal of contaminated soil (Alternatives 3A and 4A), a geotextile fabric and a protective layer of imported clean backfill would be placed over the top of soil remaining in the excavation to prevent direct contact by residents. Backfilling would occur after confirmation sampling has been conducted in the common area excavation. Imported fill would be properly compacted. After the excavation has been backfilled, the area would be revegetated and fences would be replaced.

#### Postclosure Monitoring of Land Use and Drainage and Erosion Control

For all alternatives, O&M and postclosure monitoring has been included to account for ongoing maintenance of drainage and erosion control topographical features of the sites and preparation of a status report every 5 years summarizing possible changes at Site 12. For purposes of the cost opinion for this EE/CA, the monitoring period was assumed to be 30 years, a possible lifetime for existing housing units within Site 12. The actual monitoring period would be developed in the RI/FS and record of decision for Site 12.

### 4.1.1 Alternative 1A: Capping All Backyards with Poured-in-place Concrete and Excavation of Common Areas

A description of Alternative 1A and an evaluation of its effectiveness, implementability, and cost are provided in the following sections.

#### Description

Alternative 1A is illustrated in Figure 4-1. Major components of this alternative would be as follows:

1. Excavate solid waste and soil in common areas to a depth of 2 feet bgs.
2. Cap backyards with a poured-in-place concrete slab.

3. Backfill excavated areas with imported material and perform site restoration.
4. Dispose of chemical- and solid-waste-contaminated soil at a permitted off-site facility.
5. Conduct postclosure monitoring of land use and O&M, including drainage and erosion control.

The concrete cap construction would occur in all backyards within the known SWDAs. Preparation for these caps would involve; removing existing patios (if necessary), clearing; excavating topsoil; placing replacement subgrade soil; and grading the surface. The entire backyard would be capped with a 4-inch-thick, mesh-reinforced concrete slab. The slab would be sloped to drain storm water away from buildings. Backyard restoration would include installation of wood fencing that was removed that is similar to the original wood fence.

The common area excavation is the same for all three alternatives for the known SWDAs and was discussed in Section 4.1.

**Effectiveness**

Each alternative is evaluated against five criteria: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, or volume through treatment; and (5) short-term effectiveness. Each of these criteria is discussed in the following paragraphs.

**Overall Protection of Human Health and the Environment**

Because residential exposure pathways to contaminants in soil are through direct contact, ingestion, and dust inhalation, construction of a poured-in-place concrete cap covering the entire backyard would prevent long-term residential exposure to possible contaminants in soil. The concrete would provide a durable barrier to underlying contaminants. The concrete cap also would prevent erosion. As with the soil cover in common areas, restrictions ensuring that residents are prohibited from engaging in any type of activity that would involve disturbance of the cap would be needed. In addition, ICs would be needed to address excavated soils removed during necessary maintenance activities (for example, utility maintenance).

**Compliance with ARARs**

This alternative would comply with identified ARARs.

This alternative, as with all alternatives involving soil excavation, would comply with chemical-specific ARARs for determining whether excavated materials contain hazardous waste, as discussed in Appendix E. In most cases, material found to be hazardous would be stored within the area of contamination before off-site disposal and therefore would not be subject to RCRA hazardous waste management requirements. If hazardous material cannot be stored within the area of contamination, it will be stored in compliance with RCRA hazardous waste management requirements. Alternatives must comply with ARARs identified for on-site actions only. Off-site disposal must comply with all applicable requirements, including, as appropriate, Department of Transportation requirements at Title 49 of CFR Part 171; however, because off-site disposal is not an on-site action, applicable requirements are not addressed as ARARs.

Off-site disposal of contaminated soil would be consistent with the San Francisco Bay Conservation and Development Commission Bay Plan (1968); therefore, all alternatives would comply with location-specific ARARs. All alternatives also would comply with BAAQMD regulations.

All evaluated alternatives would comply with action-specific ARARs for monitoring changes in postclosure land use and for designing and maintaining drainage and erosion control systems that prevent public contact with solid waste remaining in the known SWDAs and residential backyards. As applicable, each alternative assumes annual inspections for changes in land use and annual inspections of capped surfaces. Each alternative also assumes annual repairs of about 10 percent of the vegetative cover and about 10 percent of the paved surfaces at 10-year intervals.

## Long-term Effectiveness and Permanence

Factors evaluated under long-term effectiveness and permanence include: (1) the magnitude of residual risks and (2) the adequacy and reliability of controls. For known SWDAs, chemical- and solid-waste-contaminated soil would be permanently removed to a depth of 2 feet bgs from common areas and excavations would be backfilled with clean soil, so that no residual risk to future residents and workers would remain above 2 feet bgs. The long-term adequacy and reliability of controls above 2 feet bgs would depend on the controls of the off-site disposal facility.

Construction and maintenance of a concrete cap would provide adequate long-term protection to a resident. Any remaining chemical- and solid-waste-contaminated soil is not expected to degrade significantly with time. Long-term adequacy and reliability requirements of the soil cover and backyard cap would be set as ICs and maintained as long as residents occupy the area. The concrete cap would be low-maintenance and would be reliable in providing long-term protection to a resident.

## Reduction of Toxicity, Mobility, or Volume Through Treatment

Implementation of this alternative would not reduce the volume or toxicity of chemicals and solid waste present in excavated soil; however, the on-site volume of contaminated soil would be reduced. This alternative would rely on engineering controls of the permitted, off-site disposal facility to limit mobility of excavated chemicals and solid waste. This alternative also would rely on the soil cover and backyard cap and restrictions to limit penetration into the remaining solid waste. By limiting penetration by residents, the potential to mobilize and move chemicals and solid waste left on site would be limited.

## Short-term Effectiveness

Three factors are considered when assessing short-term effectiveness: (1) protection of the community and workers during removal actions, (2) environmental impacts resulting from construction and implementation of the alternative, and (3) time required to complete the removal action.

Although most of the buildings adjacent to common areas are currently unoccupied, in some cases, occupied buildings do occur where backyards would be capped and also occur adjacent to common areas that would be excavated. The community may face short-term risks during excavation and removal activities resulting from inhalation of fugitive dust and direct contact with excavated soil. The local community also may face additional short-term impacts resulting from increased truck traffic during excavation and backfilling and increased inconvenience in using backyards while excavations are open. These impacts could include noise, increased traffic, and temporary disruption of utility services. Trucks would be decontaminated before they leave controlled areas to avoid spreading contamination off site. Contact with exposed utilities would be avoided.

Measures would be taken during excavation, staging, and loading of contaminated soil to reduce and control short-term risks. Risks would be minimized through use of dust suppression measures (water and physical barriers) and prevention of nonauthorized access to work areas. In addition, appropriate equipment decontamination procedures would be used to prevent the unintentional transport of contaminated soil.

About 22 weeks would be required to mobilize necessary equipment, prepare the site for excavation, excavate chemical- and solid-waste-contaminated soil, install backyard capping, transport and dispose of excavated material off site, restore the site, and demobilize.

## Implementability

This alternative is evaluated against two criteria to determine its implementability: (1) technical feasibility and (2) commercial availability. Alternative 1A is technically easy to implement. This alternative would use standard construction methods to excavate chemical- and solid-waste-contaminated soil and to cap backyards. No excavation would occur below the water table, thereby avoiding any structural stability problems. After excavation and transportation of chemical- and solid-waste-contaminated soil and site restoration, O&M of the soil cover and backyard cap may be required. Contractors are readily available and have the equipment and specialists necessary to excavate chemical- and solid-waste-contaminated soil. The capacity of off-site disposal facilities is adequate to handle the volume of excavated soil.

## Cost

Details for the cost opinion for Alternative 1A are provided in Appendix F. The cost opinion for Alternative 1A is $4.4 million. Costs associated with this alternative include site preparation, excavation of about 10,000 $yd^3$ of soil and debris, installation of the poured-in-place concrete cap, confirmation sampling, transportation and disposal of excavated material, site restoration (backfill, fencing, and seeding), postclosure care, and O&M.

### 4.1.2 Alternative 2A: Capping all Backyards with Precast Concrete Pavers and Excavation of Common Areas

A description of Alternative 2A and an evaluation of its effectiveness, implementability, and cost are provided in the following sections. Excavation of common areas is the same for all three alternatives for the known SWDAs and was discussed in Section 4.1.

#### Description

Alternative 2A is illustrated in Figure 4-2. Major components of this alternative would be as follows:

1. Excavation of solid waste and soil in common areas to a depth of 2 feet bgs
2. Capping of backyards with precast concrete pavers
3. Backfilling of excavated areas with imported material and site restoration
4. Disposal of chemical- and solid-waste-contaminated soil at a permitted off-site facility
5. Postclosure monitoring of land use and O&M, including drainage and erosion control

Construction of concrete capping would occur in all backyards within the known SWDAs. Preparation would involve; removing existing patios (if necessary); clearing; excavating topsoil; placing replacement subgrade soil; and grading the surface to be capped. The entire backyard would be capped with precast concrete pavers. The pavers measure about 3 by 3 feet and weigh about 450 pounds each. The intent of using precast concrete pavers is to allow future access to underground utilities without demolishing the cap. In addition to the precast pavers, a poured-in-place concrete perimeter edge would be necessary to account for any irregularities in the backyard size or shape. The paver surface would be sloped to drain storm water away from buildings. Backyard restoration would include installation of new wood fencing that is similar to the original wood fence.

#### Effectiveness

Evaluation of this alternative for the five effectiveness criteria is discussed in the following paragraphs.

<u>**Overall Protection of Human Health and the Environment**</u>

Because exposure pathways for residents to contaminants in soil are through direct contact, ingestion, and dust inhalation, construction of a concrete paver cap covering the entire backyard would prevent long-term residential exposure to possible contaminants in soil. The concrete provides a durable barrier to underlying contaminants. The concrete paver cap also would prevent erosion. As with the soil cover in the common areas, restrictions would be needed to ensure that residents are prohibited from engaging in any type of activity that would involve disturbance of the paver cap. In addition, ICs would be needed to address excavated soils removed during necessary maintenance activities (for example, utility maintenance).

## Compliance with ARARs

This alternative would comply with ARARs identified and discussed in Section 4.1.1.

## Long-term Effectiveness and Permanence

Factors evaluated under long-term effectiveness and permanence include: (1) the magnitude of residual risks and (2) the adequacy and reliability of controls.

Construction and maintenance of a concrete cap would provide adequate long-term protection to residents. Any remaining chemical- and solid-waste-contaminated soil would not be expected to degrade significantly with time. Long-term adequacy and reliability requirements of the backyard cap would be set and maintained as long as residents occupy the area. The concrete cap would be low-maintenance and reliable in preventing exposure. Because the concrete cap would be constructed of individual segments or "pavers," the cap surface could be subject to differential settlement over the long term. Differential settlement could be prevented or minimized with proper subgrade compaction.

## Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would rely on the concrete cap and restrictions to limit penetration into the remaining solid waste below the cap. By limiting penetration by residents, the potential to mobilize and move chemicals and solid waste left on site would be limited.

## Short-term Effectiveness

Three factors are considered when assessing short-term effectiveness: (1) protection of the community during removal actions, (2) environmental impacts resulting from construction and implementation of the alternative, and (3) time required to complete the removal action.

Although most of the buildings adjacent to common areas are currently unoccupied, in some cases, occupied buildings occur where backyards would be capped and also occur adjacent to common areas that would be excavated. The community may face short-term risks during excavation and removal activities resulting from inhalation of fugitive dust and direct contact with excavated soil. The local community also may face additional short-term impacts resulting from increased truck traffic during excavation and backfilling, and increased inconvenience in using backyards while excavations are open. These impacts could include noise, increased traffic, and temporary disruption of utility services. Trucks would be decontaminated before they leave controlled areas to avoid spreading contamination off site. Contact with exposed utilities would be avoided.

Measures would be taken during excavation, staging, and loading of contaminated soil to reduce and control short-term risks. Risks would be minimized through use of dust suppression measures (water and physical barriers) and prevention of nonauthorized access to work areas. In addition, appropriate equipment decontamination procedures would be used to prevent the unintentional transport of contaminated soil.

About 22 weeks would be required to mobilize necessary equipment, prepare the site for excavation, excavate chemical- and solid-waste-contaminated soil, install backyard capping, transport and dispose of excavated material off site, restore the site, and demobilize.

#### Implementability

This alternative is evaluated against two criteria to determine its implementability: (1) technical feasibility and (2) commercial availability. Alternative 2A would be technically easy to implement. This alternative would use standard construction methods to excavate chemical- and solid-waste-contaminated soil and to cap backyards. No excavation would occur below the water table. After excavation and transportation of chemical- and solid-waste-contaminated soil and site restoration, O&M of the soil cover and backyard cap may be required. Contractors are readily available and have the equipment and specialists necessary to excavate chemical- and solid-waste-contaminated soil. The capacity of the off-site disposal facilities is adequate to handle the volume of excavated soil.

#### Cost

Details for the cost opinion for Alternative 2A are provided in Appendix F. The cost opinion for Alternative 2A is $4.6 million. Costs associated with this alternative include site preparation, excavation of about 10,000 $yd^3$ of soil and debris, installation of the precast concrete cap, confirmation sampling, transportation and disposal of excavated material, site restoration (backfill and seeding), and postclosure care.

### 4.1.3 Alternative 3A: Excavation of Backyards and Common Areas in Known Solid Waste Disposal Areas Only

A description of Alternative 3A and an evaluation of its effectiveness, implementability, and cost are provided in the following sections. Excavation of common areas is the same for all three alternatives for the known SWDAs and was discussed in Section 4.1.

#### Description

Alternative 3A is illustrated in Figure 4-3. Major components of this alternative would be as follows:

1. Excavate solid waste and soil in known SWDAs.
2. Backfill excavated areas with imported material and perform site restoration.
3. Dispose of chemical- and solid-waste-contaminated soil at a permitted off-site facility.
4. Conduct postclosure monitoring of land use and drainage and erosion control.

Excavation would occur in all backyards and common areas within the known SWDAs, except in driveways and other paved areas. Excavations would be advanced to a depth of 2 feet bgs in backyards to prevent direct contact with potential underlying hazardous substances and solid waste. The depth of excavation in backyards may require a minor amount of mechanical support or removal and replacement of underground utilities.

**Effectiveness**

Evaluation of this alternative for the five effectiveness criteria is discussed in the following paragraphs.

**Overall Protection of Human Health and the Environment**

This alternative would protect human health and the environment, because it would involve excavating and removing chemical- and solid-waste-contaminated soil to a depth of 2 feet bgs from backyards, thereby minimizing the potential for exposure to residents. Because most utilities exist below depths of 2 feet, ICs would be necessary to protect workers during utility maintenance.

**Compliance with ARARs**

This alternative would comply with all ARARs identified and discussed in Section 4.1.1.

**Long-term Effectiveness and Permanence**

Factors evaluated under long-term effectiveness and permanence include: (1) the magnitude of residual risks and (2) the adequacy and reliability of controls. Chemical- and solid-waste-contaminated soil would be permanently removed to a depth of 2 feet bgs from backyards, so no residual risk to future residents and workers would remain above a depth of 2 feet bgs in backyards. The long-term adequacy and reliability of controls for excavated material would depend on the controls of the off-site disposal facility.

**Reduction of Toxicity, Mobility, or Volume through Treatment**

Implementation of this alternative would not reduce the volume or toxicity of chemicals and solid waste present in excavated soil; however, the on-site volume of contaminated soil would be reduced. This alternative would rely on engineering controls of the permitted, off-site disposal facility to limit mobility of excavated chemicals and solid waste. This alternative also would rely on the soil cover and restrictions to limit penetration into the remaining solid waste. By limiting penetrations by residents, the potential to mobilize and move chemicals and solid waste left on site would be limited.

**Short-term Effectiveness**

The discussion about short-term effectiveness presented in Sections 4.1.1 and 4.1.2 for Alternatives 1A and 2A applies to Alternative 3A as well. However, the amount of excavation in Alternative 3A is greater than in Alternatives 1A and 2A; as a result, the potential for disturbances to occupants from noise, dust, trucking, excavation, and utility disruption is greater.

About 24 weeks would be required to mobilize necessary equipment, prepare the site for excavation, excavate chemical- and solid-waste-contaminated soil, transport and dispose of excavated material off site, restore the site, and demobilize.

**Implementability**

This alternative is evaluated against two criteria to determine its implementability: (1) technical feasibility and (2) commercial availability. Alternative 3A is technically easy to implement. This alternative would use standard construction methods to excavate chemical- and solid-waste-contaminated soil. No excavation would occur below the water table, and interference with most utilities would be avoided. After excavation and transportation of chemical- and solid-waste-contaminated soil and site restoration, O&M would be required to maintain the integrity of the soil cover. Contractors are readily available and have the equipment and specialists necessary to excavate chemical- and solid-waste-contaminated soil. The capacity of the off-site disposal facilities is adequate to handle the volume of excavated soil.

**Cost**

Details for the cost opinion for Alternative 3A are provided in Appendix F. The cost opinion for Alternative 3A is $4.6 million. Costs associated with this alternative include site preparation, excavation of about 11,600 $yd^3$ of soil and debris, confirmation sampling, transportation and disposal of excavated material, site restoration (backfill and seeding), and postclosure care.

### 4.1.4 Alternative 4A: Excavation of Backyards and Common Areas in Known Solid Waste Disposal Areas Only

A description of Alternative 4A and an evaluation of its effectiveness, implementability, and cost are provided in the following sections. Excavation of common areas is the same for all three alternatives for the known SWDAs and was discussed in Section 4.1.

**Description**

Alternative 4A is illustrated in Figure 4-4. Major components of this alternative would be as follows:

1. Excavation of solid waste and soil in known SWDAs
2. Backfilling of excavated areas with imported material and site restoration
3. Disposal of chemical- and solid-waste-contaminated soil at a permitted off-site facility
4. Postclosure monitoring of land use and drainage and erosion control

Excavation would occur in all backyards and common areas within the known SWDAs, except in driveways and other paved areas. Excavations would be advanced to a depth of 4 feet bgs in backyards to prevent direct contact with potential underlying hazardous substances and solid waste. The depth of excavation in the backyards may require a moderate amount of mechanical support or removal and replacement of underground utilities.

**Effectiveness**

Evaluation of this alternative for the five effectiveness criteria is discussed in the following paragraphs.

**Overall Protection of Human Health and the Environment**

This alternative would protect human health and the environment, because it would involve excavating and removing chemical- and solid-waste-contaminated soil to a depth of 4 feet bgs from backyards, thereby minimizing the potential for exposure to residents and future utility workers.

**Compliance with ARARs**

This alternative would comply with all ARARs identified and discussed in Section 4.1.1.

**Long-term Effectiveness and Permanence**

Factors evaluated under long-term effectiveness and permanence include: (1) the magnitude of residual risks and (2) the adequacy and reliability of controls. Chemical- and solid-waste-contaminated soil would be permanently removed to a depth of 4 feet bgs from backyards, so no residual risk to future residents and workers would remain above a depth of 4 feet bgs in backyards. The long-term adequacy and reliability of controls for excavated material would depend on the controls of the off-site disposal facility.

**Reduction of Toxicity, Mobility, or Volume through Treatment**

Implementation of this alternative would not reduce the volume or toxicity of chemicals and solid waste present in excavated soil; however, the on-site volume of contaminated soil would be reduced. This alternative would rely on engineering controls of the permitted off-site disposal facility to limit mobility of excavated chemicals and solid waste. This alternative also would rely on the soil cover and restrictions to limit penetration into the remaining solid waste. By limiting penetration by residents, the potential to mobilize and move chemicals and solid waste left on site would be limited.

### Short-term Effectiveness

The discussion about short-term effectiveness presented in Sections 4.1.1 and 4.1.2 for Alternatives 1A and 2A applies to Alternative 4A as well. However, the amount of excavation in Alternative 4A is greater than in Alternatives 1A, 2A, and 3A; as a result, the potential for disturbances to occupants from noise, dust, trucking, excavation, and utility disruption is greater. In addition, because some of the buildings are occupied where backyards are to be excavated, residents in those buildings may have to be relocated during the backyard work.

About 27 weeks would be required to mobilize necessary equipment, prepare the site for excavation, excavate chemical- and solid-waste-contaminated soil, transport and dispose of excavated material off site, restore the site, and demobilize.

### Implementability

This alternative is evaluated against two criteria to determine its implementability: (1) technical feasibility and (2) commercial availability. Alternative 4A is technically easy to implement. This alternative would use standard construction methods to excavate chemical- and solid-waste-contaminated soil. No excavation would occur below the water table. However, excavation will likely occur near buried utility lines and would be completed to the fullest extent practical with small equipment or by hand. Mechanical support to underground utilities during excavation may be necessary. After excavation and transportation of chemical- and solid-waste-contaminated soil and site restoration, O&M would be required to maintain the integrity of the soil cover. Contractors are readily available and have the equipment and specialists necessary to excavate chemical- and solid-waste-contaminated soil. The capacity of the off-site disposal facilities is adequate to handle the volume of excavated soil.

### Cost

Details for the cost opinion for Alternative 4A are provided in Appendix F. The cost opinion for Alternative 4A is \$5.3 million. The costs associated with this alternative include site preparation, excavation of about 13,700 $yd^3$ of soil and debris, confirmation sampling, transportation and disposal of excavated material, site restoration (backfill, fencing, and seeding), and postclosure care.

## 4.2 BACKYARDS OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS

The following eight alternatives apply only to backyards that are located outside of the known SWDAs. Backyards currently are fenced in the 1100-, 1200-, and 1300-series buildings. In addition, in order to prevent possible exposure in the 1400-series housing buildings backyards, removal action alternatives were considered for these backyards. Six hundred and eighty five (685) backyards are included in the following alternatives.

### 4.2.1 Alternative 1B: Capping All Backyards with Poured-in-place Concrete

**Description**

Alternative 1B is illustrated in Figure 4-5. Major components of this alternative would be as follows:

1. Capping backyards with a poured-in-place concrete slab
2. Disposal of chemical- and solid-waste-contaminated topsoil at a permitted off-site facility
3. Postclosure monitoring of land use and drainage and erosion control

Construction of concrete capping would occur in all backyards outside of the known SWDAs. Preparation would involve; removing existing patios (if necessary), clearing; excavating topsoil; placing replacement subgrade soil; and grading the surface to be capped. The entire backyard would be capped with a 4-inch-thick, mesh-reinforced, poured-in-place concrete slab. The slab would be sloped to drain storm water away from buildings. Backyard restoration would include installation of new wood fencing that is similar to the original wood fence.

**Effectiveness**

Evaluation of this alternative for the five effectiveness criteria is discussed in the following paragraphs.

**<u>Overall Protection of Human Health and the Environment</u>**

Because exposure pathways for residents to contaminants in soil are through direct contact, ingestion, and dust inhalation, construction of a poured-in-place concrete cap covering the entire backyard would prevent long-term residential exposure to possible contaminants in soil. The concrete provides a durable barrier to underlying contaminants. The concrete cap also would prevent erosion. Restrictions would be needed to ensure that residents would be prohibited from engaging in any type of activity that would involve disturbance of the cap. In addition, ICs would be needed to address excavated soils removed during necessary maintenance activities (for example, utility maintenance).

### Compliance with ARARs

This alternative would comply with ARARs identified and discussed in Section 4.1.1.

### Long-term Effectiveness and Permanence

Factors evaluated under long-term effectiveness and permanence include: (1) the magnitude of residual risks and (2) the adequacy and reliability of controls.

Construction and maintenance of a concrete cap would provide adequate long-term protection to a resident. Any remaining chemical- and solid-waste-contaminated soil is not expected to degrade significantly with time. Long-term adequacy and reliability requirements of the backyard cap would be set and maintained as long as residents occupy the area. The concrete cap would be low-maintenance and would be reliable in preventing exposure.

### Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would rely on the concrete cap and restrictions to limit penetration into the remaining solid waste below the cap. By limiting penetration by residents, the potential to mobilize and move chemicals and solid waste left on site would be limited. Reduction of toxicity or volume through treatment would not occur.

### Short-term Effectiveness

Three factors are considered when assessing short-term effectiveness: (1) protection of the community during removal actions, (2) environmental impacts resulting from construction and implementation of the alternative, and (3) time required to complete the removal action.

Most of the buildings where backyards would be capped are occupied. The local community may face short-term impacts resulting from increased truck traffic during excavation and concrete placement and increased inconvenience in using backyards while work is being conducted. These impacts could include noise, increased traffic, and temporary loss of backyard use.

Measures would be taken during excavation, staging, and loading of contaminated soil to reduce and control short-term risks. These measures include restricting access to work areas, implementing dust suppression measures, and using engineering controls to minimize any environmental impacts. In addition, appropriate equipment decontamination procedures would be used to prevent the transport of contaminated soil.

About 34 weeks would be required to mobilize necessary equipment, prepare backyards for capping, excavate chemical- and solid-waste-contaminated soil, install backyard capping, transport and dispose of excavated material off site, restore the site, and demobilize.

### Implementability

This alternative is evaluated against two criteria to determine its implementability: (1) technical feasibility and (2) commercial availability. Alternative 1B would be technically easy to implement. This alternative would use standard construction methods to cap backyards. After excavation and transportation of chemical- and solid-waste-contaminated topsoil and site restoration, O&M of the cap might be required. Contractors are readily available and have the equipment and specialists necessary to excavate chemical- and solid-waste-contaminated topsoil and construct concrete capping. The capacity of the off-site disposal facilities is adequate to handle the volume of excavated topsoil.

### Cost

Details for the cost opinion for Alternative 1B are provided in Appendix H. The cost opinion for Alternative 1B is $4.6 million. Costs associated with this alternative include site preparation, construction of a poured-in-place concrete cap, transportation and disposal of excavated material, site restoration (fencing), and postclosure care.

## 4.2.2 Alternative 2B: Capping All Backyards with Precast Concrete Pavers

A description of Alternative 2B and an evaluation of its effectiveness, implementability, and cost are provided in the following sections.

### Description

Alternative 2B is illustrated in Figure 4-6. Major components of this alternative would be as follows:

1. Capping of backyards with precast concrete pavers
2. Disposal of chemical- and solid-waste-contaminated topsoil at a permitted off-site facility
3. Postclosure monitoring of land use and drainage and erosion control

Preparation would involve; removing existing patios (if necessary), clearing, excavating topsoil, placing replacement subgrade soil, and grading the surface to be capped. The entire backyard would be capped with precast concrete pavers. The size of the pavers is about 3 by 3 feet, and they would weigh 450 pounds each. The intent of using precast concrete pavers is to allow future access to underground utilities without demolishing the cap. In addition to precast pavers, a poured-in-place concrete perimeter edge may be necessary to account for any irregularities in backyard size or shape. The paver surface would be sloped to drain storm water away from buildings. Backyard restoration would include installation of new wood fencing that is similar to the original wood fence.

**Effectiveness**

Evaluation of this alternative for the five effectiveness criteria is discussed in the following paragraphs.

**Overall Protection of Human Health and the Environment**

Because exposure pathways for residents to contaminants in soil are through direct contact, ingestion, and dust inhalation, construction of a concrete cap covering the entire backyard would prevent long-term residential exposure to possible contaminants in soil. The concrete provides a durable barrier to underlying contaminants. With this alternative, the cap would consist of several precast concrete segments placed continuously over the entire backyard area. The concrete cap also would prevent erosion and reduce potential leaching of underlying chemical contaminants into groundwater. Restrictions would be needed to ensure that residents are prohibited from engaging in any type of activity that would involve disturbance of the cap. In addition, ICs would be needed to address excavated soils removed during necessary maintenance activities (for example, utility maintenance).

**Compliance with ARARs**

This alternative would comply with ARARs identified and discussed in Section 4.1.1.

**Long-term Effectiveness and Permanence**

Factors evaluated under long-term effectiveness and permanence include: (1) the magnitude of residual risks and (2) the adequacy and reliability of controls.

Construction and maintenance of a concrete cap would provide adequate long-term protection to a resident. Any remaining chemical- and solid-waste-contaminated soil is not expected to degrade significantly with time. Long-term adequacy and reliability requirements of the backyard cap would be set and maintained as long as residents occupy the area. The concrete cap would be low-maintenance and would be reliable in preventing exposure. Because the concrete cap would be constructed of individual segments or "pavers," the cap surface could be subject to differential settlement over the long term. Differential settlement would be prevented or minimized with proper subgrade compaction.

**Reduction of Toxicity, Mobility, or Volume through Treatment**

This alternative relies on the concrete cap and restrictions to limit penetration into the remaining solid waste below the cap. By limiting penetration by residents, the potential to mobilize and move chemicals and solid waste left on site would be limited.

## Short-term Effectiveness

Three factors are considered when assessing short-term effectiveness: (1) protection of the community during removal actions, (2) environmental impacts resulting from construction and implementation of the alternative, and (3) time required to complete the removal action.

Most of the buildings where backyards are to be capped are occupied. The community may face short-term risks during topsoil excavation and removal activities resulting from inhalation of fugitive dust and direct contact with excavated topsoil. The local community also may be faced with additional short-term impacts resulting from increased truck traffic during excavation and concrete placement and increased inconvenience in using backyards while work is being conducted. These impacts could include noise, increased traffic, and temporary loss of backyard use.

Measures would be taken during excavation, staging, and loading of contaminated topsoil to reduce and control short-term risks. These measures include restricting access to work areas and implementing dust suppression measures and engineering controls to minimize any environmental impacts. In addition, appropriate equipment decontamination procedures would be used to prevent the transport of contaminated soil.

About 34 weeks would be required to mobilize necessary equipment, prepare backyards for capping, excavate chemical- and solid-waste-contaminated topsoil, install backyard capping, transport and dispose of excavated material off site, restore the site, and demobilize.

### Implementability

This alternative is evaluated against two criteria to determine its implementability: (1) technical feasibility and (2) commercial availability. Alternative 2B is technically easy to implement. This alternative would use standard construction methods to excavate chemical- and solid-waste-contaminated soil and to cap backyards. No excavation would occur below the water table. After excavation and transportation of chemical- and solid-waste-contaminated soil and site restoration, O&M of the soil cover and backyard cap may be required. Many contractors are readily available and have the equipment and specialists necessary to excavate chemical- and solid-waste-contaminated soil. The capacity of the off-site disposal facilities is adequate to handle the volume of excavated soil.

### Cost

The details for the cost opinion for Alternative 2B are provided in Appendix H. The cost opinion for Alternative 2B is $8.2 million. Costs associated with this alternative include site preparation, installation of the precast concrete cap, transportation and disposal of excavated material, site restoration (fencing), and postclosure care.

#### 4.2.3 Alternative 3B: Excavation of Backyards

A description of Alternative 3B and an evaluation of its effectiveness, implementability, and cost are provided in the following sections.

**Description**

Alternative 3B is illustrated in Figure 4-7. Major components of this alternative would be as follows:

1. Excavation of solid waste and soil in backyards to a depth of 2 feet
2. Backfilling excavated areas with imported material and site restoration
3. Disposal of chemical- and solid-waste-contaminated soil at a permitted off-site facility
4. Postclosure monitoring of land use and drainage and erosion control

Excavations would be advanced to a depth of 2 feet bgs in backyards to prevent direct contact with potential underlying hazardous substances and solid waste. The depth of excavation in the backyards may require a minimal amount of mechanical support or removal and replacement of underground utilities.

**Effectiveness**

Evaluation of this alternative for the five effectiveness criteria is discussed in the following paragraphs.

**Overall Protection of Human Health and the Environment**

This alternative would protect human health and the environment, because it would involve excavating and removing chemical- and solid-waste-contaminated soil to a depth of 2 feet bgs from backyards, thereby minimizing the potential for exposure to a resident. Because most utilities exist below depths of 2 feet, ICs would be necessary to protect workers during utility maintenance.

**Compliance with ARARs**

This alternative would comply with all ARARs identified and discussed in Section 4.1.1.

**Long-term Effectiveness and Permanence**

Factors evaluated under long-term effectiveness and permanence include: (1) the magnitude of residual risks and (2) the adequacy and reliability of controls. Chemical- and solid-waste-contaminated soil would be permanently removed to a depth of 2 feet bgs from backyards, so no residual risk to future residents and workers would remain above a depth of 2 feet bgs in backyards. The long-term adequacy and reliability of controls for excavated material would depend on the controls of the off-site disposal facility.

## Reduction of Toxicity, Mobility, or Volume through Treatment

Implementation of this alternative would not reduce the volume or toxicity of chemicals and solid waste present in excavated soil; however, the on-site volume of contaminated soil would be reduced. This alternative would rely on engineering controls of the permitted off-site disposal facility to limit mobility of excavated chemicals and solid waste. This alternative also would rely on the soil cover and restrictions to limit penetrations into the remaining solid waste. By limiting penetrations by residents, the potential to mobilize and move chemicals and solid waste left on site would be limited.

## Short-term Effectiveness

The discussion about short-term effectiveness presented in Sections 4.2.1 and 4.2.2 for Alternatives 1B and 2B applies to Alternative 3B as well. However, the amount of excavation in Alternative 3B is greater than in Alternatives 1B and 2B; as a result, the potential for disturbances to occupants from noise, dust, trucking, excavation, and utility disruption is greater.

About 28 weeks would be required to mobilize necessary equipment, prepare the site for excavation, excavate chemical- and solid-waste-contaminated soil, transport and dispose of excavated material off site, restore the site, and demobilize.

## Implementability

This alternative is evaluated against two criteria to determine its implementability: (1) technical feasibility and (2) commercial availability. Alternative 3B is technically easy to implement. This alternative would use standard construction methods to excavate chemical- and solid-waste-contaminated soil. No excavation would occur below the water table. After excavation and transportation of chemical- and solid-waste-contaminated soil and site restoration, O&M would be required to maintain the integrity of the soil cover. Contractors are readily available and have the equipment and specialists necessary to excavate chemical- and solid-waste-contaminated soil. The capacity of the off-site disposal facilities is adequate to handle the volume of excavated soil.

## Cost

Details for the cost opinion for Alternative 3B are provided in Appendix H. The cost opinion for Alternative 3B is \$8.5 million. Costs associated with this alternative include site preparation, excavation of about 24,000 $yd^3$ of soil and debris, transportation and disposal of excavated material, site restoration (backfill, fencing, and seeding), and postclosure care.

#### 4.2.4 Alternative 4B: Excavation of Backyards

A description of Alternative 4B and an evaluation of its effectiveness, implementability, and cost are provided in the following sections.

**Description**

Alternative 4B is illustrated in Figure 4-8. Major components of this alternative would be as follows:

1. Excavation of solid waste and soil in backyards to a depth of 4 feet

2. Backfilling excavated areas with imported material and site restoration

3. Disposal of chemical- and solid-waste-contaminated soil at a permitted off-site facility

4. Postclosure monitoring of land use and drainage and erosion control

Excavations would be advanced to a depth of 4 feet bgs in backyards to prevent direct contact with potential underlying hazardous substances and solid waste. The depth of excavation in backyards may require a moderate amount of mechanical support or removal and replacement of underground utilities.

**Effectiveness**

Evaluation of this alternative for the five effectiveness criteria is discussed in the following paragraphs.

**Overall Protection of Human Health and the Environment**

This alternative would protect human health and the environment, because it would involve excavating and removing chemical- and solid-waste-contaminated soil to a depth of 4 feet bgs from backyards, thereby minimizing the potential for exposure to a resident and future utility worker. Because a higher level of possible exposure of underlying soil exists to a resident in a backyard and utilities exist mainly at depths below 2 feet, the Navy has considered an excavation depth of 4 feet to be protective for the backyard excavation alternative.

**Compliance with ARARs**

This alternative would comply with all ARARs identified and discussed in Section 4.1.1.

## Long-term Effectiveness and Permanence

The factors evaluated under long-term effectiveness and permanence include: (1) the magnitude of residual risks and (2) the adequacy and reliability of controls. Chemical- and solid-waste-contaminated soil would be permanently removed to a depth of 4 feet bgs from backyards, so no residual risk to future residents and workers would remain above a depth of 4 feet bgs in backyards. In backyards, a higher level of exposure potentially exists than in common areas and an excavation depth of 4 feet bgs (down to the water table) would be effective. The long-term adequacy and reliability of controls for excavated material would depend on the controls of the off-site disposal facility.

## Reduction of Toxicity, Mobility, or Volume through Treatment

Implementation of this alternative would not reduce the volume or toxicity of chemicals and solid waste present in excavated soil; however, the on-site volume of contaminated soil would be reduced. This alternative would rely on engineering controls of the permitted off-site disposal facility to limit mobility of the excavated chemicals and solid waste. This alternative also would rely on the soil cover and restrictions to limit penetration into the remaining solid waste. By limiting penetration by residents, the potential to mobilize and move chemicals and solid waste left on site would be limited.

## Short-term Effectiveness

The discussion about short-term effectiveness presented in Sections 4.2.1 and 4.2.2 for Alternatives 1B, 2B, and 3B applies to Alternative 4B as well. However, the amount of excavation in Alternative 4B is much greater than in Alternatives 1B, 2B, and 3B; as a result, the potential for disturbances to occupants from noise, dust, trucking, excavation, and utility disruption is greater. In addition, because most of the buildings are occupied where backyards are to be excavated, the residents in those buildings might have to be relocated during the backyard work.

About 53 weeks would be required to mobilize necessary equipment, prepare the site for excavation, excavate chemical- and solid-waste-contaminated soil, transport and dispose of excavated material off site, restore the site, and demobilize.

## Implementability

This alternative is evaluated against two criteria to determine its implementability: (1) technical feasibility and (2) commercial availability. Alternative 4B is technically easy to implement. This alternative would use standard construction methods to excavate chemical- and solid-waste-contaminated soil. No excavation would occur below the water table. After excavation and transportation of chemical- and solid-waste-contaminated soil and site restoration, O&M would be required to maintain the integrity of the soil cover. Contractors are readily available and have the equipment and specialists necessary to excavate chemical- and solid-waste-contaminated soil. The capacity of the off-site disposal facilities is adequate to handle the volume of excavated soil.

### Cost

Details for the cost opinion for Alternative 4B are provided in Appendix H. The cost opinion for Alternative 4B is $14.6 million. Costs associated with this alternative include site preparation, excavation of about 49,000 $yd^3$ of soil and debris, confirmation sampling, transportation and disposal of excavated material, site restoration (backfill, fencing, and seeding), and postclosure care.

### 4.2.5 Alternative 5B: Field Investigation of Each Backyard and Capping Backyards that Exceed Cleanup Criteria

### Description

Alternative 5B is illustrated in Figure 4-9. Major components of this alternative would be as follows:

1. Field investigation of each backyard
2. Capping with a poured-in-place concrete slab for backyards that exceed cleanup criteria
3. Disposal of chemical- and solid-waste-contaminated soil at a permitted off-site facility
4. Postclosure monitoring of land use and drainage and erosion control

Field investigation in backyards has the potential to identify areas that pose an unacceptable risk. The field investigation would identify backyards that contain unacceptable levels of hazardous debris, have mean concentrations of contaminants that exceed the action levels, and have areas of contamination that are of a significant size. The sampling plan for this alternative is provided in Appendix H.

Sampling would be conducted at three depth intervals within each backyard: 0 to 1, 1 to 2, and 2 to 4 feet bgs. The statistically based sampling approach includes multiple tiers of testing and analysis, both onsite and at an off-site analytical laboratory. The on-site component includes a screen for hazardous debris, as well as a screen for the presence of unacceptable concentrations of lead and PCBs in soil. The off-site component evaluates concentrations of PAHs in soil. The existing data set and action levels also allowed a statistically based estimate to be developed to predict the approximate number of backyards that would require remediation after the investigation. The basis and details of the sampling plan are included in Appendix H.

After backyards that require remediation are identified, a cap would be constructed in backyards. The backyard cap would consist of a poured-in-place concrete slab, identical to the cap described in Alternative 1B. The following discussion of effectiveness and implementability only relate to the investigation portion of the alternative. The effectiveness and implementability of the poured-in-place cap are discussed in Section 4.2.1.

**Effectiveness**

Evaluation of this alternative for the five effectiveness criteria is discussed in the following paragraphs.

**Overall Protection of Human Health and the Environment**

The proposed investigation scheme was developed based on a statistical analysis of the data. Main elements presented in the investigation conceptual model are that: (1) the design should have a reasonable assurance of detecting some predetermined threshold level of debris (based on either the presence or absence of different types of debris or estimates of their densities), (2) the size of the largest unsampled area within a backyard should be reasonably small (no greater than 4 feet, based on the diameter of a circular target), and (3) a sufficient number of samples is collected to reliably compare the mean concentration of contaminants within individual backyards to a set of appropriate CSs. An auxiliary requirement for comparing the mean concentrations with the CS is that the maximum concentration within a backyard should not exceed any individual CS by a factor of more than 1.5. For 4-foot circular targets, at least 48 samples would be required for each depth interval. This would require samples to be evenly spaced over a square grid, with a distance between adjacent samples of approximately 3.34 feet. A minimum sample size of 48 samples per depth interval was chosen to satisfy performance requirements for testing the mean against the CS, as well as to ensure that the size of the largest unsampled area would not be greater than 4 feet. This results in a total of 144 samples collected for each backyard.

Because development of the sampling approach was based on analysis of site data and establishment of minimum performance criteria, implementation of the sampling design to identify backyards that pose an unacceptable level of risk and subsequent capping of the backyard would be protective. However, because no sampling strategy can completely characterize a backyard, some level of uncertainty would remain in the areas within a backyard that go unsampled.

**Compliance with ARARs**

This alternative would comply with ARARs identified and discussed in Section 4.1.1.

**Long-term Effectiveness and Permanence**

Long-term effectiveness of the backyard cap is discussed in Section 4.2.1.

**Reduction of Toxicity, Mobility, or Volume through Treatment**

Reduction of toxicity, mobility, or volume through treatment is discussed in Section 4.2.1.

**Short-term Effectiveness**

Three factors are considered when assessing short-term effectiveness: (1) protection of the community during removal actions, (2) environmental impacts resulting from construction and implementation of the alternative, and (3) time required to complete the removal action.

Most of the buildings where backyards are to be investigated and subsequently capped are occupied. Short-term effects of capping are discussed in Section 4.2.1. Short-term effects of investigation would include temporary loss of backyard use and noise from the investigation process.

About 75 weeks would be required to mobilize necessary equipment, investigate backyards, prepare backyards for capping, excavate chemical- and solid-waste-contaminated soil, install backyard capping, transport and dispose of excavated material off site, restore the site, and demobilize.

**Implementability**

This alternative is evaluated against two criteria to determine its implementability: (1) technical feasibility and (2) commercial availability. Alternative 5B is moderately difficult to implement. Because of the limited space, collection of 144 samples in each backyard would be difficult. In addition, off-site laboratories may have difficulty in analyzing this volume of samples in a timely manner.

**Cost**

Details for the cost opinion for Alternative 5B are provided in Appendix H. The cost opinion for Alternative 5B is $23.2 million. Costs associated with this alternative include investigation of all backyards and capping of an estimated 533 backyards. Capping of backyards includes site preparation, construction of a poured-in-place concrete cap, transportation and disposal of excavated material, site restoration (fencing), and postclosure care.

### 4.2.6 Alternative 6B: Field Investigation of Each Backyard and Capping Backyards that Exceed Cleanup Criteria

**Description**

Alternative 6B is illustrated in Figure 4-10. Major components of this alternative would be as follows:

1. Field investigation of each backyard
2. Capping of backyards with precast concrete pavers that exceed cleanup criteria

3. Disposal of chemical- and solid-waste-contaminated soil at a permitted off-site facility

4. Postclosure monitoring of land use and drainage and erosion control

The field investigation would be the same one described in Section 4.2.5. After backyards that require remediation are identified, a cap would be constructed in backyards. The backyard cap would be accomplished with precast concrete pavers, identical to the cap described in Alternative 2B. The effectiveness and implementability of the investigation are presented in Section 4.2.5. The effectiveness and implementability of the precast cap are discussed in Section 4.2.2.

#### Cost

Details for the cost opinion for Alternative 6B are provided in Appendix H. The cost opinion for Alternative 6B is $25.9 million. Costs associated with this alternative include investigation of all backyards and capping of an estimated 533 backyards. Capping of backyards includes site preparation, construction of a precast concrete cap, transportation and disposal of excavated material, site restoration (fencing), and postclosure care.

### 4.2.7 Alternative 7B: Field Investigation of Each Backyard and Excavating Backyards that Exceed Cleanup Criteria

#### Description

Alternative 7B is illustrated in Figure 4-11. Major components of this alternative would be as follows:

1. Field investigation of each backyard

2. Excavation of backyards that exceed the cleanup criteria to a depth of 2 feet bgs

3. Disposal of chemical- and solid-waste-contaminated soil at a permitted off-site facility

4. Postclosure monitoring of land use and drainage and erosion control

The field investigation would be the same one described in Section 4.2.5. After backyards that require remediation are identified, they would be excavated to a depth of 2 feet bgs. The backyard excavation would be identical to the excavation described in Alternative 3B. The effectiveness and implementability of the investigation are presented in Section 4.2.5. The effectiveness and implementability of the backyard excavation are presented in Section 4.2.3.

### Cost

Details for the cost opinion for Alternative 7B are provided in Appendix H. The cost opinion for Alternative 7B is $26.5 million. Costs associated with this alternative include investigation of all backyards and excavation of an estimated 533 backyards, including transportation and disposal of excavated material, site restoration (backfill, fencing, and seeding), and postclosure care.

## 4.2.8 Alternative 8B: Field Investigation of Each Backyard and Excavating Backyards that Exceed Cleanup Criteria

### Description

Alternative 8B is illustrated in Figure 4-12. Major components of this alternative would be as follows:

1. Field investigation of each backyard
2. Excavation of backyards that exceed the cleanup criteria to a depth of 4 feet bgs
3. Disposal of chemical- and solid-waste-contaminated soil at a permitted off-site facility
4. Postclosure monitoring of land use and drainage and erosion control

The field investigation would be the same one described in Section 4.2.5. After backyards that require remediation are identified, they would be excavated to a depth of 4 feet bgs. The backyard excavation would be identical to the excavation described in Alternative 4B. The effectiveness and implementability of the investigation are presented in Section 4.2.5. The effectiveness and implementability of the backyard excavation are presented in Section 4.2.4.

### Cost

Details for the cost opinion for Alternative 8B are provided in Appendix H. The cost opinion for Alternative 8B is $30.4 million. Costs associated with this alternative include investigation of all backyards and excavation of an estimated 533 backyards, including transportation and disposal of excavated material, site restoration (backfill, fencing, and seeding), and postclosure care.

# 5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

In this section, the alternatives analyzed in Section 4.0 are compared against each other to evaluate the relative performance of each alternative in relation to each of the criteria. The criteria used in this comparison are the same as in Section 4.0 – namely, effectiveness, implementability, and cost. A summary of the comparative analysis is provided in Tables 5-1 and 5-2.

Tables 5-1 and 5-2 present a summary of the discussions in the text and are intended to provide a concise and comprehensive mechanism for comparing alternatives. Descriptions in the tables are necessarily short and subjective; however, they are consistent and based on the discussion in Section 4.0.

## 5.1 BACKYARDS AND COMMON AREAS WITHIN KNOWN SOLID WASTE DISPOSAL AREAS

### 5.1.1 Effectiveness of Alternatives

Each alternative is evaluated against five criteria to determine its effectiveness: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, or volume through treatment; and (5) short-term effectiveness. Each of these criteria is discussed in the following paragraphs.

#### Overall Protection of Human Health and the Environment

Alternative 4A would provide the greatest overall protection to human health and the environment. In Alternative 4A, backyards would be excavated to 4 feet bgs, preventing exposure to chemical- and solid-waste-contaminated soil. Alternative 4A is the most protective, because both residents and future utility workers would be protected through removal of 4 feet of soil in the backyards, with reliance on ICs.

Although slightly less protective than Alternative 4A, Alternatives 1A, 2A, and 3A would provide adequate protection to human health and the environment. In Alternatives 1A, 2A, and 3A, concrete or soil would cap all backyards, preventing exposure by a resident to chemical- and solid-waste-contaminated soil. These alternatives would rely upon an IC to protect utility workers.

#### Compliance with ARARs

All four alternatives would comply with all ARARS identified and discussed in Section 4.1.1 and Appendix E.

### Long-term Effectiveness and Permanence

Alternative 4A would provide the best long-term and permanent treatment, because the largest volume of chemical- and solid-waste-contaminated soil would be removed and transported for disposal at a permitted off-site disposal facility, where engineering controls are already in place. Alternative 4A would remove soil in the backyards to the water table (4 feet bgs). It would be difficult for residents to come into contact with chemical- and solid waste- contaminated soil left in place below the water table.

Alternative 3A would provide the next best long-term effectiveness and permanence, because chemical- and solid-waste-contaminated soil also would be removed and transported for disposal.

Alternative 2A would provide the next best long-term effectiveness and permanence, because the chemical- and solid-waste-contaminated soil would be capped in backyards under the concrete surface. In addition, because the cap in Alternative 2A is constructed of precast concrete pavers, future utility maintenance could occur in backyards without demolition of the cap.

Alternative 1A also would provide an adequate amount of long-term and permanent protection, although future maintenance of utilities would require cutting or demolition of the cap.

Alternatives 1A, 2A, and 3A are slightly less effective than Alternative 4A because they rely on an IC to maintain the integrity of the cap and protect future utility workers.

### Reduction in Toxicity, Mobility, and Volume through Treatment

Under all alternatives, the volume and toxicity of chemical- and solid-waste-contaminated soil would not be reduced through treatment, although on-site volumes of contaminated material would be reduced in Alternatives 3A and 4A. In all of these alternatives, disposal of excavated soil at a permitted off-site facility with engineering controls, such as impermeable liners, interim covers, final caps, and leachate collection systems, would be effective in reducing the mobility of chemicals and solid waste. The mobility of chemicals and solid waste remaining on site would be reduced in each alternative; however, Alternative 4A would result in the greatest reduction.

Alternatives 1A and 2A would reduce the mobility of chemicals and solid waste left on site by construction of a cap in all backyards.

### Short-term Effectiveness

Under all alternatives, the community and workers might face short-term risks during excavation activities; however, measures would be taken to reduce risks such as controlling site access and providing protective equipment and awareness training to workers. The local community might be faced with additional short-term impacts resulting from increased truck traffic during excavation and backfilling and increased inconvenience in using backyards while excavations are open and buried utilities are exposed. These impacts could include noise, increased traffic, and temporary disruption of utility services. Alternative 4A would have the greatest short-term impact because a larger volume is being excavated and it would take longer. For Alternative 4A, the residents of some buildings may have to be temporarily relocated while work is performed adjacent to their buildings.

### 5.1.2 Implementability of Alternatives

All alternatives are technically easy to implement, and many contractors are readily available and have the equipment and specialists necessary to excavate chemical- and solid-waste-contaminated soil. Alternatives 1A and 2A would be the easiest to implement, because they do not require excavation from backyards. Alternative 4A would be the most difficult to implement, because it requires the most excavation in backyards.

### 5.1.3 Cost of Alternatives

The cost opinion for each alternative is as follows:

| Alternative | Description | Cost Opinion (in millions) |
|---|---|---|
| 1A | Cap Backyards (poured-in-place) and Excavate Common Areas to 2 ft bgs in Known SWDAs | $4.4 |
| 2A | Cap Backyards (Precast Pavers) and Excavate Common Areas to 2 ft bgs in Known SWDAs | $4.6 |
| 3A | Excavate Backyards to 2 Ft bgs and Common Areas to 2 ft bgs in Known SWDAs | $4.6 |
| 4A | Excavate Backyards to 4’ and Common Areas to 2 ft bgs in Known SWDAs | $5.3 |

Notes:

ft bgs Feet below ground surface
SWDA Solid waste disposal area

The range in cost opinions for the four alternatives does not significantly vary, because most of the cost is from excavation of common areas and the backyard portion is a small percentage of the total.

## 5.2 BACKYARDS OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS

Each alternative is evaluated against five criteria to determine its effectiveness: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, or volume through treatment; and (5) short-term effectiveness. The following section also compares the effectiveness, implementability, and cost of conducting a removal action in all backyards (Alternatives 1B to 4B) to that of conducting an investigation, followed by a removal action, in a portion of the backyards (Alternatives 5B to 8B). Each of these criteria is discussed in the following paragraphs.

### 5.2.1 Effectiveness of Alternatives

#### Overall Protection of Human Health and the Environment

Alternative 4B would provide the greatest overall protection to human health and the environment. In Alternative 4B, all backyards would be excavated to 4 feet bgs, preventing potential exposure to chemical- and solid-waste-contaminated soil. Alternative 4B is the most protective, because both residents and future utility workers would be protected through removal of 4 feet of soil in all backyards, with reliance on ICs.

Although slightly less protective than Alternative 4B, Alternatives 1B, 2B, and 3B would provide protection to human health and the environment. In Alternatives 1B, 2B, and 3B, concrete or soil would cap all backyards, preventing exposure by a resident to chemical- and solid-waste-contaminated soil. These alternatives would rely on an IC to protect utility workers.

Alternatives 5B, 6B, 7B, and 8B would be less protective than Alternatives 1B, 2B, 3B, and 4B because they rely on a sampling program to identify backyards that could pose a risk to residents and to a future utility worker. Although the proposed sampling scheme is robust, some uncertainty would remain in backyards that go unremediated. Because Alternatives 1B, 2B, 3B, and 4B include a remedy in every backyard, there would be very little remaining uncertainty.

#### Compliance with ARARs

All eight alternatives would comply with all ARARS identified and discussed in Section 4.1.1 and in Appendix E.

#### Long-term Effectiveness and Permanence

Alternative 4B would provide the best long-term and permanent treatment, because the largest volume of chemical- and solid-waste-contaminated soil would be removed and transported for disposal at a permitted off-site disposal facility, where engineering controls are already in place. Alternative 4B would remove soil in all backyards to the water table (4 feet bgs). It would be difficult for residents to come into contact with chemical- and solid waste- contaminated soil left in place below the water table.

Alternative 3B would provide the next best long-term and permanent treatment, because a significant volume of chemical- and solid-waste-contaminated soil would be removed and transported for disposal to a permitted off-site disposal facility, where engineering controls are already in place. Alternative 3B would remove soil in all backyards to 2 feet bgs.

Alternative 2B would provide the next best long-term effectiveness and permanence, because the chemical- and solid-waste-contaminated soil would be capped in backyards under the concrete surface. In addition, because the cap in Alternative 2B is constructed of precast concrete pavers, future utility maintenance could occur in the backyards without demolition of the cap.

Alternative 1B also would provide an adequate amount of long-term and permanent protection, although future maintenance of utilities would require cutting or demolition of the cap.

Alternatives 1B, 2B, and 3B are slightly less effective than Alternative 4B, because they rely on an IC to maintain the integrity of the cap and to protect a future utility worker.

**Reduction in Toxicity, Mobility, and Volume through Treatment**

Under all alternatives, the volume and toxicity of chemical- and solid-waste-contaminated soil would not be reduced through treatment, although on-site volumes of contaminated material would be reduced in Alternatives 3B, 4B, 7B, and 8B. For all of these alternatives, disposal of excavated soil at a permitted off-site facility with engineering controls, such as impermeable liners, interim covers, final caps, and leachate collection systems, would be effective in reducing the mobility of chemicals and solid waste. The mobility of chemicals and solid waste remaining on site would be reduced in each alternative; however, Alternative 4B would result in the greatest reduction.

Alternatives 1B, 2B, 5B, and 6B would reduce the mobility of chemicals and solid waste left on site by construction of a cap in all backyards.

**Short-term Effectiveness**

Under all alternatives, the community and workers might face short-term risks during excavation activities; however, measures would be taken to reduce risks such as controlling site access and providing protective equipment and awareness training to workers. The local community might be faced with additional short-term impacts resulting from increased truck traffic during excavation and backfilling and increased inconvenience in using backyards while excavations are open, and buried utilities are exposed. These impacts could include noise, increased traffic, and temporary disruption of utility services. Alternative 4B would have the greatest short-term impact, because backyards of occupied buildings are being excavated. Alternative 3B would be less disruptive, because the excavation would take less time. For Alternatives 4B and 8B, the residents of these buildings might have to be temporarily relocated during the work adjacent to their buildings. Alternatives 1B and 2B would be the least disruptive, because no investigation would occur and minimal disruption would occur from construction of a concrete cap.

### 5.2.2 Implementability of Alternatives

Alternatives 1B, 2B, and 3B are technically easy to implement, and contractors are readily available and have the equipment and specialists necessary to excavate or construct a concrete cap. Alternative 4B would be more difficult to implement because of the large volume of excavation from backyards. Alternatives 5B, 6B, 7B, and 8B would be the most difficult to implement, because they require investigation of every backyard, followed by remediation of a large portion.

### 5.2.3 Cost of Alternatives

The cost opinion for each alternative is listed as follows:

| | | | Cost Opinion (in millions) | | |
|---|---|---|---|---|---|
| **Alternative** | **Description** | **Number of Backyards** | **Investigation of Backyards** | **Remediation** | **Total** |
| 1B | Cap Backyards (poured-in-place) | 685 | NA | $4.59 | $4.6 |
| 2B | Cap Backyards (precast pavers) | 685 | NA | $8.2 | $8.2 |
| 3B | Excavate Backyards to 2 Ft bgs | 685 | NA | $8.5 | $8.5 |
| 4B | Excavate Backyards to 4 Ft bgs | 685 | NA | $14.6 | $14.6 |
| 5B | Investigate/Cap (poured-in-place) Backyards | 685 (533 remediated) | $19.6 | $3.6 | $23.2 |
| 6B | Investigate/Cap (precast pavers) Backyards | 685 (533 remediated) | $19.6 | $6.3 | $25.9 |
| 7B | Investigate/Excavate Backyards to 2 Ft bgs | 685 (533 remediated) | $19.6 | $6.9 | $26.5 |
| 8B | Investigate/Excavate Backyards to 4 Ft bgs | 685 (533 remediated) | $19.6 | $10.8 | $30.4 |

Notes:

Ft bgs Feet below ground surface
NA Not applicable

Alternatives 5B, 6B, 7B, and 8B have the highest costs, because they include investigation of every backyard, followed by remediation of approximately 78 percent of the backyards.

## 6.0 SUMMARY

This EE/CA was performed in accordance with current EPA and Navy guidance documents for a NTCRA under CERCLA. The purpose of this EE/CA was to identify and analyze alternative removal actions to address chemical- and solid-waste-contaminated soil at Site 12. In addition, the site description, background, risk evaluation, and removal action objectives were presented.

Four alternatives were evaluated for the known SWDAs, and eight alternatives were evaluated for backyards outside of the known SWDAs. Each alternative was evaluated considering its effectiveness, implementability, and cost. Each alternative would be effective in protection of human health and each alternative would be implementable. With regards to cost, the capping and 2-foot excavation alternatives are similar and the alternatives that include investigation would cost significantly more.

Before the Navy chooses a preferred alternative, regulatory and public input is necessary. The public will have an opportunity to review and comment on the EE/CA during a 30-day public comment period. State and community acceptance will be evaluated after the public comment period and will be discussed in an action memorandum documenting the removal action decision.

## REFERENCES


Agency for Toxic Substances and Disease Registry (ATSDR). 1995. "Toxicological Profile for Polycyclic Aromatic Hydrocarbons." http://www.atsdr.cdc.gov/toxprofiles/tp69.html

ATSDR. 2000. Toxicological Profile for Polychlorinated Biphenyls (PCBs). http://www.atsdr.cdc.gov/toxprofiles/tp17.html

Cowherd, C., G. Muleski, P. Engelhart, and D. Gillette. 1985. "Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination." Office of Health and Environmental Assessment. EPA/600/8-85/002.

Dames and Moore. 1988. "Final Preliminary Assessment/Site Inspection of Naval Station Treasure Island [NAVSTA TI]." Prepared for the Naval Energy and Environmental Support Activity. April.

Department of the Navy (Navy). 1987. "Draft Environmental Impact Statement for Battleship/Battlegroup/Cruiser Destroyer Group Homeporting." San Francisco, California.

U.S. Environmental Protection Agency (EPA) 1989. Final Covers on Hazardous Waste Landfills and Surface Impoundments. Office of Solid Waste and Emergency Response Washington, DC.

EPA 1989. "Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual (Part A)." Office of Emergency and Remedial Response. EPA/540/1-89/002. December.

EPA 1995. "Aerial Photographic Analysis of Naval Station Treasure Island." Characterization Research Division. EPA/TS-PIC-95707. June.

EPA. 1997. "Exposure Factors Handbook. Volume I." Office of Research and Development." EPA/600/P-95/002Fa. August.

EPA. 2000. "EPA Region IX Preliminary Remediation Goals (PRG) 2000." November 1. http://www.epa.gov/region09/waste/sfund/prg/

Fetter, C.F. 1988. "Applied Hydrogeology." Second Edition. Macmillan Publishing Company. New York, New York.

Fetter, C.F. 1993. "Contaminant Hydrogeology." Macmillan Publishing Company. New York, New York.

Harding Lawson Associates. 1985. "Dewatering Recommendations, Repair of Steam Distribution System, Treasure Island, California." Prepared for the Department of the Navy (Navy), Western Division, Naval Facilities Engineering Command (NFEC). August 24.

IT Corporation. 2002. “Final Field Activity Report, Site 12 Interim Measures Trench Exploration TIHDI Buildings, Treasure Island, California”. June.

Office of Environmental Health Hazard Assessment. 1999. “Air Toxics Hot Spots Program Risk Assessment Guidelines, Part II, Technical Support Document for Describing Available Cancer Potency Factors”. Air Toxicology and Epidemiology.

PRC Environmental Management, Inc. (PRC). 1992. “Final Remedial Risk Assessment, NAVSTA TI, Site 12.” Prepared for the Navy, NFEC, Engineering Field Activity West. September.

PRC. 1993. “Storm Water Pollution Prevention Plan, NAVSTA TI.” Navy, NFEC, Western Division. June 14.

PRC. 1997. “Draft Final Remedial Investigation [RI] Report, NAVSTA, San Francisco, California.” September.

R.S. Means Company, Inc. (R.S. Means). 2000a. “Environmental Remediation Cost Data – Assemblies.” 6th Annual Edition.

R.S. Means. 2000b. “Environmental Remediation Cost Data – Unit Cost.” 6th Annual Edition.

San Francisco Bay Conservation and Development Commission. 1968. “San Francisco Bay Plan.” Adopted by the San Francisco Bay Conservation and Development Commission in 1968; Incorporated in 1969 into the McAteer-Petris Act, Which Was Signed into Law on August 7, 1969.

San Francisco Estuary Project. 1992. “State of the Estuary. San Francisco Estuary Project.” Prepared with the U.S. Environmental Protection Agency by the Association of Bay Area Governments. Oakland, California. June.

San Francisco Redevelopment Agency (SFRA). 1996. “NAVSTA TI Reuse Plan.” June 3.

Tetra Tech EM Inc. (Tetra Tech). 1999a. “Draft Treasure Island Comment Resolution Meeting Summary.” San Francisco, California. April 28.

Tetra Tech. 1999b. “Draft, RI Report Site 12 Operable Unit.” San Francisco, California. June 1.

Tetra Tech. 1999c. “Final, Site 12 Removal Site Evaluation and Action Memorandum for Time-critical Removal of Lead-contaminated Soil Near Building 1133.” San Francisco, California. November 9.

Tetra Tech. 2000a. “Draft, Former Storage Yard Area of Concern Construction Oversight Work Plan for the Removal of Polychlorinated Biphenyl (PCB)-contaminated Soil.” San Francisco, California. June 9.

Tetra Tech. 2000b. “Additional Investigation of North Point and Mason Court Areas and Debris Disposal Area B at Site 12.” San Francisco, California. March 15.

Tetra Tech. 2000c. “Summary of Results from the Investigation within Installation Restoration [IR] Site 12 In the Vicinity of Buildings 1202, 1217, 1228, and 1230.” San Francisco, California. January 28.

Tetra Tech. 2000d. “Summary of Results from the Investigation within IR Site 12 in the Vicinity of Buildings 1205/1207, 1244, 1251/1253, Debris Disposal Area C, and Debris Disposal Area D.” San Francisco, California. January 28.

Tetra Tech. 2000e. “Summary of Results from the Investigation of the Elementary School Yard Area NAVSTA TI.” San Francisco, California. February 23.

Tetra Tech. 2000f. “Summary of Results from the Additional Investigation of Debris Disposal Area A and Debris Disposal Area B, IR Site 12.” San Francisco, California. August 21.

Tetra Tech. 2002. “Groundwater Status Report, Summary of Groundwater Monitoring, March through October 2000, Naval Station Treasure Island, San Francisco, California.” March.

TRC Environmental Consultants, Inc. (TRC). 1990. “Results of Soil Sampling from Trench at Westside Drive, Treasure Island Naval Facility, TRC Project No. 6808-N73.” January 2.

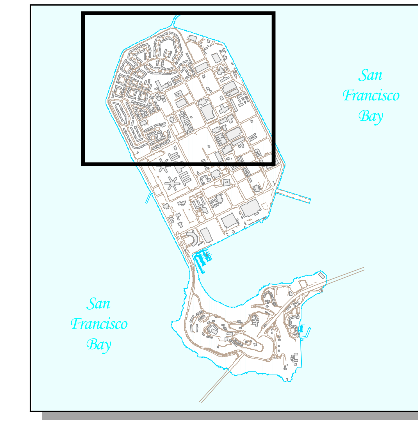
EPA. 1999. Letter Providing U.S. Environmental Protection Agency (EPA) Region 9 Preliminary Remediation Goals (PRG). From Stanford J. Smucker, Ph.D., to PRG Table Mailing List. EPA Region 9. October.

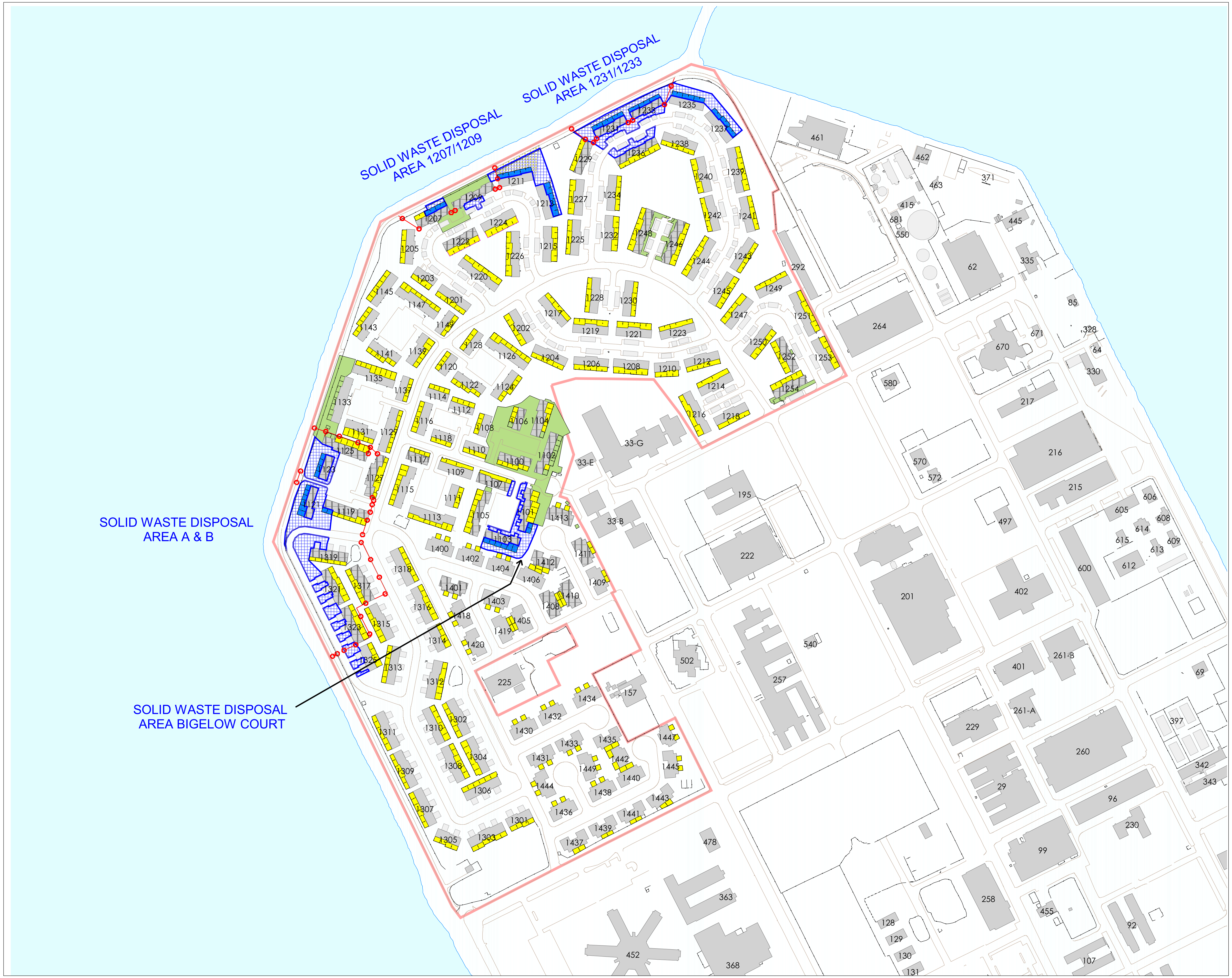
## FIGURES


ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12 DEBRIS DISPOSAL AREA
TREASURE ISLAND, CALIFORNIA

**FIGURE 1-1**
**TREASURE ISLAND LOCATION MAP**

## AREA OF INTEREST




## LEGEND:

- SOLID WASTE DISPOSAL AREAS (BACKYARDS AND COMMON AREAS THAT ARE INCLUDED IN EECA)
- AREAS EXCAVATED
- BACKYARDS OUTSIDE SOLID WASTE DISPOSAL AREAS THAT ARE INCLUDED IN EECA
- SITE 12 BOUNDARY
- UNOCCUPIED BUILDINGS
- BUILDINGS
- FENCES
- ROADS
- BACKYARD FENCES

N

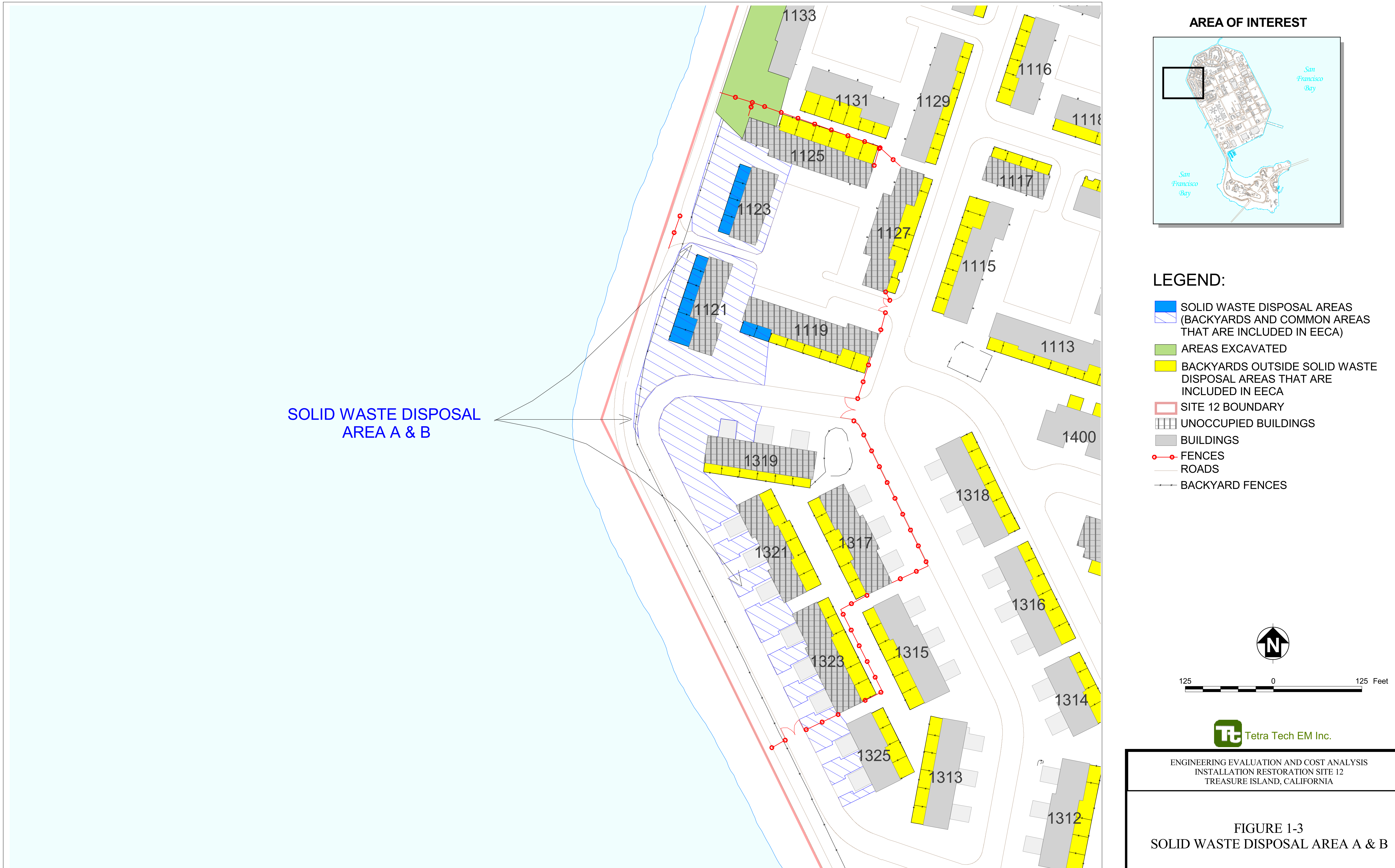
400 0 400 Feet

Tetra Tech EM Inc.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION SITE 12
TREASURE ISLAND, CALIFORNIA

FIGURE 1-2
SITE FEATURE MAP

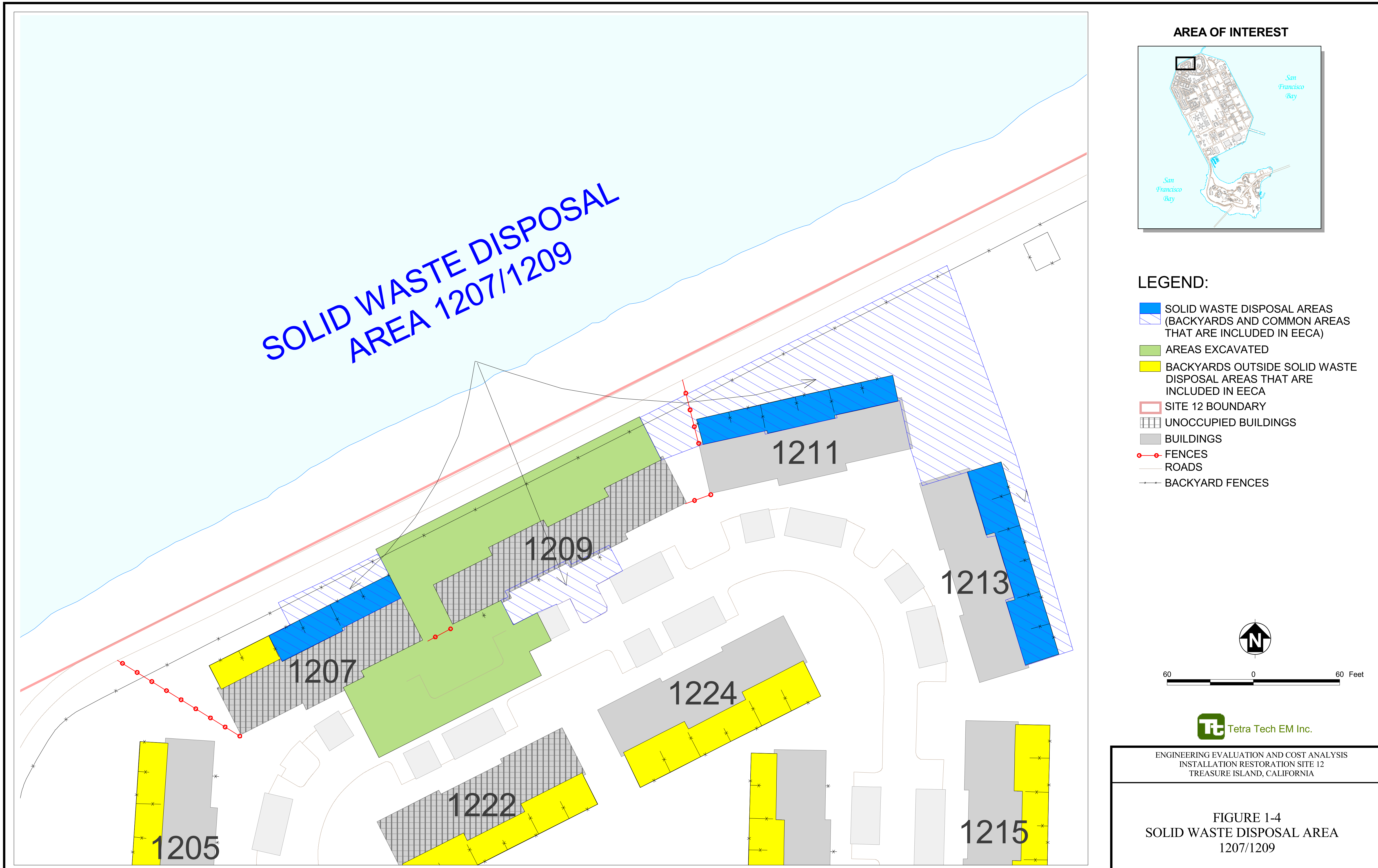
09-11-2002 v:\treasure island\projects\cto323\eeca\debris area fig\proj2.apr TtEMI-SF aleksandr.zhuk




Tetra Tech EM Inc.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION SITE 12
TREASURE ISLAND, CALIFORNIA

FIGURE 1-3
SOLID WASTE DISPOSAL AREA A & B

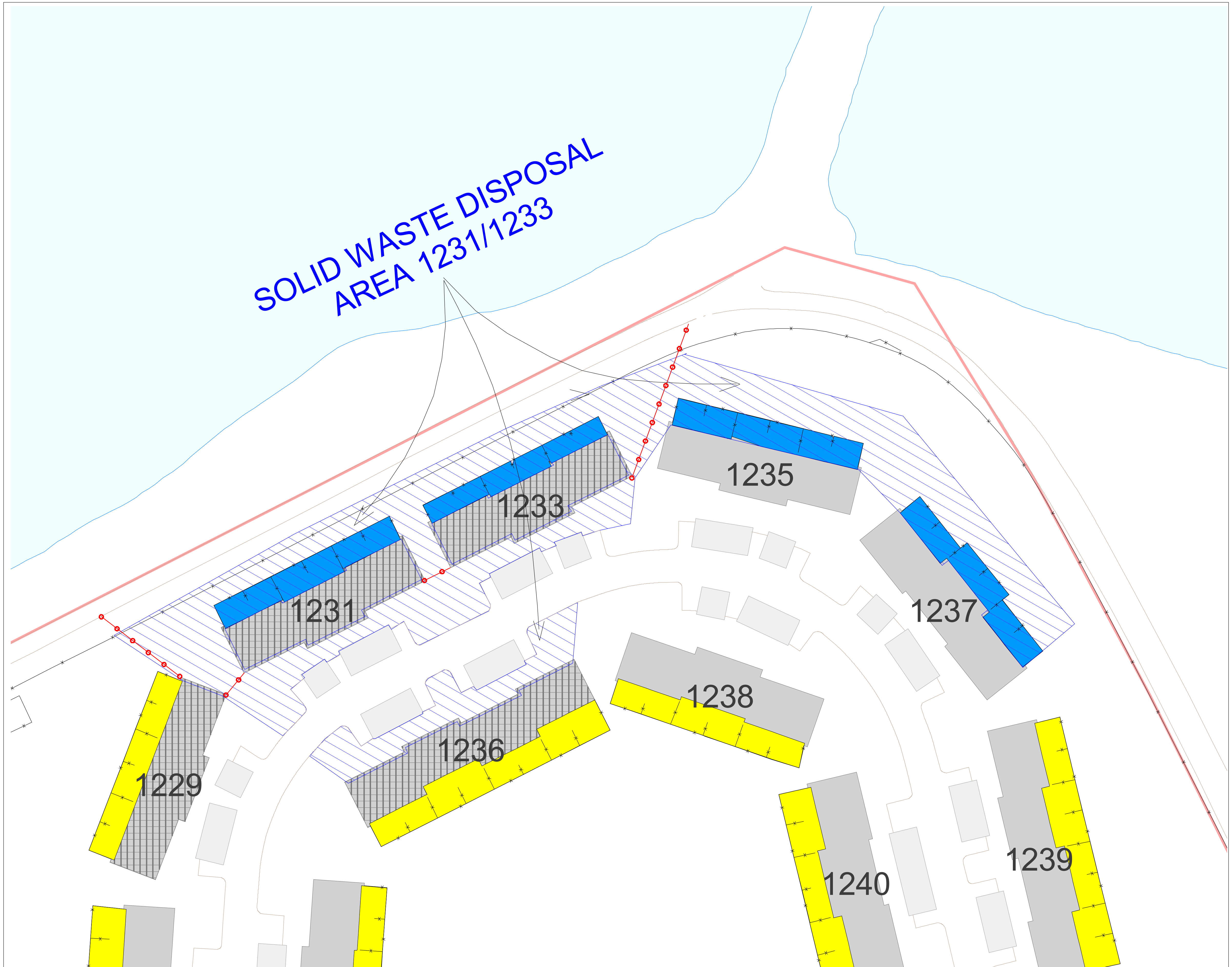



Tetra Tech EM Inc.

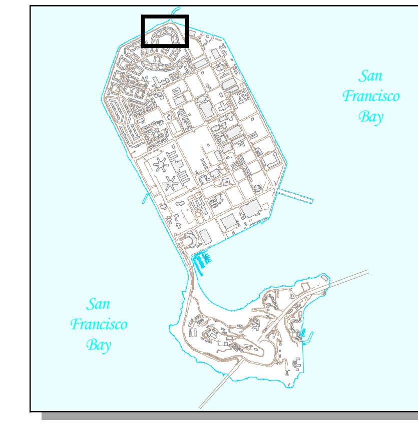
ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION SITE 12
TREASURE ISLAND, CALIFORNIA

FIGURE 1-4
SOLID WASTE DISPOSAL AREA
1207/1209

09-11-2002 v:\treasure island\projects\cto323\eeca\debris area fig\proj2.apr TtEMI-SF aleksandr.zhuk




AREA OF INTEREST




LEGEND:

- SOLID WASTE DISPOSAL AREAS (BACKYARDS AND COMMON AREAS THAT ARE INCLUDED IN EECA)
- AREAS EXCAVATED
- BACKYARDS OUTSIDE SOLID WASTE DISPOSAL AREAS THAT ARE INCLUDED IN EECA
- SITE 12 BOUNDARY
- UNOCCUPIED BUILDINGS
- BUILDINGS
- FENCES
- ROADS
- BACKYARD FENCES

N

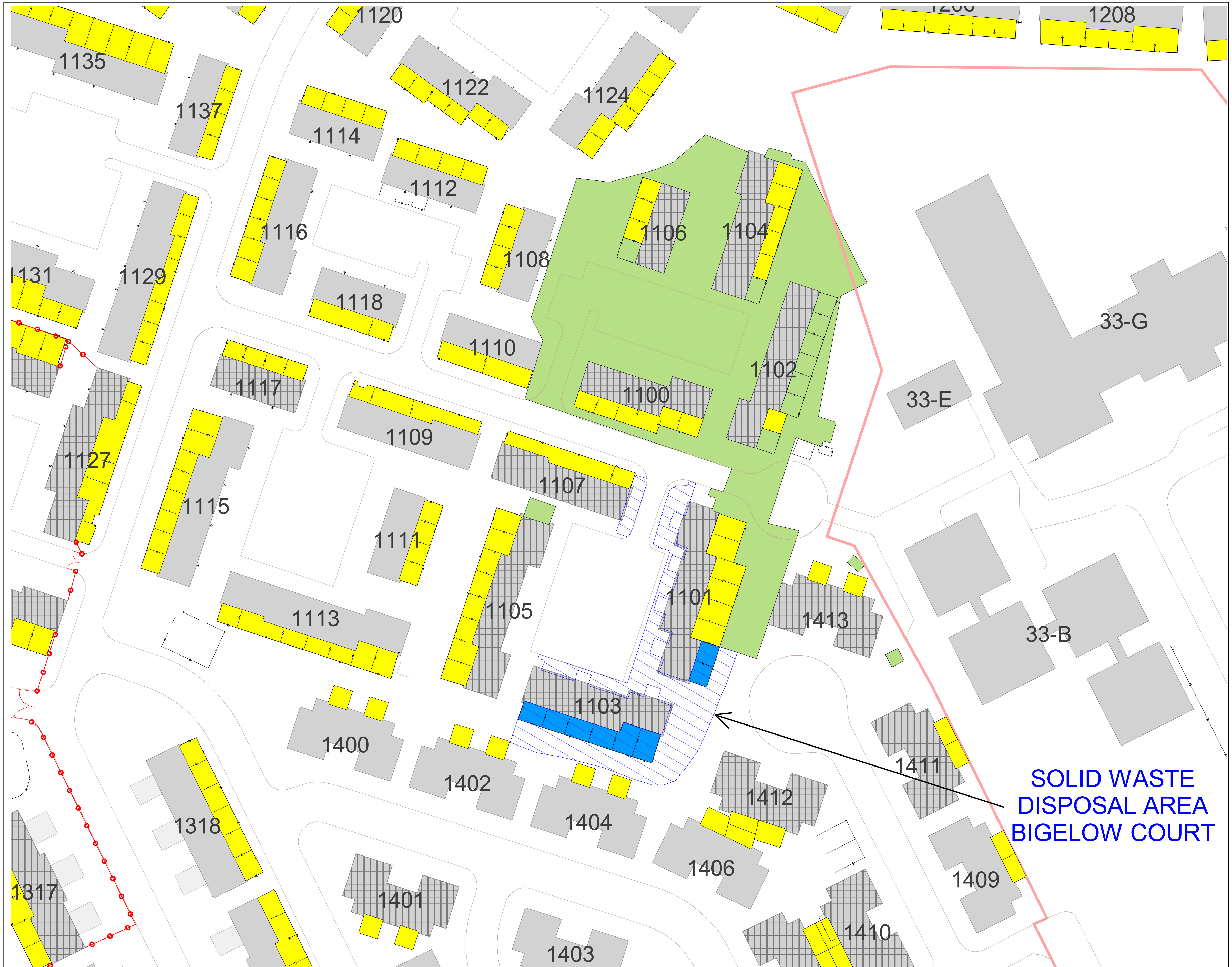
70 0 70 Feet

Tetra Tech EM Inc.

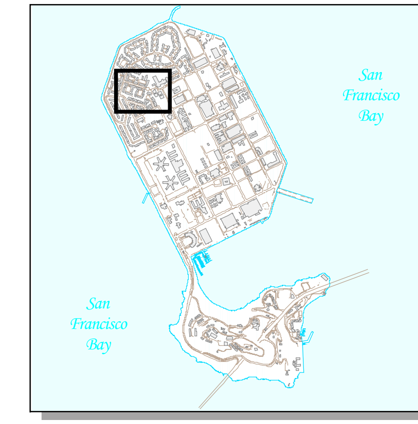
ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION SITE 12
TREASURE ISLAND, CALIFORNIA

FIGURE 1-5
SOLID WASTE DISPOSAL AREA
1231/1233

09-11-2002 v:\treasure island\projects\cto323\eeca\debris area fig\proj2.apr TtEMI-SF aleksandr.zhuk




**AREA OF INTEREST**




LEGEND:

- SOLID WASTE DISPOSAL AREAS (BACKYARDS AND COMMON AREAS THAT ARE INCLUDED IN EECA)
- AREAS EXCAVATED
- BACKYARDS OUTSIDE SOLID WASTE DISPOSAL AREAS THAT ARE INCLUDED IN EECA
- SITE 12 BOUNDARY
- UNOCCUPIED BUILDINGS
- BUILDINGS
- FENCES
- ROADS
- BACKYARD FENCES

N

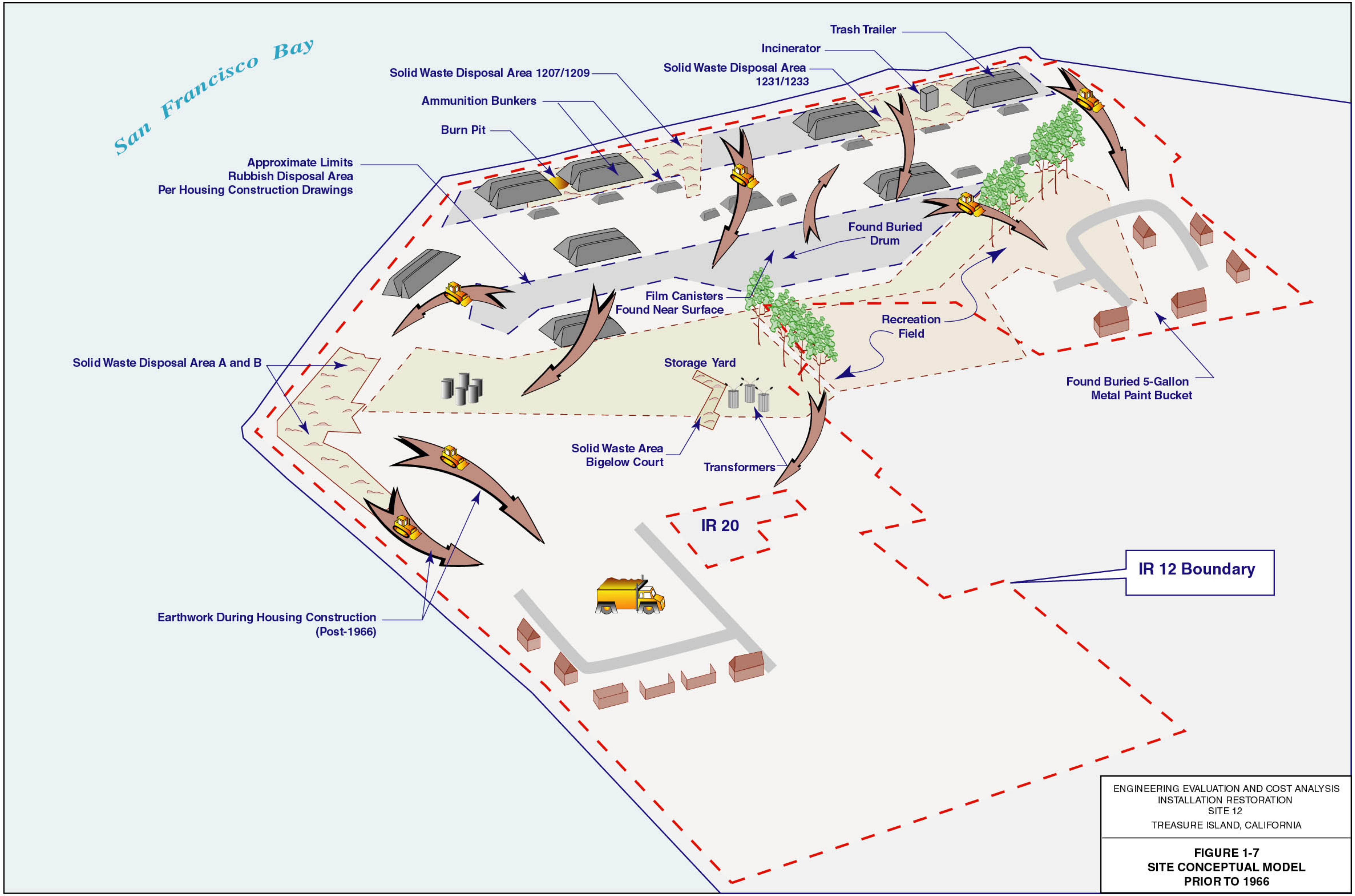
100 0 100 Feet

Tetra Tech EM Inc.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION SITE 12
TREASURE ISLAND, CALIFORNIA

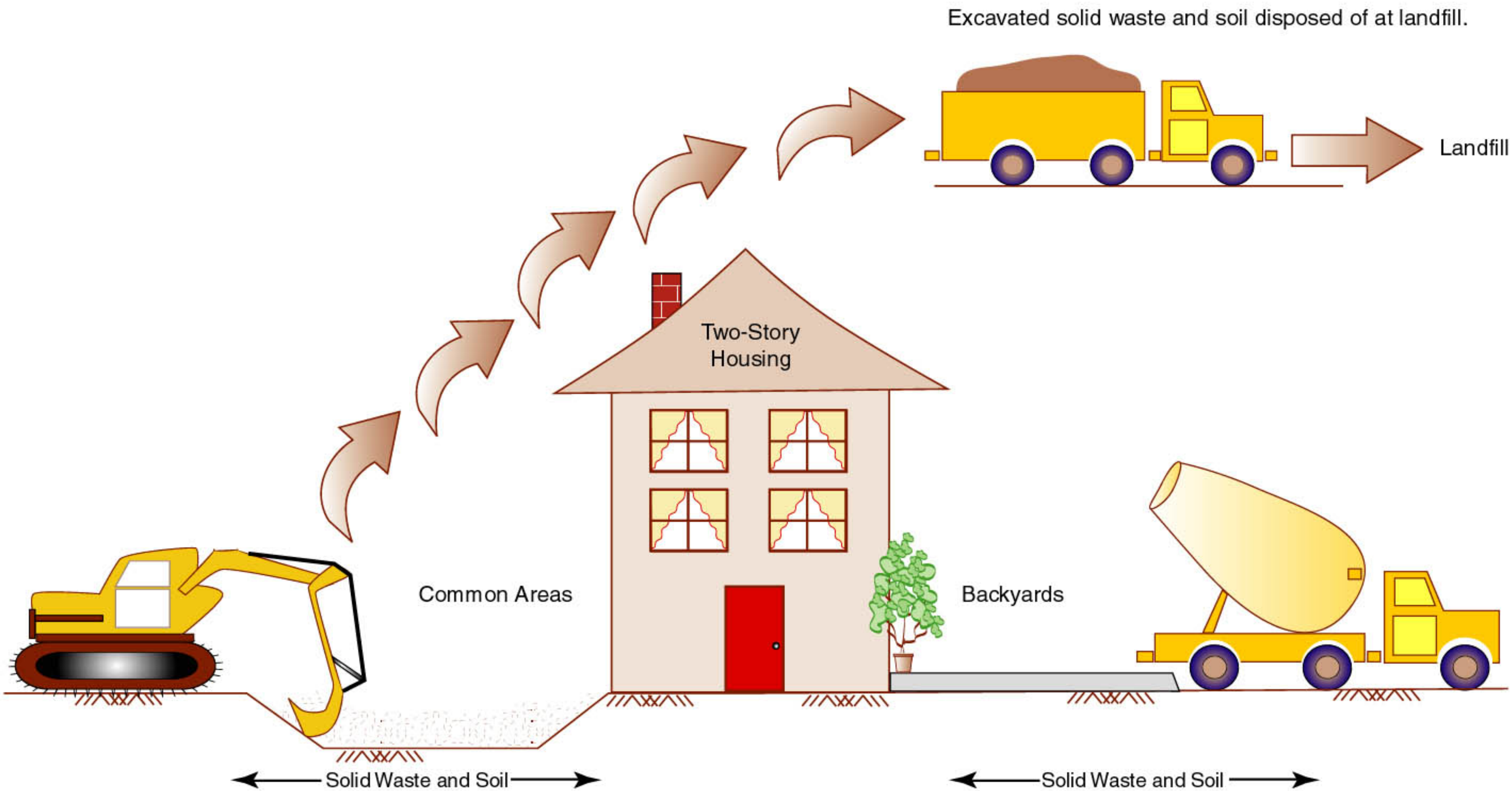
FIGURE 1-6
SOLID WASTE DISPOSAL AREA
BIGELOW COURT

09-11-2002 v:\treasure island\projects\cto323\eeca\debris area fig\proj2.apr TtEMI-SF aleksandr.zhuk




ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

**FIGURE 1-7**
**SITE CONCEPTUAL MODEL**
**PRIOR TO 1966**



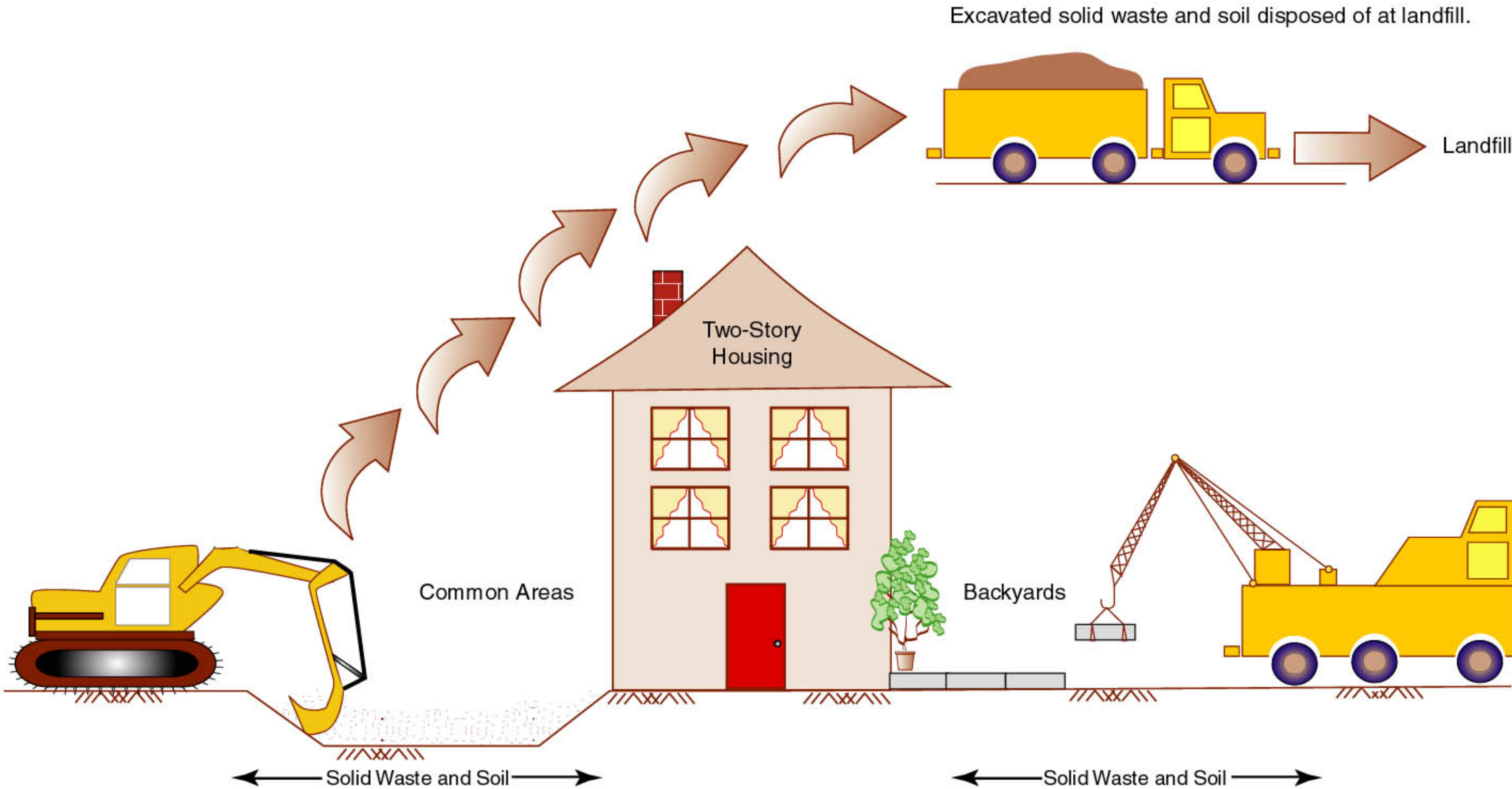

1. Excavate common areas to 2 feet below ground surface
2. Backfill with clean soil
3. Dispose of excavated material at landfill

1. Clear and grade surface
2. Pave backyards with 4-inch, mesh-reinforced concrete slab on grade

**NOTE:** This alternative applies to known solid waste disposal areas only.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

**FIGURE 4-1**
**ALTERNATIVE 1A**



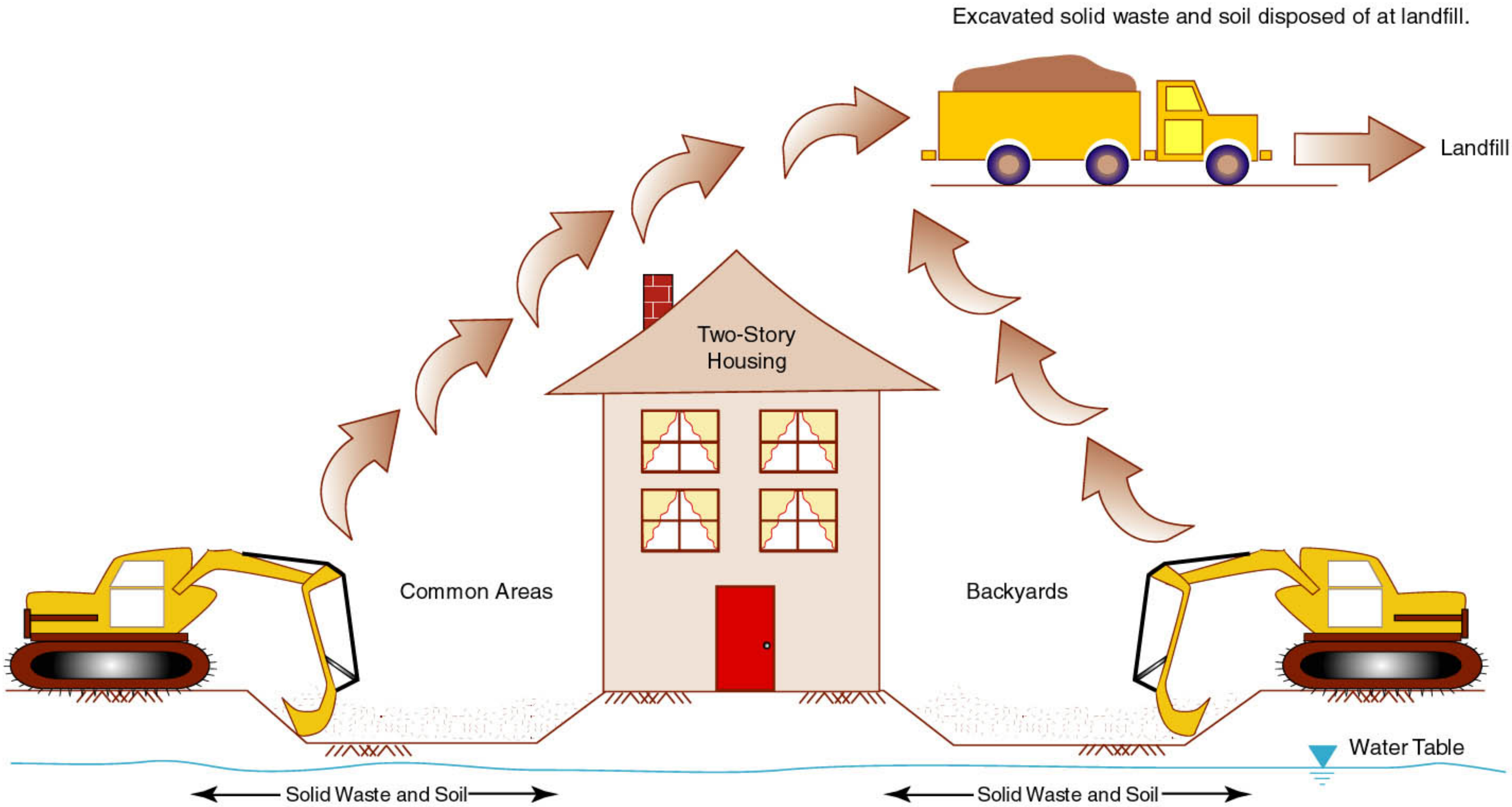

1. Excavate common areas to 2 feet below ground surface in known solid waste disposal areas
2. Backfill with clean soil
3. Dispose of excavated material at landfill

1. Cap backyards (Pre-Cast Pavers)

**NOTE:** This alternative applies to known solid waste disposal areas only.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

**FIGURE 4-2**
**ALTERNATIVE 2A**



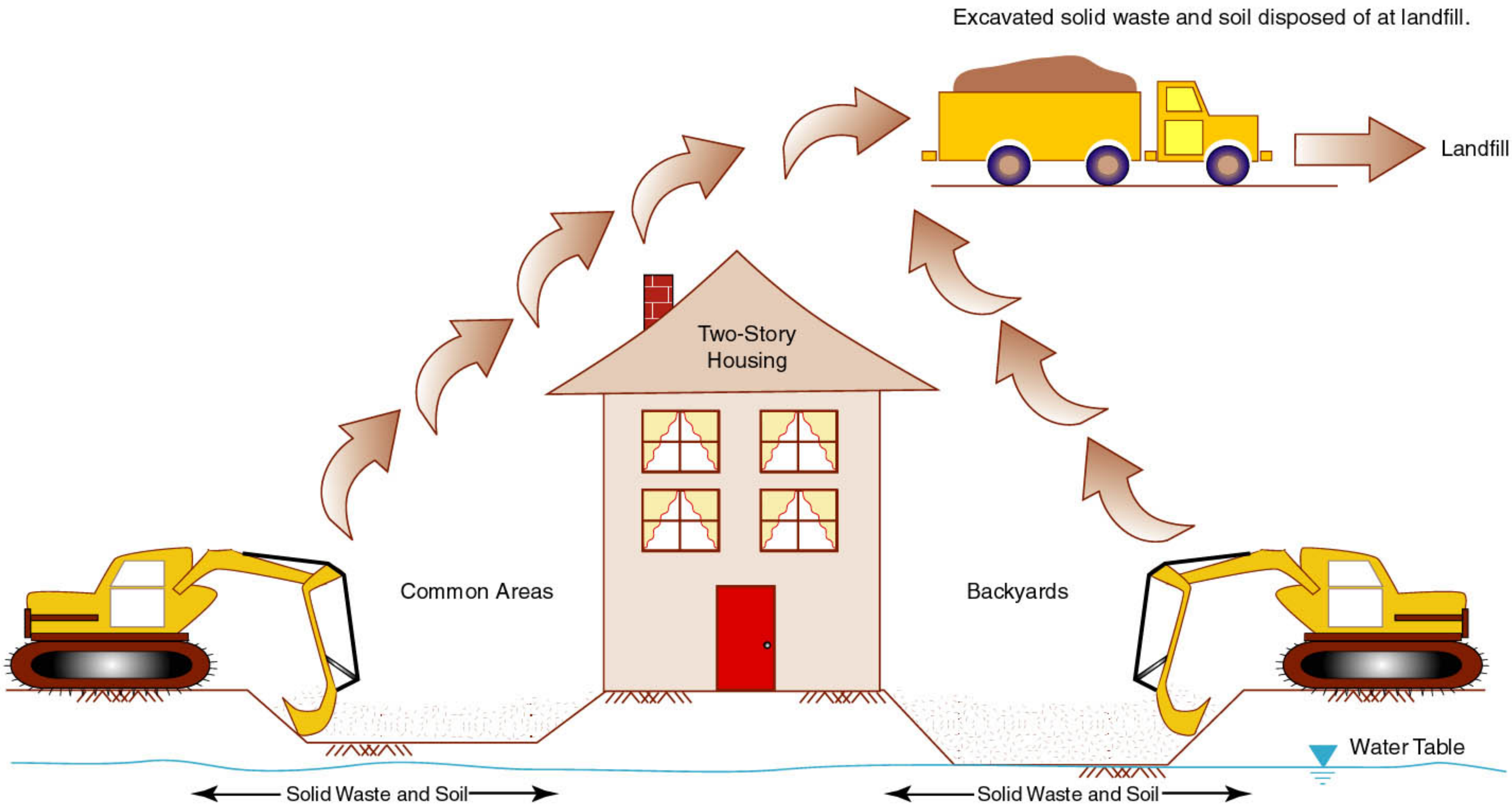

1. Excavate common areas to 2 feet below ground surface
2. Backfill with clean soil
3. Dispose of excavated material at landfill

1. Excavate backyards to 2 feet below ground surface
2. Backfill with clean soil
3. Dispose of excavated material at landfill

**NOTE:** This alternative applies to known solid waste disposal areas only.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

**FIGURE 4-3**
**ALTERNATIVE 3A**



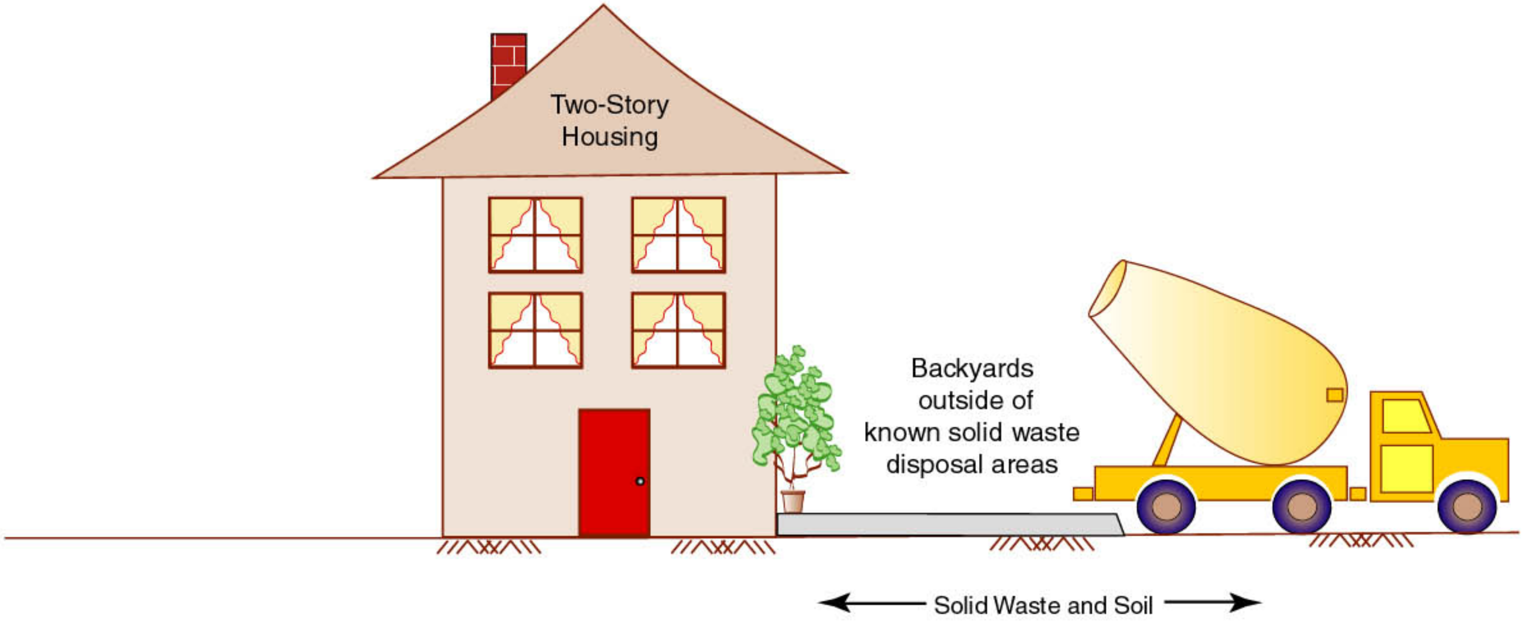

1. Excavate common areas to 2 feet below ground surface
2. Backfill with clean soil
3. Dispose of excavated material at landfill

1. Excavate backyards to 4 feet below ground surface
2. Backfill with clean soil
3. Dispose of excavated material at landfill

**NOTE:** This alternative applies to known solid waste disposal areas only.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

**FIGURE 4-4**
**ALTERNATIVE 4A**



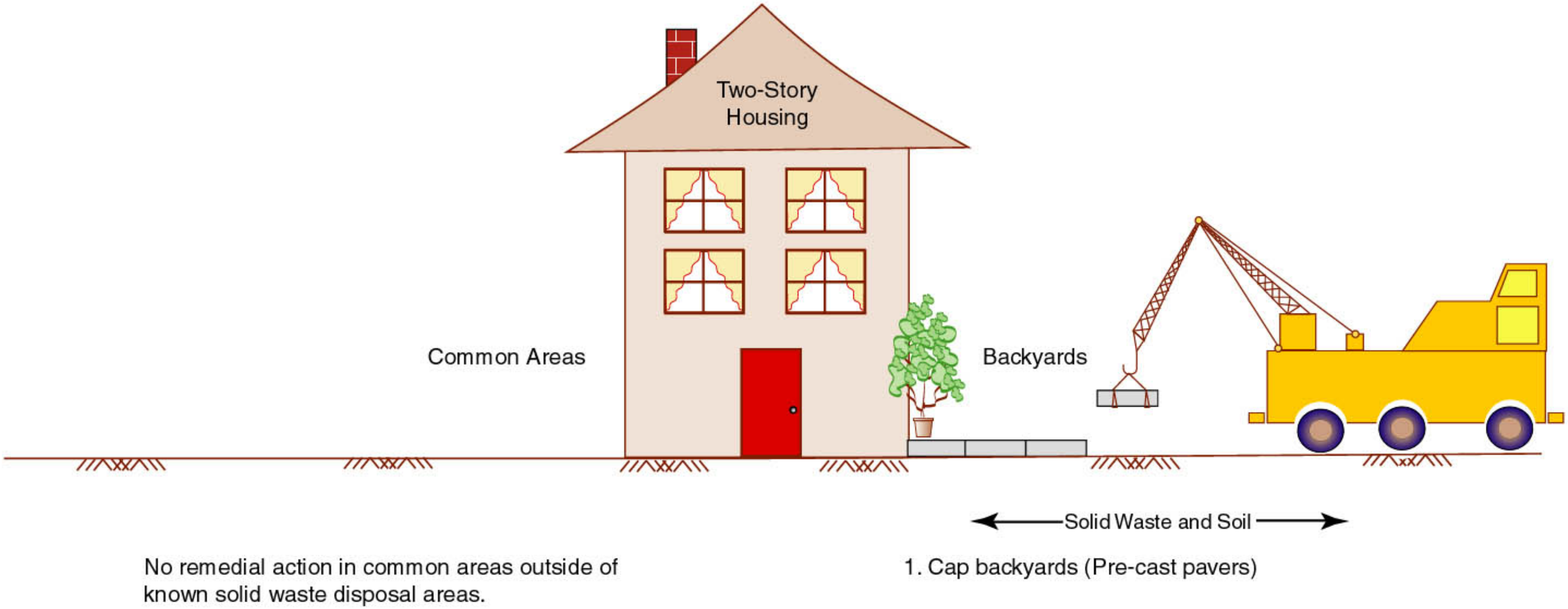

No remedial action in common areas outside of known solid waste disposal areas.

1. Clear and grade surface
2. Pave backyards with 4-inch, mesh-reinforced concrete slab on grade

**NOTE:** This alternative applies to backyards outside of the known solid waste disposal areas.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

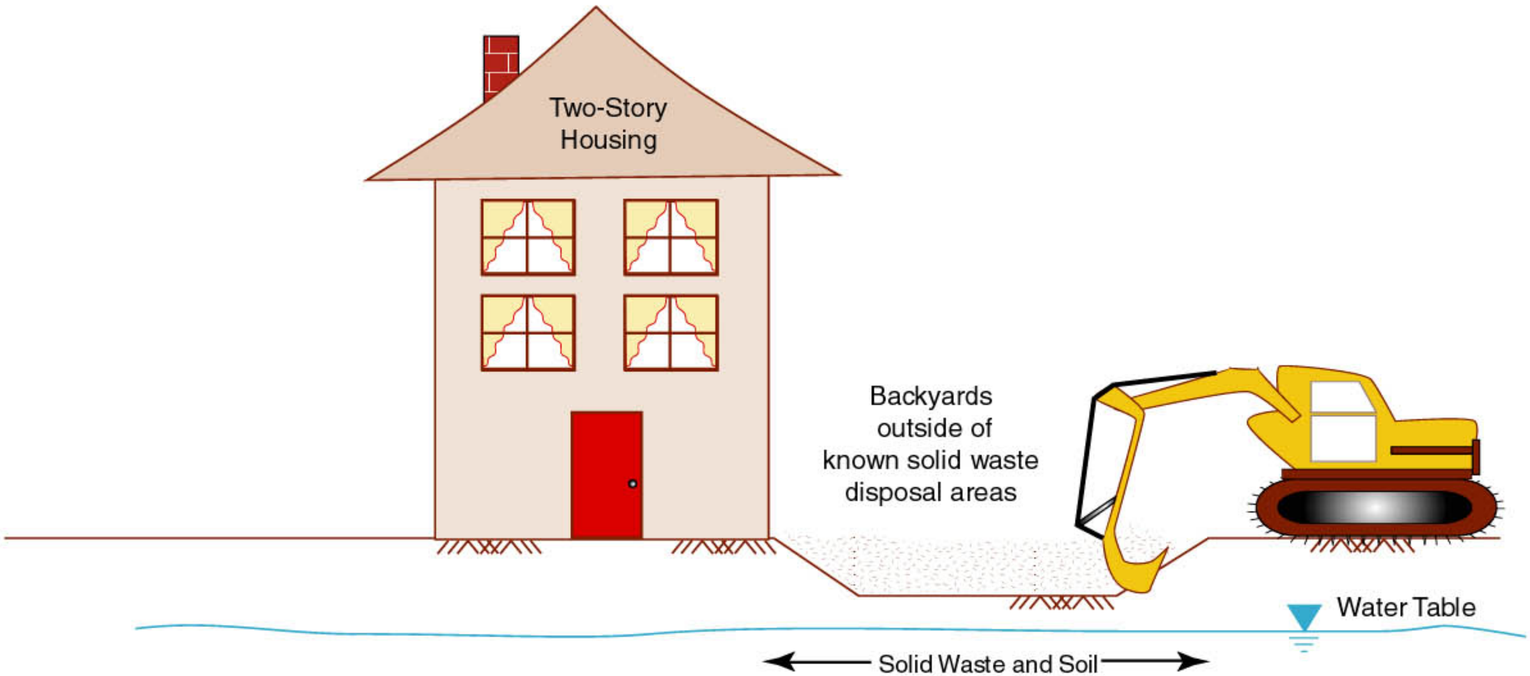
**FIGURE 4-5**
**ALTERNATIVE 1B**




**NOTE:** This alternative applies to backyards outside of the known solid waste disposal area.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

**FIGURE 4-6**
**ALTERNATIVE 2B**



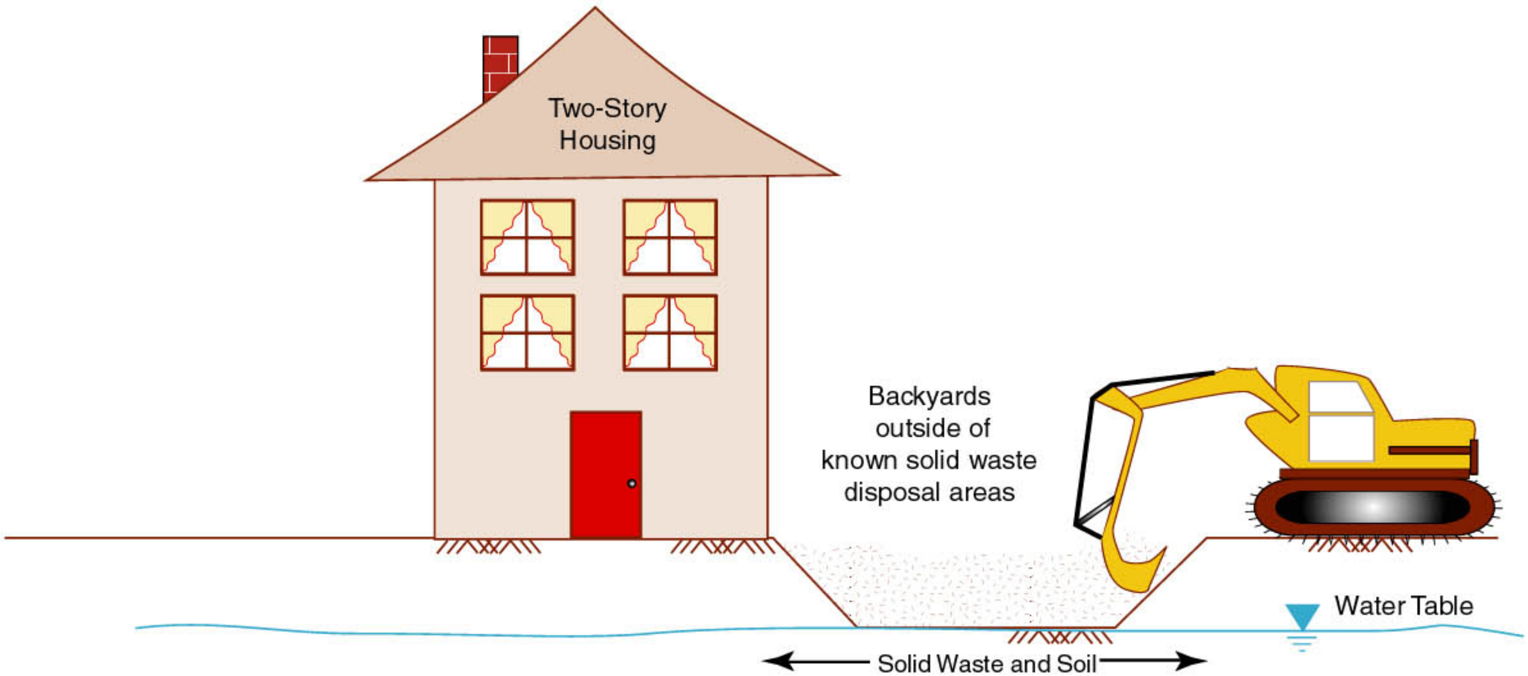

1. Excavate backyards to 2 feet below ground surface
2. Backfill with clean soil
3. Dispose of excavated material at landfill

No remedial action in common areas outside of solid waste areas.

**NOTE:** This alternative applies to backyards outside of the known solid waste disposal areas.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

**FIGURE 4-7**
**ALTERNATIVE 3B**



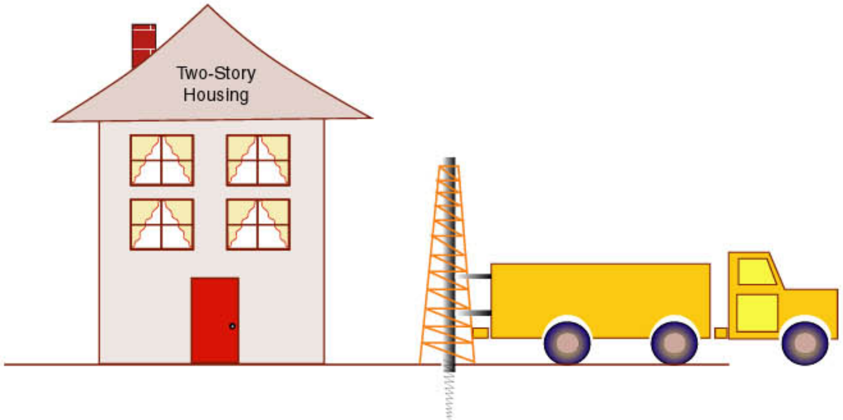

1. Excavate backyards to 4 feet below ground surface
2. Backfill with clean soil
3. Dispose of excavated material at landfill

No remedial action in common areas outside of solid waste areas.

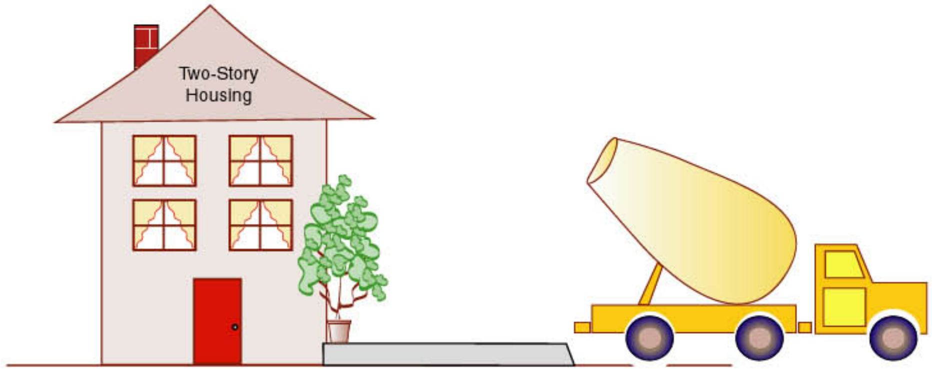
**NOTE:** This alternative applies to backyards outside of the known solid waste disposal areas.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

**FIGURE 4-8**
**ALTERNATIVE 4B**




Field investigate backyards outside known solid waste disposal areas



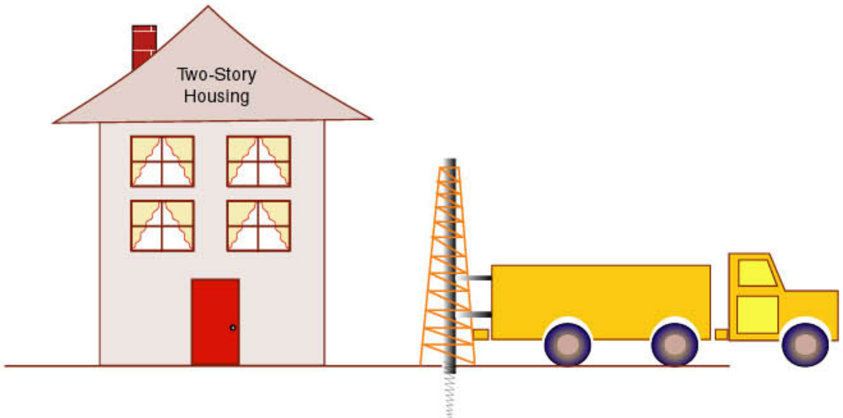

If investigation fails cleanup criteria then,

1. Clean and grade surface
2. Pave backyards with 4-inch mesh reinforced concrete slab on grade

**NOTE:** This alternative applies to backyards outside of the known solid waste disposal areas.

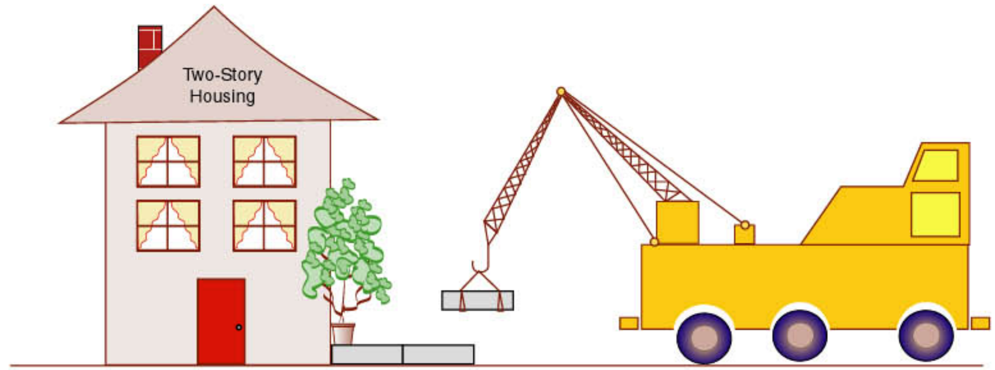
ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

**FIGURE 4-9**
**ALTERNATIVE 5B**




Field investigate backyards outside known solid waste disposal areas

If investigation fails cleanup criteria then,

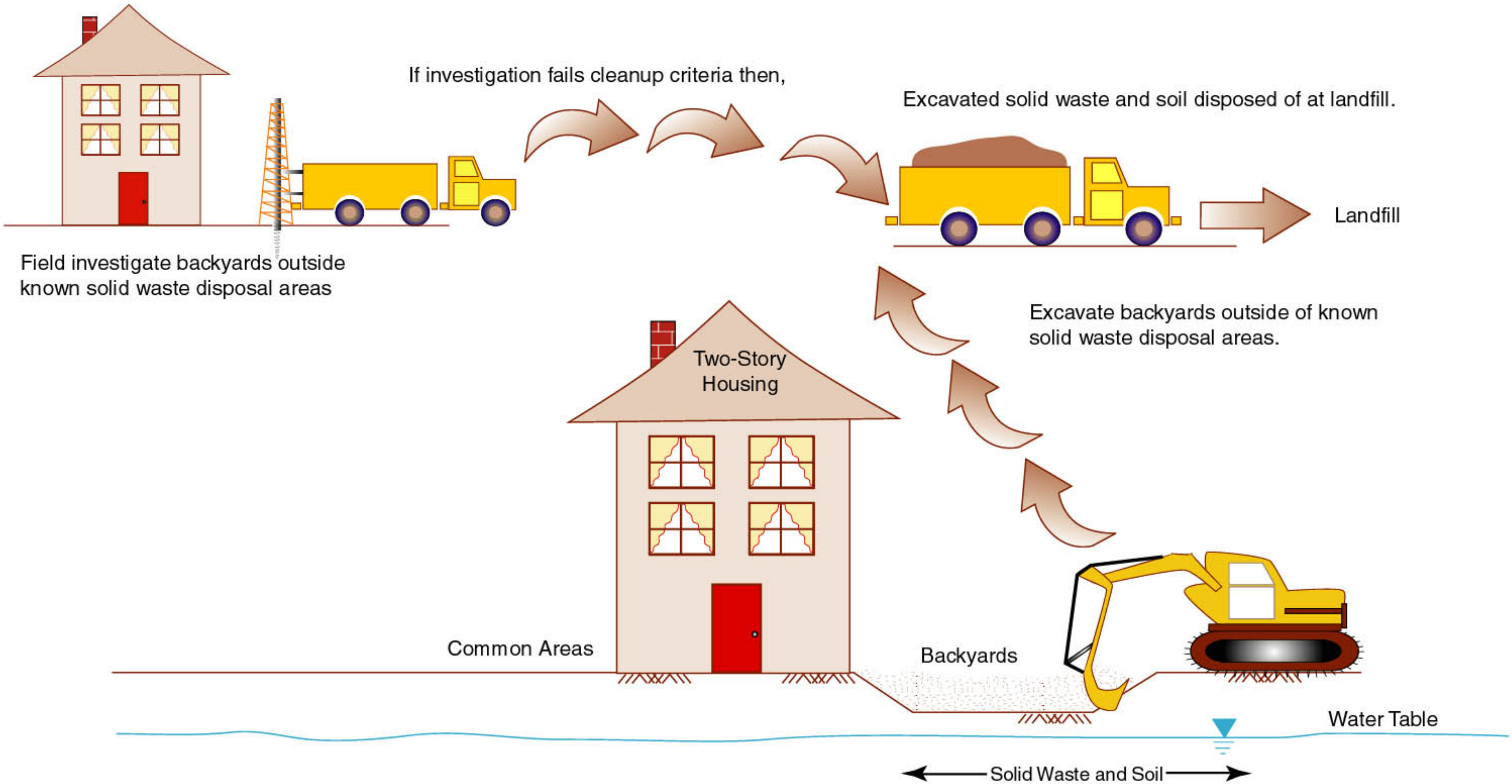



1. Cap backyards (Pre-cast pavers)

**NOTE:** This alternative applies to backyards outside of the known solid waste disposal areas.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

**FIGURE 4-10**
**ALTERNATIVE 6B**



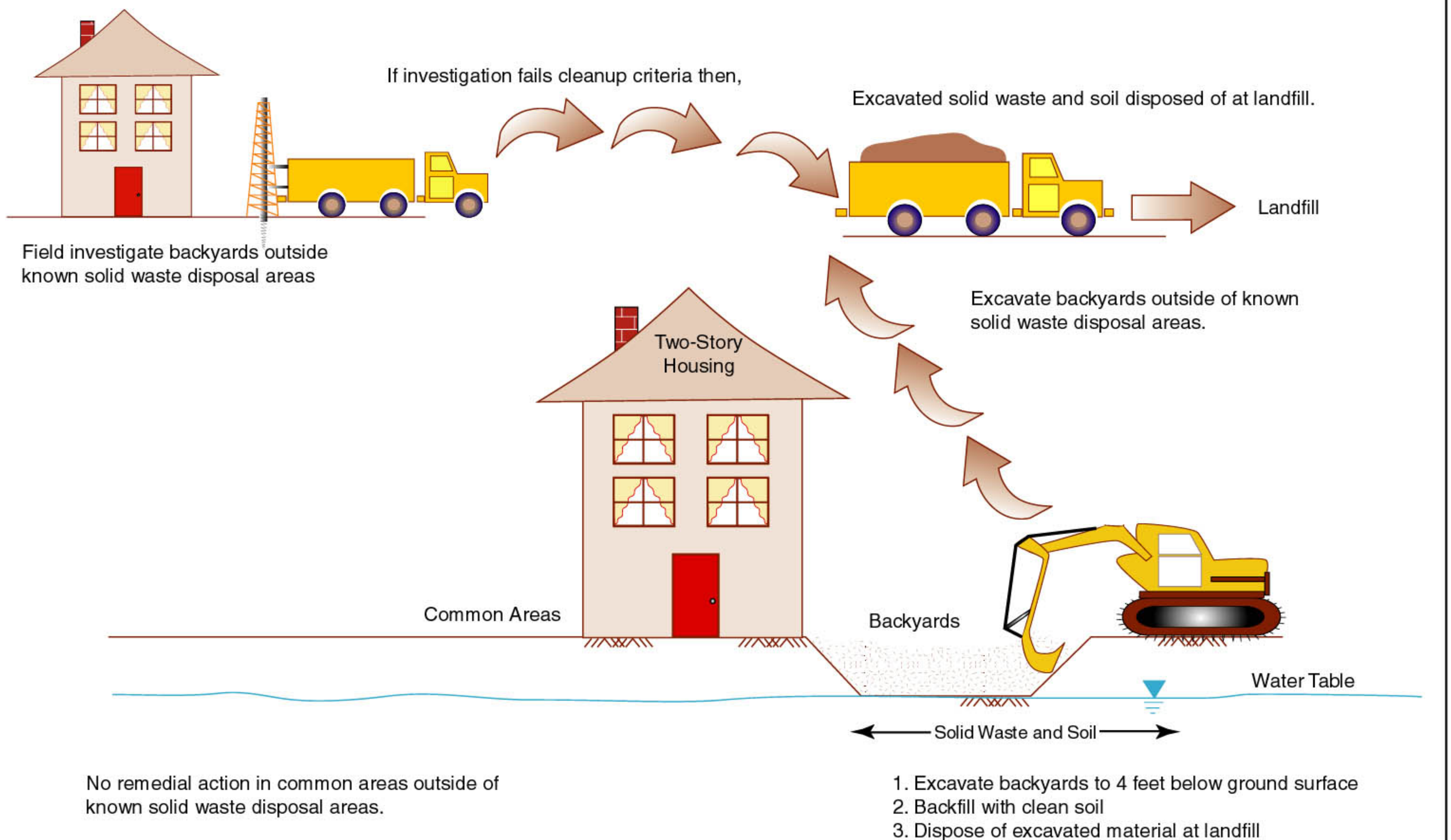

No remedial action in common areas outside of known solid waste disposal areas.

1. Excavate backyards to 2 feet below ground surface
2. Backfill with clean soil
3. Dispose of excavated material at landfill

**NOTE:** This alternative applies to backyards outside of the known solid waste disposal areas.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

**FIGURE 4-11**
**ALTERNATIVE 7B**




**NOTE:** This alternative applies to backyards outside of the known solid waste disposal areas.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

**FIGURE 4-12**
**ALTERNATIVE 8B**

# TABLES

## TABLE 5-1: REMOVAL ACTION COMPARATIVE ANALYSIS BACKYARDS AND COMMON AREAS WITHIN KNOWN SOLID WASTE DISPOSAL AREAS

| | Alternative 1A: Capping Backyards (Poured-In-Place Concrete) and Excavation of Common Areas (2 feet bgs) | Alternative 2A: Capping Backyards (Precast Concrete Pavers) and Excavation of Common Areas (2 feet bgs) | Alternative 3A: Excavation of Backyards (2 feet bgs) and Common Areas (2 feet bgs) | Alternative 4A: Excavation of Backyards (4 feet bgs) and Common Areas (2 feet bgs) |
|---|---|---|---|---|
| **Criterion** | **Comment** | **Comment** | **Comment** | **Comment** |
| **Effectiveness** | | | | |
| 1. Overall Protection of Human Health and the Environment | Concrete capping would provide a durable physical barrier to protect a resident from direct exposure to underlying soil. ICs would be required to protect utility workers and to restrict digging below 2' in common areas and the backyard cap. | Concrete capping would provide a durable physical barrier to protect a resident from direct exposure to underlying soil. ICs would be required to protect utility workers and to restrict digging below 2' in common areas and the backyard cap. | A soil cover would decrease potential exposure and direct contact with underlying soil. ICs would be required to protect utility workers and to restrict digging below 2' bgs. | A soil cover would decrease potential exposure and direct contact with underlying soil. ICs would be required to protect utility workers and to restrict digging below 2' bgs in common areas and 4' bgs in backyards. |
| 2. Compliance with ARARs | It complies with chemical-specific ARARs for lead. It complies with location-specific ARARs because it is consistent with the BCDC Bay Plan. | It complies with chemical-specific ARARs for lead. It complies with location-specific ARARs because it is consistent with the BCDC Bay Plan. | It complies with chemical-specific ARARs for lead. It complies with location-specific ARARs because it is consistent with the BCDC Bay Plan. | It complies with chemical-specific ARARs for lead. It complies with location-specific ARARs because it is consistent with the BCDC Bay Plan. |
| 3. Long-term Effectiveness and Permanence | Long-term effectiveness is achievable with proper maintenance of an off-site landfill for material excavated from site. Concrete would be durable although would require some maintenance. Maintenance of underlying utilities would require partial demolition of cap and protection of workers from exposure to soil. Change in building or site configuration may require further remediation of capped areas and other areas. | Long-term effectiveness is achievable with proper maintenance of an off-site landfill for material excavated from site. Concrete would be durable although would require some maintenance. Maintenance of underlying utilities would require protection of workers from exposure to soil. Change in building or site configuration may require further remediation of capped areas and other areas. | Long-term effectiveness is achievable with proper maintenance of an off-site landfill for material excavated from site. Soil cover would require maintenance to prevent erosion. Change in building or site configuration may require further remediation, although excavated area would not likely require further remediation. | Long-term effectiveness is achievable with proper maintenance of an off-site landfill for material excavated from site. Soil cover would require maintenance to prevent erosion. Change in building or site configuration may require further remediation, although excavated area would not likely require further remediation. |
| 4. Reduction in Toxicity, Mobility, and Volume through Treatment | Capping would reduce mobility of chemical contaminants in soil left on site. Mobility of excavated material would be reduced by controls at off-site landfill.<br>Overall toxicity and volume would not change.<br>Reduction of an on-site volume in common areas. | Capping would reduce mobility of chemical contaminants in soil left on site. Mobility of excavated material would be reduced by controls at off-site landfill.<br>Overall toxicity and volume would not change.<br>Reduction of an on-site volume in common areas. | Mobility of excavated material would be reduced by controls at off-site landfill.<br>Overall toxicity and volume would not change.<br>Reduction of an on-site volume in common areas and backyards. | Mobility of excavated material would be reduced by controls at off-site landfill.<br>Overall toxicity and volume would not change.<br>Greatest reduction of an on-site volume in common areas and backyards. |
| 5. Short-term Effectiveness | Disturbances would occur from cap construction and excavation activities. Approximately 22 weeks will be required to complete this alternative. | Disturbances would occur from cap construction and excavation activities. Approximately 22 weeks will be required to complete this alternative. | Moderate disturbances would occur from excavation of backyards in occupied buildings. Approximately 24 weeks will be required to complete this alternative. | Significant disturbances would occur from excavation of backyards in occupied buildings. Approximately 27 weeks will be required to complete this alternative. |
| **Implementability** | | | | |
| 6. Technical Feasibility and Commercial Availability | Readily implementable.<br>Standard construction techniques are used. Storm water management system may be affected. | Readily implementable.<br>Standard construction techniques are used and pre-cast pavers are available. Storm water management system may be affected. | Readily implementable.<br>Standard construction techniques are used. Some excavation would interfere with utilities. | Readily implementable.<br>Standard construction techniques are used. Excavation would interfere with utilities in backyards. |
| **Cost** | | | | |
| 7. Total Cost | $4.4 million | $4.6 million | $4.6 million | $5.3 million |

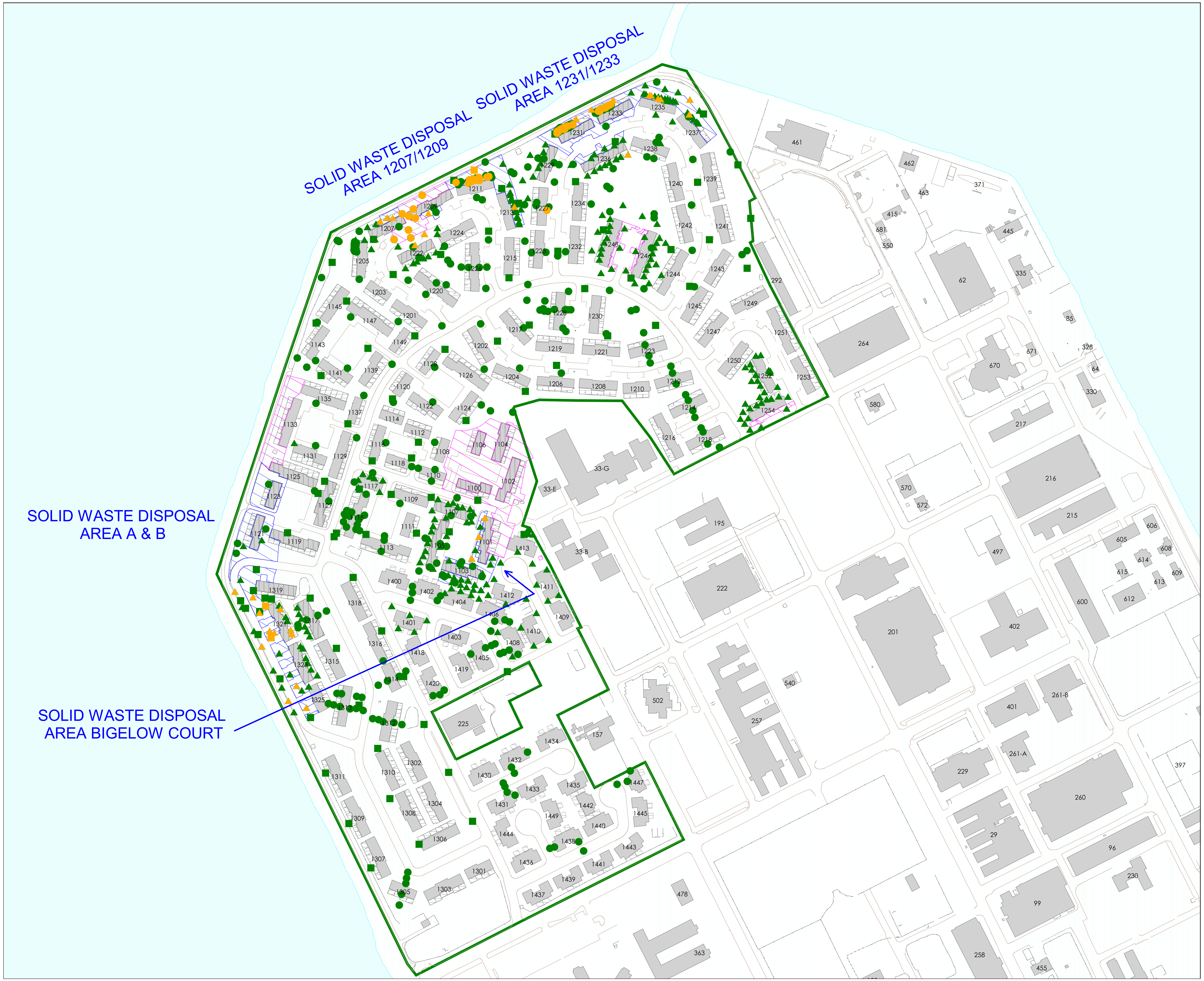
**TABLE 5-2: REMOVAL ACTION COMPARATIVE ANALYSIS**
**BACKYARDS OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**

| | Alternative 1B<br>Capping Backyards (Poured-in-Place Concrete) | Alternative 2B:<br>Capping Backyards (Precast Concrete Pavers) | Alternative 3B<br>Excavation of Backyards to 2' bgs | Alternative 4B<br>Excavation of Backyards to 4' bgs | Alternative 5B:<br>Field Investigation of each Backyard and Capping (Poured In-Place Concrete) those that exceed Cleanup Criteria | Alternative 6B:<br>Field Investigation of each Backyard and Capping (Precast Concrete Pavers) those that exceed Cleanup Criteria | Alternative 7B<br>Field Investigation of each Backyard and Excavation to 2' bgs those that exceed Cleanup Criteria | Alternative 8B<br>Field Investigation of each Backyard and Excavation to 4' bgs those that exceed Cleanup Criteria |
|---|---|---|---|---|---|---|---|---|
| | **Comment** | **Comment** | **Comment** | **Comment** | **Comment** | **Comment** | **Comment** | **Comment** |
| **Effectiveness** | | | | | | | | |
| 1. Overall Protection of Human Health and the Environment | Concrete capping would provide a durable physical barrier to protect a resident from direct exposure to underlying soil. ICs would be required to protect utility workers and to restrict digging below the cap | Concrete capping would provide a durable physical barrier to protect a resident from direct exposure to underlying soil. ICs would be required to protect utility workers and to restrict digging below the cap. | A soil cover would decrease potential exposure and direct contact with underlying soil. ICs would be required to protect utility workers and to restrict digging below 2' bgs. | A soil cover would decrease potential exposure and direct contact with underlying soil. ICs would be required to protect utility workers and to restrict digging below 4' bgs. | Some uncertainty would remain in backyards that are not capped. For backyards that exceed the cleanup criteria, concrete capping would provide a durable physical barrier to protect a resident from direct exposure to underlying soil. ICs would be required to protect utility workers and to restrict digging below the cap | Some uncertainty would remain in backyards that are not capped. For backyards that exceed the cleanup criteria, concrete capping would provide a durable physical barrier to protect a resident from direct exposure to underlying soil. ICs would be required to protect utility workers and to restrict digging below the cap | Some uncertainty would remain in backyards are not excavated. For backyards that exceed the cleanup criteria, a soil cover would decrease potential exposure and direct contact with underlying soil. ICs would be required to protect utility workers and to restrict digging below 2' bgs. | Some uncertainty would remain in backyards are not excavated. For backyards that exceed the cleanup criteria, a soil cover would decrease potential exposure and direct contact with underlying soil. ICs would be required to protect utility workers and to restrict digging below 4' bgs. |
| 2. Compliance with ARARs | It complies with chemical-specific ARARs for lead. It complies with location-specific ARARs because it is consistent with the BCDC Bay Plan. | It complies with chemical-specific ARARs for lead. It complies with location-specific ARARs because it is consistent with the BCDC Bay Plan. | It complies with chemical-specific ARARs for lead. It complies with location-specific ARARs because it is consistent with the BCDC Bay Plan. | It complies with chemical-specific ARARs for lead. It complies with location-specific ARARs because it is consistent with the BCDC Bay Plan. | It complies with chemical-specific ARARs for lead. It complies with location-specific ARARs because it is consistent with the BCDC Bay Plan. | It complies with chemical-specific ARARs for lead. It complies with location-specific ARARs because it is consistent with the BCDC Bay Plan. | It complies with chemical-specific ARARs for lead. It complies with location-specific ARARs because it is consistent with the BCDC Bay Plan. | It complies with chemical-specific ARARs for lead. It complies with location-specific ARARs because it is consistent with the BCDC Bay Plan. |
| 3. Long-term Effectiveness and Permanence | Long-term effectiveness is achievable with proper maintenance of an off-site landfill for material excavated from site. Concrete would be durable although would require some maintenance. Maintenance of underlying utilities would require partial demolition of cap and protection of workers from exposure to soil. Change in building or site configuration may require further remediation of capped areas and other areas. | Long-term effectiveness is achievable with proper maintenance of an off-site landfill for material excavated from site. Concrete would be durable although would require some maintenance. Maintenance of underlying utilities would require protection of workers from exposure to soil. Change in building or site configuration may require further remediation of capped areas and other areas. | Long-term effectiveness is achievable with proper maintenance of an off-site landfill for material excavated from site. Soil cover would require maintenance to prevent erosion. Change in building or site configuration may require further remediation, although excavated area would not likely require further remediation. | Long-term effectiveness is achievable with proper maintenance of an off-site landfill for material excavated from site. Soil cover would require maintenance to prevent erosion. Change in building or site configuration may require further remediation, although excavated area would not likely require further remediation. | For backyards that are below the cleanup criteria (as the result of the field investigation), future soil samples could exceed the cleanup criteria. For backyards that exceed the cleanup criteria, long-term effectiveness is achievable with proper maintenance of an off-site landfill for material excavated from site. Concrete would be durable although would require some maintenance. Maintenance of underlying utilities would require partial demolition of cap and protection of workers from exposure to soil. Change in building or site configuration may require further remediation of capped areas and other areas. | For backyards that are below the cleanup criteria (as the result of the field investigation), future soil samples could exceed the cleanup criteria. For backyards that exceed the cleanup criteria, long-term effectiveness is achievable with proper maintenance of an off-site landfill for material excavated from site. Concrete would be durable although would require some maintenance. Maintenance of underlying utilities would require protection of workers from exposure to soil. Change in building or site configuration may require further remediation of capped areas and other areas. | For backyards that are below the cleanup criteria (as the result of the field investigation), future soil samples could exceed the cleanup criteria. For backyards that exceed the cleanup criteria, long-term effectiveness is achievable with proper maintenance of an off-site landfill for material excavated from site. Soil cover would require maintenance to prevent erosion. Change in building or site configuration may require further remediation, although excavated area would not likely require further remediation. | For backyards that are below the cleanup criteria (as the result of the field investigation), future soil samples could exceed the cleanup criteria. For backyards that exceed the cleanup criteria, long-term effectiveness is achievable with proper maintenance of an off-site landfill for material excavated from site. Soil cover would require maintenance to prevent erosion. Change in building or site configuration may require further remediation, although excavated area would not likely require further remediation. |

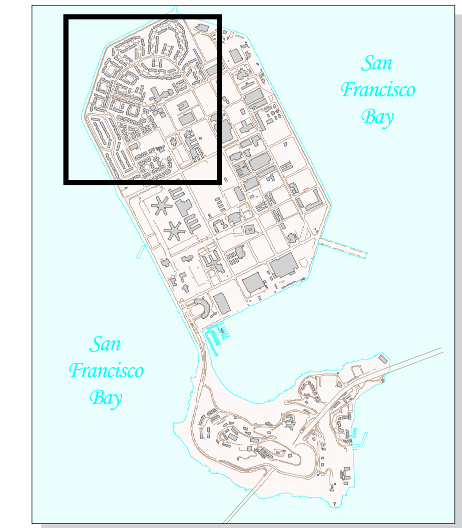
**TABLE 5-2: REMOVAL ACTION COMPARATIVE ANALYSIS**
**BACKYARDS OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**(Continued)**

| | Alternative 1B<br>Capping Backyards (Poured-in-Place Concrete) | Alternative 2B:<br>Capping Backyards (Precast Concrete Pavers) | Alternative 3B<br>Excavation of Backyards to 2' bgs | Alternative 4B<br>Excavation of Backyards to 4' bgs | Alternative 5B:<br>Field Investigation of each Backyard and Capping (Poured In-Place Concrete) those that exceed Cleanup Criteria | Alternative 6B:<br>Field Investigation of each Backyard and Capping (Precast Concrete Pavers) those that exceed Cleanup Criteria | Alternative 7B<br>Field Investigation of each Backyard and Excavation to 2' bgs those that exceed Cleanup Criteria | Alternative 8B<br>Field Investigation of each Backyard and Excavation to 4' bgs those that exceed Cleanup Criteria |
|---|---|---|---|---|---|---|---|---|
| | **Comment** | **Comment** | **Comment** | **Comment** | **Comment** | **Comment** | **Comment** | **Comment** |
| 4. Reduction in Toxicity, Mobility, and Volume through Treatment | Capping would reduce mobility of chemical contaminants in soil left on site. Mobility of excavated material would be reduced by controls at off-site landfill.<br>Toxicity and volume would not change. | Capping would reduce mobility of chemical contaminants in soil left on site. Mobility of excavated material would be reduced by controls at off-site landfill. Toxicity and volume would not change. | Mobility of excavated material would be reduced by controls at off-site landfill. Overall toxicity and volume would not change. Reduction of an on-site volume would occur. | Mobility of excavated material would be reduced by controls at off-site landfill. Overall toxicity and volume would not change. Greatest reduction of an on-site volume would occur. | Capping would reduce mobility of chemical contaminants in soil left on site. Mobility of excavated material would be reduced by controls at off-site landfill. Overall toxicity and volume would not change. Reduction of an on-site volume would occur. | Capping would reduce mobility of chemical contaminants in soil left on site. Mobility of excavated material would be reduced by controls at off-site landfill. Overall toxicity and volume would not change. Reduction of an on-site volume would occur. | Mobility of excavated material would be reduced by controls at off-site landfill. Toxicity and volume would not change. Reduction of an on-site volume would occur. | Mobility of excavated material would be reduced by controls at off-site landfill. Toxicity and volume would not change. Reduction of an on-site volume would occur. |
| 5. Short-term Effectiveness | Disturbances would occur from cap construction and excavation activities. Approximately 34 weeks would be required to complete this alternative. | Disturbances would occur from cap construction and excavation activities. Approximately 34 weeks would be required to complete this alternative. | Significant disturbances would occur from excavation of backyards. Approximately 28 weeks would be required to complete this alternative. | Significant disturbances would occur from excavation of backyards. Approximately 53 weeks would be required to complete this alternative. | Disturbances would occur from site investigation, cap construction, and excavation activities. Approximately 75 weeks would be required to complete this alternative. | Disturbances would occur from site investigation, cap construction, and excavation activities. Approximately 75 weeks would be required to complete this alternative. | Disturbances would occur from site investigation and excavation activities. Approximately 75 weeks would be required to complete this alternative. | Disturbances would occur from site investigation and excavation activities. Approximately 90 weeks would be required to complete this alternative. |
| **Implementability** | | | | | | | | |
| 6. Technical Feasibility and Commercial Availability | Readily implementable.<br>Standard construction techniques are used. Storm water management system may be affected. | Readily implementable.<br>Standard construction techniques are used and pre-cast pavers are available. Storm water management system may be affected. | Readily implementable.<br>Standard construction techniques are used. Excavation would interfere with utilities. | Readily implementable.<br>Standard construction techniques are used. Excavation would interfere with utilities. | Readily implementable.<br>Standard investigation and construction techniques are used. Storm water management system may be affected. | Readily implementable.<br>Standard investigation and construction techniques are used and pre-cast pavers are available. | Readily implementable.<br>Standard investigation and construction techniques are used. Excavation would interfere with utilities. | Readily implementable.<br>Standard investigation and construction techniques are used. Excavation would interfere with utilities. |
| **Cost** | | | | | | | | |
| 7. Total Cost | $4.6 million | $8.2 million | $8.5 million | $14.6 million | $23.2 million | $25.9 million | $26.5 million | $30.4 million |

# APPENDIX A
# FIGURES SHOWING NATURE AND EXTENT OF CONTAMINATION THROUGHOUT INSTALLATION RESTORATION SITE 12




AREA OF INTEREST




LEGEND:

LEAD IN SOIL >= 400 mg/kg
- HYDROPUNCH
- TEST PIT
- OTHER

LEAD IN SOIL <400 mg/kg
- HYDROPUNCH
- TEST PIT
- OTHER

- PRIOR EXCAVATION
- SOLID WASTE DISPOSAL AREA
- SITE 12 BOUNDARY
- ROADS
- BACKYARD FENCING
- BUILDINGS
- UNOCCUPIED BUILDINGS
- SHORELINE

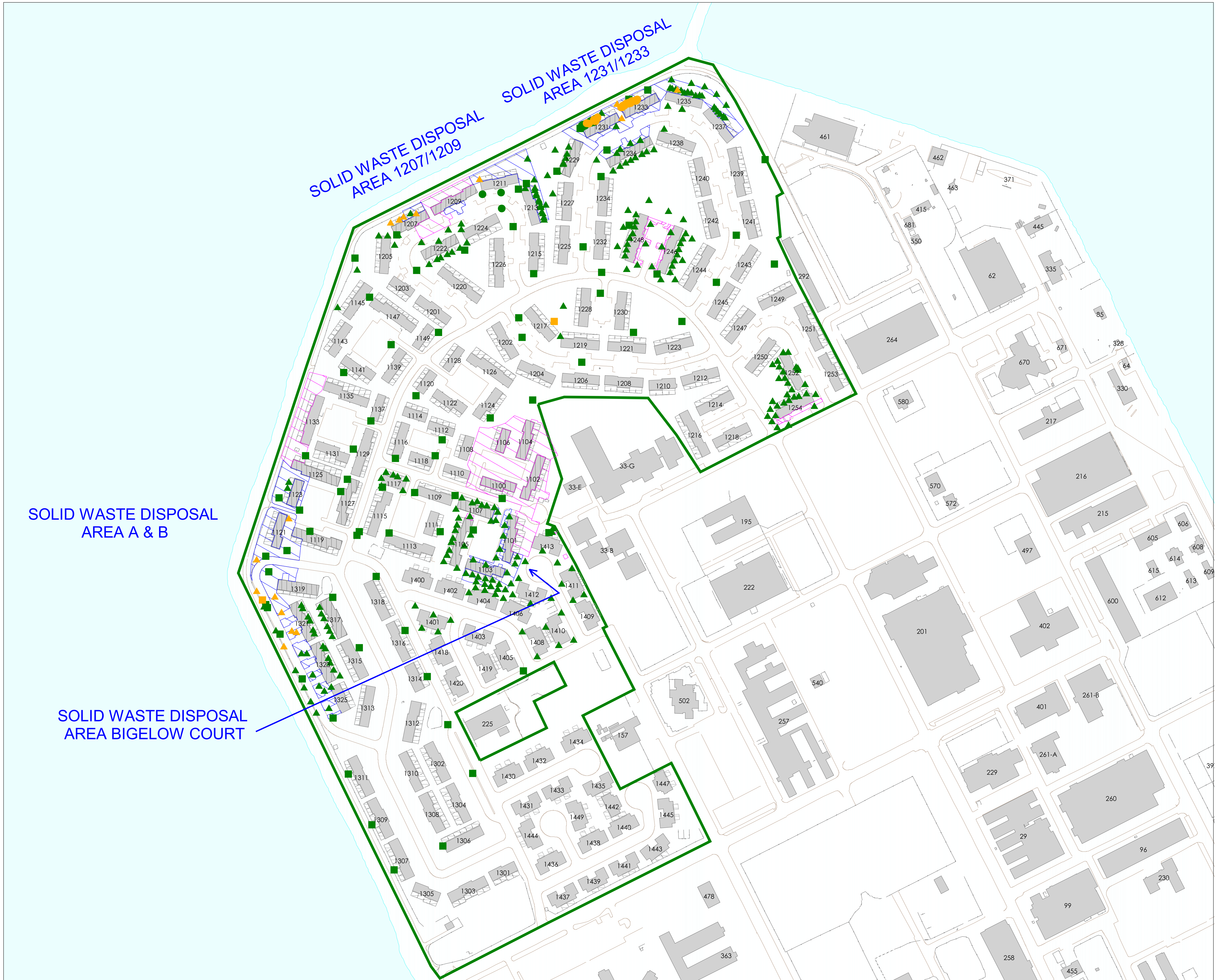
N

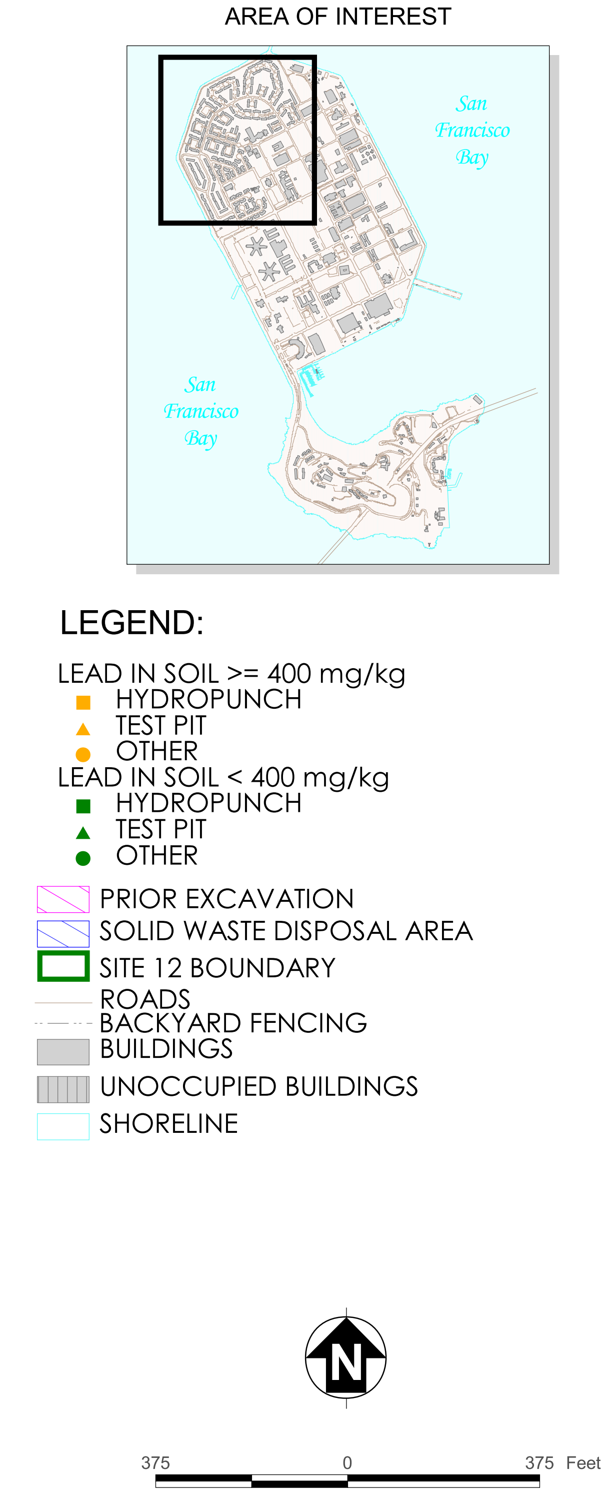
375 0 375 Feet

Tetra Tech EM Inc.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

FIGURE A-1
METAL SAMPLING LOCATIONS
0 TO 2 FEET BELOW GROUND SURFACE
AT SITE 12, NAVSTA TI



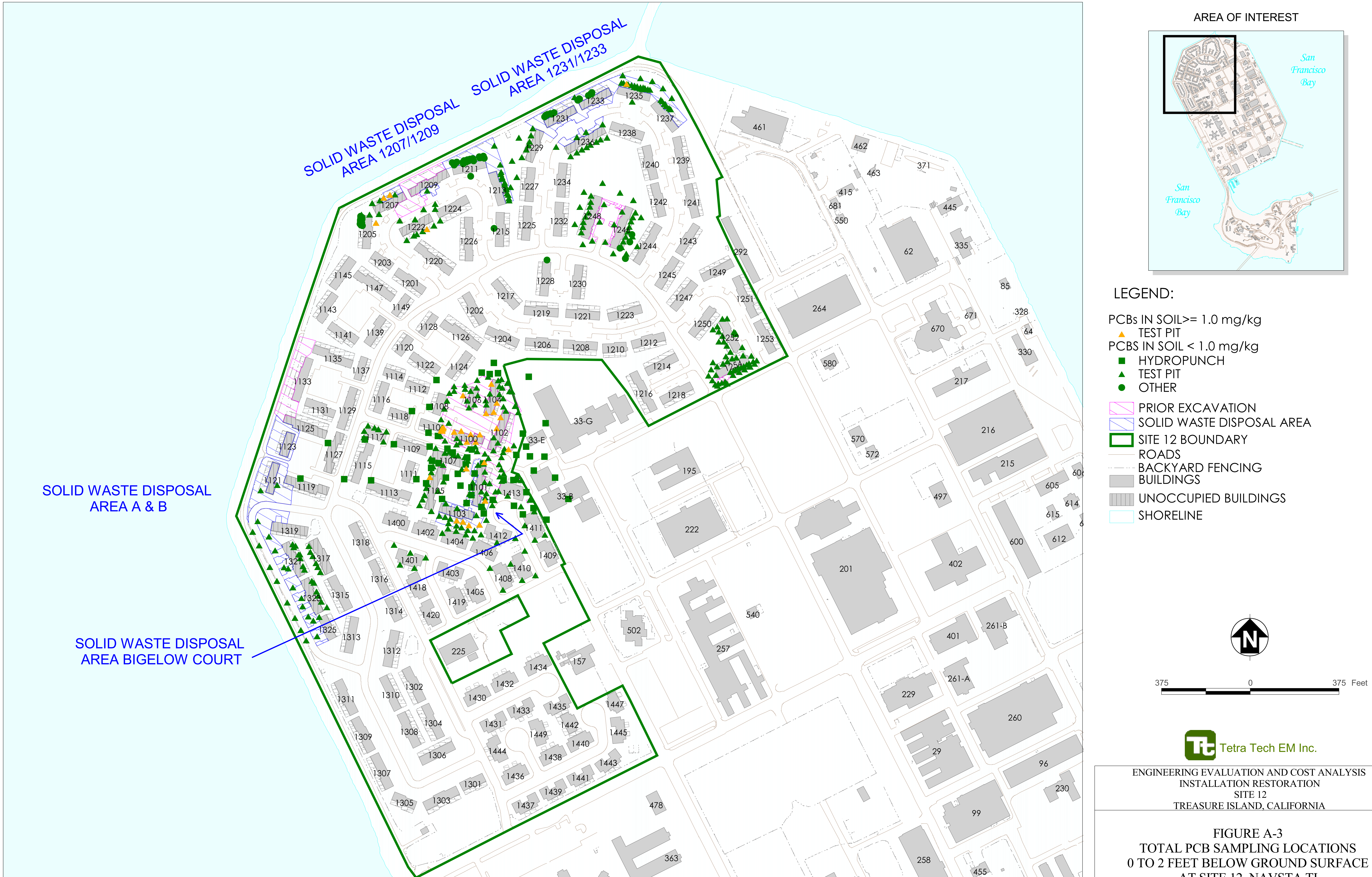

Tetra Tech EM Inc.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

FIGURE A-2
METAL SAMPLING LOCATIONS
2 TO 4 FEET BELOW GROUND SURFACE
AT SITE 12, NAVSTA TI

DS.A035.10059

08-02-2002 v:\treasure island\projects\cto323\eeca\appendix a\clnup_append_a_eeca.apr TtEMI-SF aleksandr.zhuk



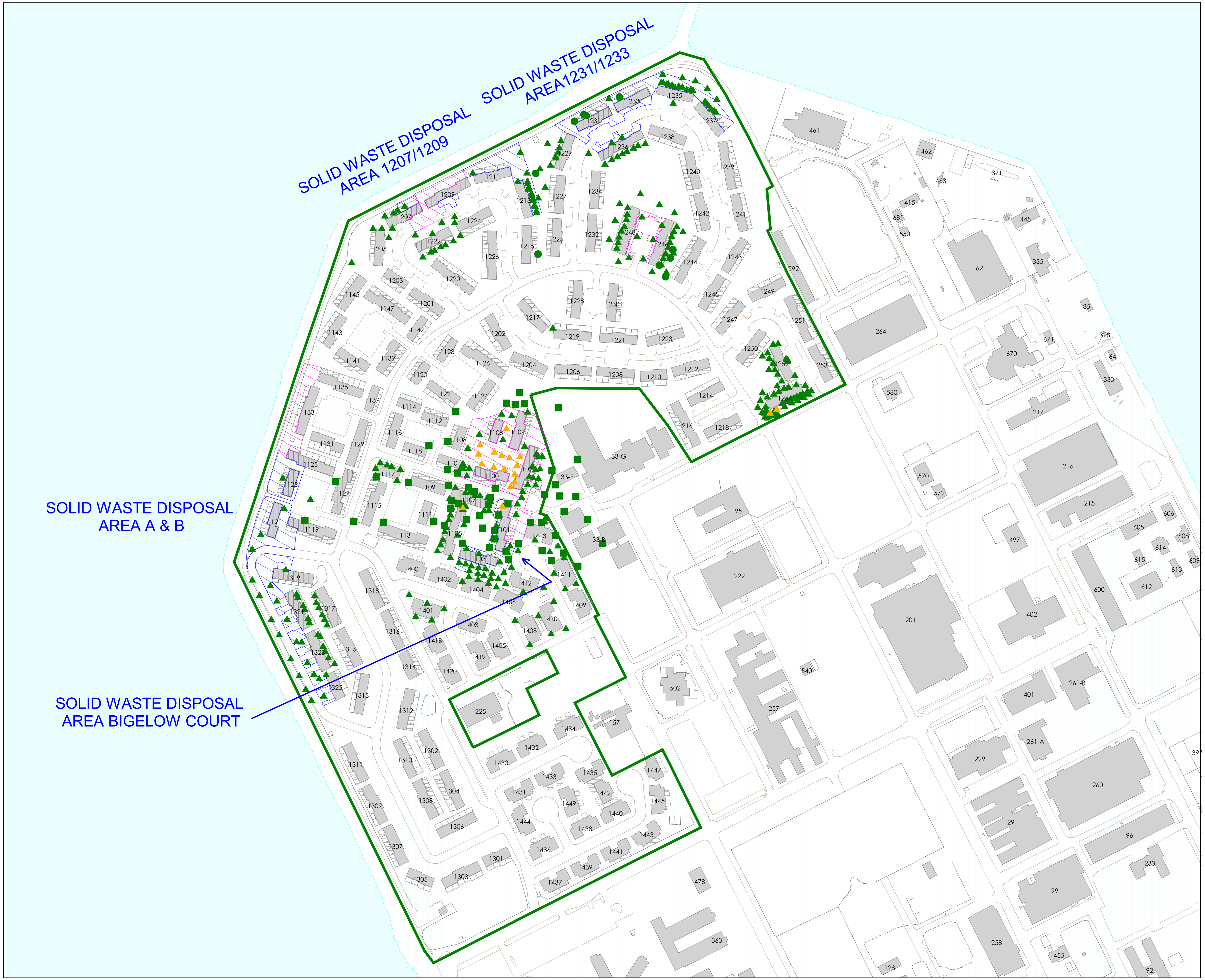

Tetra Tech EM Inc.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

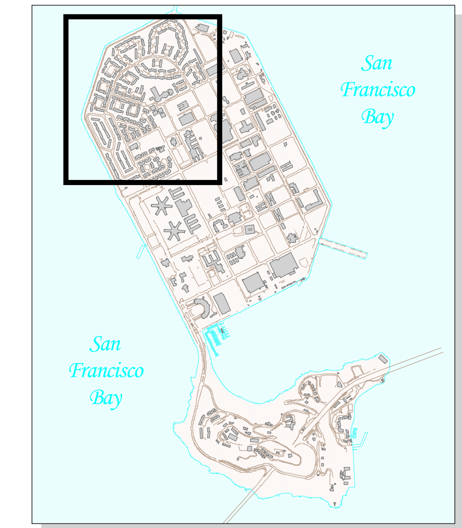
FIGURE A-3
TOTAL PCB SAMPLING LOCATIONS
0 TO 2 FEET BELOW GROUND SURFACE
AT SITE 12, NAVSTA TI

06-28-2002 v:\treasure island\projects\cto323\eeca\appendix a\clnup_append_a_eeca.apr TtEMI-SF robert.lusardi

DS.A035.10059




AREA OF INTEREST




LEGEND:

PCBs IN SOIL>= 1.0 mg/kg
- TEST PIT

PCBS IN SOIL < 1.0 mg/kg
- HYDROPUNCH
- TEST PIT
- OTHER

- PRIOR EXCAVATION
- SOLID WASTE DISPOSAL AREA
- SITE 12 BOUNDARY
- ROADS
- BACKYARD FENCING
- BUILDINGS
- UNOCCUPIED BUILDINGS
- SHORELINE

N

375 0 375 Feet

Tetra Tech EM Inc.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

FIGURE A-4
TOTAL PCB SAMPLING LOCATIONS
2 TO 4 FEET BELOW GROUND SURFACE
AT SITE 12, NAVSTA TI

08-02-2002 v:\treasure island\projects\cto323\eeca\appendix a\clnup_append_a_eeca.apr TtEMI-SF aleksandr.zhuk

DS.A035.10059


Tetra Tech EM Inc.

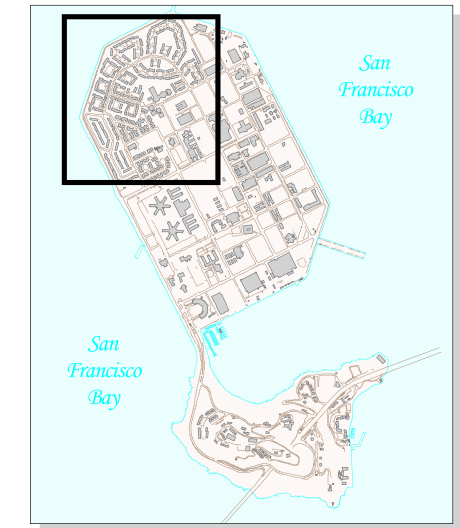
ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

FIGURE A-5
TOTAL PAH SAMPLING LOCATIONS
(BAP EQUIVALENT)
0 TO 2 FEET BELOW GROUND SURFACE
AT SITE 12, NAVSTA TI

06-28-2002 v:\treasure island\projects\cto323\eeca\appendix a\clnup_append_a_eeca.apr TtEMI-SF robert.lusardi

DS.A035.10059


AREA OF INTEREST




LEGEND:

PAHs IN SOIL >= 0.62 mg/kg
- HYDROPUNCH
- TEST PIT

PAHs IN SOIL < 0.62 mg/kg
- HYDROPUNCH
- TEST PIT
- OTHER

- PRIOR EXCAVATION
- SOLID WASTE DISPOSAL AREA
- SITE 12 BOUNDARY
- ROADS
- BACKYARD FENCING
- BUILDINGS
- UNOCCUPIED BUILDINGS
- SHORELINE

375 0 375 Feet

Tetra Tech EM Inc.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

FIGURE A-6
TOTAL PAH SAMPLING LOCATIONS
(BAP EQUIVALENT) AT SITE 12
2 TO 4 FEET BELOW GROUND SURFACE,
NAVSTA TI

## APPENDIX B
## PHOTOGRAPHS OF DEBRIS FROM TEST PITS


**Photo No. 1**
Burnt debris, bottles, and spoons taken from test pits around building 1321
(Solid waste disposal Area A and B)


**Photo No. 2**
Film, a serum bottle, and paint clump taken from test pits around buildings 1213 and 1323
(solid waste disposal areas 1213, and A and B respectively)


**Photo No. 3**
Rusted metal objects taken from test pits around building 1323
(Solid waste disposal Area A and B)


**Photo No. 4**
Typical test pit (building 1254)


**Photo No. 5**
Typical test pit (building 1105)

**Photo No. 6**
Typical test pit (building 1412)

## APPENDIX C
## CONSTRUCTION SPECIFICATIONS DENOTING GRADING PRACTICES FOR HOUSING AT INSTALLATION RESTORATION SITE 12

**RECORD DRAWING**

SHEET 5 OF 135

LETTER DATED 1/19/67

# NOTES

1. EXCAVATE TO EL.+2.0' AND COMPACT EXPOSED SUBGRADE WITH SHEEPSFOOT ROLLER OR RUBBER-TIRED EQUIPMENT HAVING NOT LESS THAN 50 P.S.I. TIRE PRESSURE, 4 PASSES, COMPLETE COVERAGE EACH PASS
2. REPLACE EXCAVATED MATERIAL AND COMPACT IN LAYERS NOT EXCEEDING 8" THICKNESS WITH SHEEPSFOOT ROLLER HAVING FOOTPRINT PRESSURE NOT LESS THAN 400 P.S.I., 4 PASSES EACH LAYER, MIN.
3. WHERE RUBBISH IS FOUND, MIX WITH SOIL TO PREVENT LOCALIZED CONCENTRATIONS OF RUBBISH. DO NOT PLACE RUBBISH ABOVE EL+4, NOR ABOVE 1 FT. BELOW FINISHED SUBGRADE ELEVATION.
4. AT EL.+4 COMPACT WITH 10 TON MINIMUM WEIGHT VIBRATORY ROLLER, 4 PASSES.
5. FROM ELEV.+4 TO FINISHED GRADE, COMPACT TO NOT LESS THAN 95% COMPACTION BASED ON AASHO STANDARD METHOD OF TEST T-180-57.
6. FOR PLANS OF EXISTING AMMO STORAGE FACILITIES TO BE DEMOLISHED, SEE Y&D DWG NO. 1043888
7. All ABOVE GROUND AND UNDERGROUND FACILITIES NOT TO BE USED IN NE[W] CONSTRUCTION ARE TO BE REMOVE[D]

# LEGEND

- TH-3 — SAMPLE BORING (SEE Y&D DWG NO 1043906)
- B-14 — STANDARD PENETRATION BORING (SEE Y&D DWG. NO. 1043[906])
- W-2 — WATER LEVEL OBSERVATION HOLE
- T-3 — TRENCH EXCAVATION (SEE Y&D DWG. NO. 1043906)
- —X— FENCE
- —W— WATER PIPE LINE
- —8— CONTOUR LINE
- FIRE HYDRANT
- STREET LIGHT
- —SD— STORM SEWER
- TREE
- PAVED AREA (A.C.) AND P.C.C. (A)
- RUBBISH DISPOSAL AREAS, LIMITS
- SOIL EXCAVATION AND RECOMPACTION, LIMITS

| | |
|---|---|
| MKE-ABRAMS-KELLER & GANNON<br>A JOINT VENTURE | DEPARTMENT OF THE NAVY — BUREAU OF YARDS & DOCKS<br>DISTRICT PUBLIC WORKS OFFICE<br>TWELFTH NAVAL DISTRICT — SAN BRUNO, CALIFORNIA |
| DES RM / DR MK / CHK RM | U.S. NAVAL STATION, TREASURE ISLAND — SAN FRANCISCO, CALIFORNIA |
| SUPV / CH ENGR RMM | 300 UNITS-APPROPRIATED FUND QUARTERS |
| SUBMITTED BY / DATE | TREASURE ISLAND |
| FIRM MEMBER (TITLE) | EXISTING SITE CONDITION<br>SHEET I |
| DPWO: FIRE / SOIL CON. / UTIL. — PL'N'G. SAMurray / E.I.C. Obrinsky / DIR. O'Connor | |
| SATISFACTORY TO<br>TITLE [illegible] DATE [illegible] | CODE IDENT NO. 80091 — SIZE C — DPWO-12 D'W'G NO. B-72087 |

SEP 4 1984

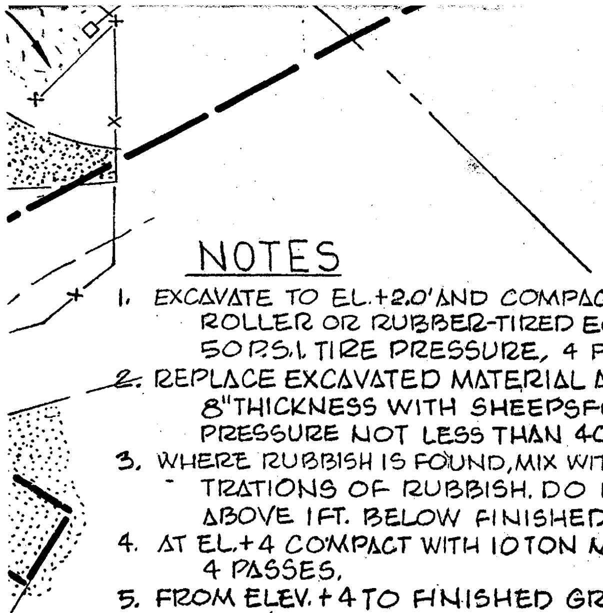
REQUIREMENTS FOR TREATMENT OF FORMER RUBBISH DISPOSAL AREAS AND ASPHALTIC STABILIZED SURFACE MATERIAL (SEE NOTE 6).

1. STRIP FORMER RUBBISH DISPOSAL AREAS TO ELEVATION +2 WITHIN THE LIMITS INDICATED.
2. COMPACT THE SUBGRADE OF THE STRIPPED FORMER RUBBISH DISPOSAL AREAS AT ELEVATION +2 WITH NOT LESS THAN FOUR PASSES OF A SHEEPSFOOT ROLLER WEIGHING NOT LESS THAN EIGHT TONS.
3. REMOVE ASPHALTIC STABLIZED SURFACE MATERIAL FROM THE AREAS INDICATED. SUCH MATERIAL SHALL BE BROKEN INTO PIECES NOT TO EXCEED 12".
4. THE STRIPPED FORMER RUBBISH DISPOSAL AREAS SHALL BE FILLED TO ELEVATION +4 IN COMPACTED LAYERS NOT TO EXCEED EIGHT INCHES IN THICKNESS WITH A THOROUGH MIXTURE OF MATERIAL STRIPPED FROM THE FORMER RUBBISH DISPOSAL AREAS, REMOVED ASPHALTIC STABLIZED SURFACE MATERIAL AND CLEAN SAND. EACH LAYER OF MIXED MATERIAL SHALL BE COMPACTED WITH NOT LESS THAN FOUR PASSES OF A SHEEPSFOOT ROLLER WEIGHING NOT LESS THAN EIGHT TONS. NO MATERIAL SHALL BE REPLACED WITHIN A DISTANCE OF FIFTEEN FEET OF AN AREA THAT IS SIMULTANEOUSLY BEING EXCAVA
5. FROM ELEVATION +4 TO FINISHED GRADE ELEVATION, PLACE CLEAN SANDY SOIL FROM REQUIRED EXCAVATION OR SUITABLE IMPORTED MATERIAL. ALL MATERIAL ABOVE ELEVATION +4 SHALL BE PLACED AND COMPACTED TO 95% MAXIMUM DENSITY AS SPECIFIED.

LETTER DATED 30 MAY 1972

1200-3782 PWC#82449

| | |
|---|---|
| A-E CONTRACT No. NFy 64299 | DEPARTMENT OF THE NAVY—NAVAL FACILITIES ENGINEERING COMMAND |
| MKE-ABRAMS-KELLER & GANNON | WESTERN DIVISION SAN BRUNO, CALIFORNIA |
| DES L.L. / DR G.N. / CHK L.L. | U.S. NAVAL STATION, TREASURE ISLAND SAN FRANCISCO, CALIFORNIA |
| SUPV RMM / CH ENGR RS | 340 UNITS-APPROPRIATED FUND QUARTERS |
| SUBMITTED BY [signature] DATE | SOIL BORING LOGS |
| FIRM MEMBER (TITLE) | |
| WFD: PWE GEEL / SOIL CON. / STR. / M.W.S. / ELEC H.L. JAMES / ENG. CRAZEN | |
| APPROVED | SIZE F / CODE IDENT NO. 80091 / NAVFAC DRWG. NO. 1064646 |
| TITLE DATE | WFD DRWG. NO. B-78646 |
| APPROVED [signature] DATE 3/6/68 | CONSTR. CONTR. NO. N 62474-68-C-0143 |
| WFD FOR COMMANDER, NAVFAC | SCALE NONE / SPEC. 64300/65 / SHEET 42 |



**RECORD DRAWING**

SHEET 5 OF 135

LETTER DATED 1/19/67

## NOTES

1. EXCAVATE TO EL.+2.0' AND COMPACT EXPOSED SUBGRADE WITH SHEEPSFOOT ROLLER OR RUBBER-TIRED EQUIPMENT HAVING NOT LESS THAN 50 P.S.I. TIRE PRESSURE, 4 PASSES, COMPLETE COVERAGE EACH PASS
2. REPLACE EXCAVATED MATERIAL AND COMPACT IN LAYERS NOT EXCEEDING 8" THICKNESS WITH SHEEPSFOOT ROLLER HAVING FOOTPRINT PRESSURE NOT LESS THAN 400 P.S.I., 4 PASSES EACH LAYER, MIN.
3. WHERE RUBBISH IS FOUND, MIX WITH SOIL TO PREVENT LOCALIZED CONCENTRATIONS OF RUBBISH. DO NOT PLACE RUBBISH ABOVE EL+4, NOR ABOVE 1 FT. BELOW FINISHED SUBGRADE ELEVATION.
4. AT EL.+4 COMPACT WITH 10 TON MINIMUM WEIGHT VIBRATORY ROLLER, 4 PASSES.
5. FROM ELEV. +4 TO FINISHED GRADE, COMPACT TO NOT LESS THAN 95% COMPACTION BASED ON AASHO STANDARD METHOD OF TEST T-180-57.
6. FOR PLANS OF EXISTING AMMO STORAGE FACILITIES TO BE DEMOLISHED, SEE Y&D DWG NO. 1043888
7. ALL ABOVE GROUND AND UNDERGROUND FACILITIES NOT TO BE USED IN NE CONSTRUCTION ARE TO BE REMOVE

## LEGEND

| Symbol | Description |
|---|---|
| TH-3 | SAMPLE BORING (SEE Y&D DWG NO 1043906) |
| B-14 | STANDARD PENETRATION BORING (SEE Y&D DWG. NO. 1043 |
| W-2 | WATER LEVEL OBSERVATION HOLE |
| T-3 | TRENCH EXCAVATION (SEE Y&D DWG. NO. 1043906) |
| ——X—— | FENCE |
| ——W—— | WATER PIPE LINE |
| ——8—— | CONTOUR LINE |
| | FIRE HYDRANT |
| | STREET LIGHT |
| ——SD—— | STORM SEWER |
| | TREE |
| | PAVED AREA (A.C.) AND P.C.C. (A) |
| | RUBBISH DISPOSAL AREAS, LIMITS |
| | SOIL EXCAVATION AND RECOMPACTION, LIMITS |

MKE - ABRAMS - KELLER & GANNON
A JOINT VENTURE

DES RM | DR MK | CHK RM
SUPV | CH ENGR RMM
SUBMITTED BY | DATE
FIRM MEMBER (TITLE)
DPWO: FIRE | SOIL CON. | UTIL. | PL'N'G. SAMurray | E.I.C. Obrinsky | DIR. O'Connor
SATISFACTORY TO
TITLE | DATE

DEPARTMENT OF THE NAVY — BUREAU OF YARDS & DOCKS
SEP 4 1984
**DISTRICT PUBLIC WORKS OFFICE**
TWELFTH NAVAL DISTRICT — SAN BRUNO, CALIFORNIA
U.S. NAVAL STATION, TREASURE ISLAND — SAN FRANCISCO, CALIFORNIA
300 UNITS - APPROPRIATED FUND QUARTERS
TREASURE ISLAND
EXISTING SITE CONDITION
SHEET I

CODE IDENT NO. 80091 | SIZE C | DPWO-12 D'W'G NO. B-72087

## REQUIREMENTS FOR TREATMENT OF FORMER RUBBISH DISPOSAL AREAS AND ASPHALTIC STABILIZED SURFACE MATERIAL (SEE NOTE 6).

1. STRIP FORMER RUBBISH DISPOSAL AREAS TO ELEVATION +2 WITHIN THE LIMITS INDICATED.
2. COMPACT THE SUBGRADE OF THE STRIPPED FORMER RUBBISH DISPOSAL AREAS AT ELEVATION +2 WITH NOT LESS THAN FOUR PASSES OF A SHEEPSFOOT ROLLER WEIGHING NOT LESS THAN EIGHT TONS.
3. REMOVE ASPHALTIC STABLIZED SURFACE MATERIAL FROM THE AREAS INDICATED. SUCH MATERIAL SHALL BE BROKEN INTO PIECES NOT TO EXCEED 12".
4. THE STRIPPED FORMER RUBBISH DISPOSAL AREAS SHALL BE FILLED TO ELEVATION +4 IN COMPACTED LAYERS NOT TO EXCEED EIGHT INCHES IN THICKNESS WITH A THOROUGH MIXTURE OF MATERIAL STRIPPED FROM THE FORMER RUBBISH DISPOSAL AREAS, REMOVED ASPHALTIC STABLIZED SURFACE MATERIAL AND CLEAN SAND. EACH LAYER OF MIXED MATERIAL SHALL BE COMPACTED WITH NOT LESS THAN FOUR PASSES OF A SHEEPSFOOT ROLLER WEIGHING NOT LESS THAN EIGHT TONS. NO MATERIAL SHALL BE REPLACED WITHIN A DISTANCE OF FIFTEEN FEET OF AN AREA THAT IS SIMULTANEOUSLY BEING EXCAVA
5. FROM ELEVATION +4 TO FINISHED GRADE ELEVATION, PLACE CLEAN SANDY SOIL FROM REQUIRED EXCAVATION OR SUITABLE IMPORTED MATERIAL. ALL MATERIAL ABOVE ELEVATION +4 SHALL BE PLACED AND COMPACTED TO 95% MAXIMUM DENSITY AS SPECIFIED.

LETTER DATED ᵘᵘ MAY 1972

1200-3782

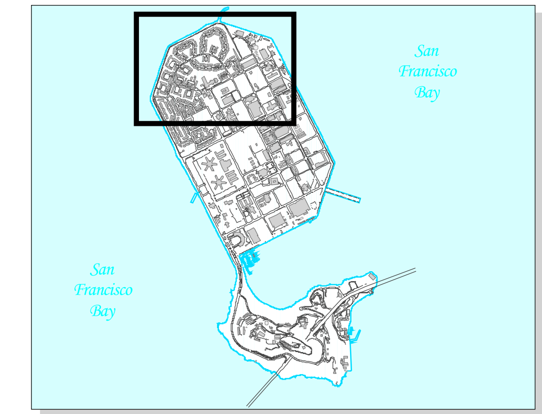
PWC#82449

| | |
|---|---|
| A-E CONTRACT No. NFy 64299<br>MKE-ABRAMS-KELLER & GANNON | DEPARTMENT OF THE NAVY—NAVAL FACILITIES ENGINEERING COMMAND<br>WESTERN DIVISION<br>SAN BRUNO, CALIFORNIA |
| DES L.L. / DR G.N. / CHK L.L.<br>SUPV RMM / CH ENGR R.S<br>SUBMITTED BY [signature] DATE<br>FIRM MEMBER (TITLE)<br>BFD: FNDR GEEL / M.W.D. / SOIL CON. / S.I.C. H.L. JAMES / ARCH. / EN. CRIZEN<br>APPROVED<br>TITLE DATE<br>APPROVED [signature] DATE 3/6/68<br>BFD FOR COMMANDER, NAVFAC | U.S. NAVAL STATION, TREASURE ISLAND SAN FRANCISCO, CALIFORNIA<br>340 UNITS-APPROPRIATED FUND QUARTERS<br>SOIL BORING LOGS |

| SIZE | CODE IDENT NO. | | |
|---|---|---|---|
| F | 80091 | NAVFAC DRWG. NO. | 1064646 |
| | | BFD DRWG. NO. | B-78646 |
| | | CONSTR. CONTR. NO. | N 62474-68-C-0143 |
| SCALE | NONE | SPEC. 64300/65 | SHEET 42 |

## APPENDIX D
## HISTORICAL AERIAL PHOTOGRAPHS


AREA OF INTEREST




LEGEND:

SITE12 BOUNDARY

REFERENCE: U.S. NAVY. 1945. AERIAL PHOTOGRAPH OF NAVAL STATION TREASURE ISLAND; SAN FRANCISCO BAY, CALIFORNIA. FEBRUARY 20.

N

400 0 400 Feet

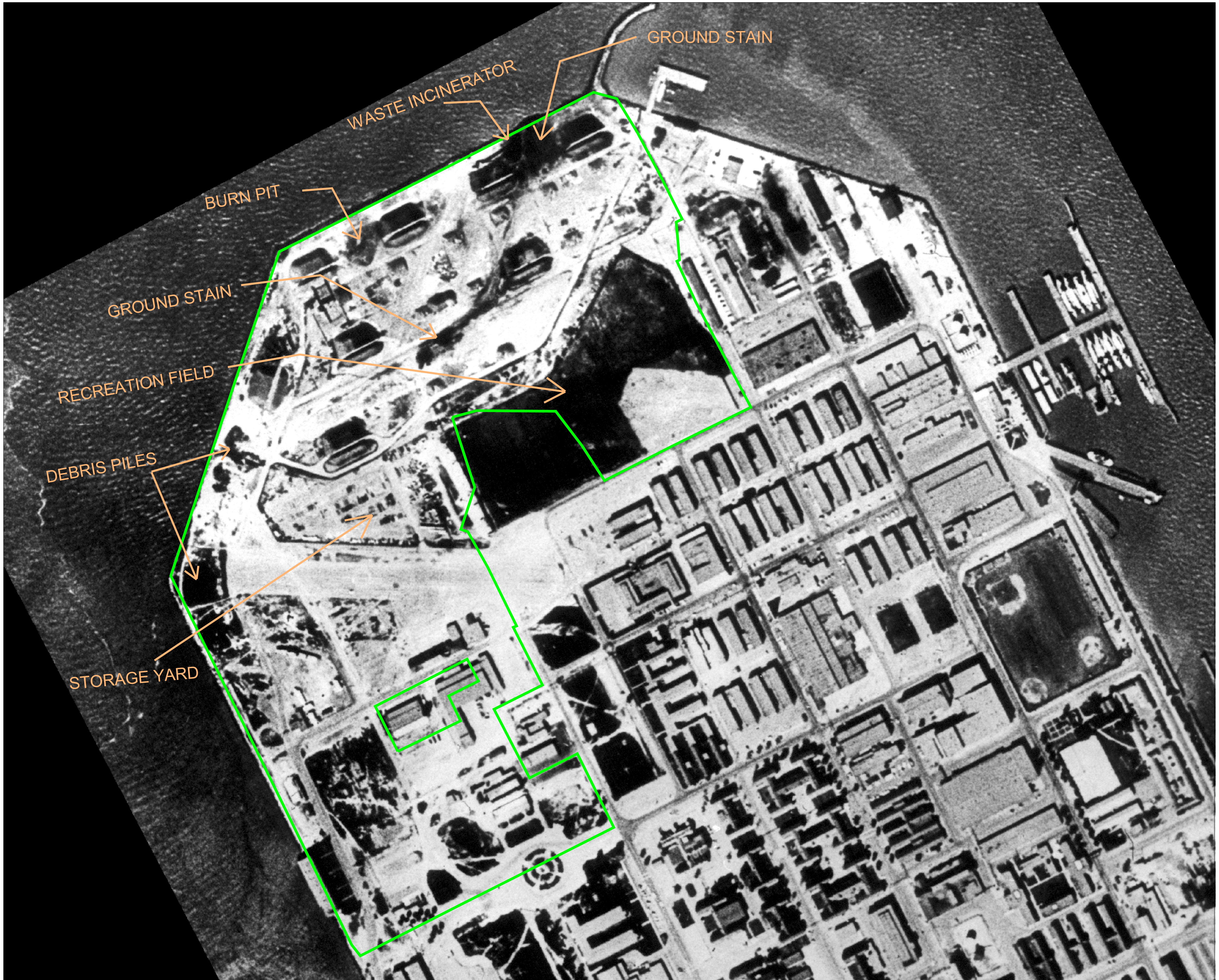
Tetra Tech EM Inc.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

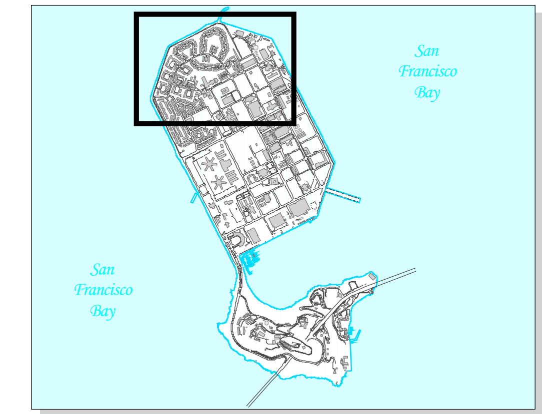
FIGURE D-1
1945 AERIAL PHOTOGRAPH OF
SITE 12, NAVSTA, TI

DS.A035.10059

08-23-2002 v:\treasure island\projects\cto323\site 12 community\aerials.apr TtEMI-SF robert.lusardi




AREA OF INTEREST




LEGEND:

SITE12 BOUNDARY

REFERENCE: PACIFIC AERIAL SURVEYS. 1958. AERIAL PHOTOGRAPH OF NAVAL STATION TREASURE ISLAND; SAN FRANCISCO BAY, CALIFORNIA. OAKLAND, CALIFORNIA. MARCH 1. PIC 95707, FRAME NO. 156.

N

400 0 400 Feet

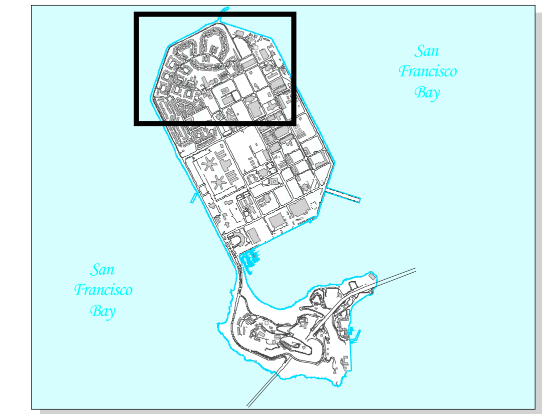
Tetra Tech EM Inc.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

FIGURE D-2
1958 AERIAL PHOTOGRAPH OF
SITE 12, NAVSTA, TI

DS.A035.10059

08-23-2002 v:\treasure island\projects\cto323\site 12 community\aerials.apr TtEMI-SF robert.lusardi


LEGEND:

SITE12 BOUNDARY

REFERENCE: PACIFIC AERIAL SURVEYS. 1968. AERIAL PHOTOGRAPH OF NAVAL STATION TREASURE ISLAND; SAN FRANCISCO BAY, CALIFORNIA. OAKLAND, CALIFORNIA. APRIL 10. PHOTO NO. AV-844-11-29.

N

400 0 400 Feet

Tetra Tech EM Inc.

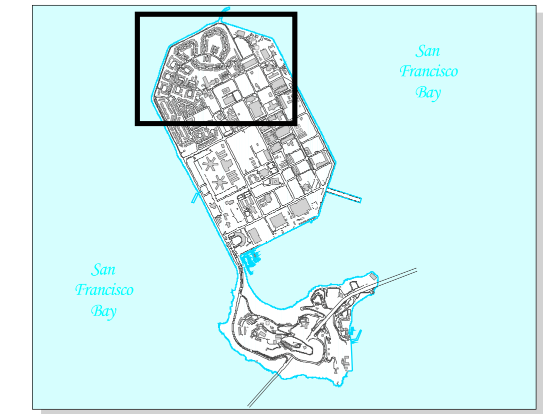
ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

FIGURE D-3
1968 AERIAL PHOTOGRAPH OF
SITE 12, NAVSTA, TI

DS.A035.10059

08-23-2002 v:\treasure island\projects\cto323\site 12 community\aerials.apr TtEMI-SF robert.lusardi


AREA OF INTEREST




LEGEND:

SITE12 BOUNDARY

REFERENCE: PACIFIC AERIAL SURVEYS. 2000. AERIAL PHOTOGRAPH OF NAVAL STATION TREASURE ISLAND; SAN FRANCISCO BAY, CALIFORNIA. OAKLAND, CALIFORNIA. AUGUST 15. PHOTO NO. SF AV 6600 8 2.

N

400 0 400 Feet

Tetra Tech EM Inc.

ENGINEERING EVALUATION AND COST ANALYSIS
INSTALLATION RESTORATION
SITE 12
TREASURE ISLAND, CALIFORNIA

FIGURE D-4
2000 AERIAL PHOTOGRAPH OF
SITE 12, NAVSTA, TI

DS.A035.10059

08-23-2002 v:\treasure island\projects\cto323\site 12 community\aerials.apr TtEMI-SF robert.lusardi

# APPENDIX E
# APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

## APPENDIX E
## APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

### INTRODUCTION

This appendix identifies and evaluates potential federal and state applicable or relevant and appropriate requirements (ARAR) from the universe of regulations, requirements, and guidance, and sets forth the U.S. Department of the Navy's determinations regarding those potential ARARs for each response action alternative retained for detailed analysis in this engineering evaluation and cost analysis (EE/CA) for IR Site 12, Treasure Island, San Francisco, California.

Because this evaluation is conducted as part of an EE/CA, this evaluation includes an initial determination of whether the potential ARARs actually qualify as ARARs. The identification of ARARs is an iterative process. The final determination of ARARs will be made by the Navy in the action memorandum (AM), after public review, as part of the response action selection process.

### SUMMARY OF CERCLA AND NCP REQUIREMENTS

Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), at 42 United States Code (U.S.C.) § 9621(d), as amended, states that remedial actions at CERCLA sites must attain (or the decision document must justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate. Although Section 121 of CERCLA does not itself expressly require that CERCLA removal actions comply with ARARs, the U.S. Environmental Protection Agency (EPA) has promulgated a requirement in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) mandating that CERCLA removal actions "… shall, to the extent practicable considering the exigencies of the situation, attain applicable or relevant and appropriate requirements under federal environmental or state environmental or facility siting laws" (Title 40 Code of Federal Regulations [CFR] § 300.415(j)]). It is Navy policy to follow this requirement. Certain specified waivers may be used for removal actions, as is the case with remedial actions.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. The requirement is applicable if the jurisdictional prerequisites of the standard show a direct correspondence when objectively compared to the conditions at the site. An applicable federal requirement is an ARAR. An applicable state requirement is an ARAR only if it is more stringent than federal ARARs.

If the requirement is not legally applicable, then the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations similar to the circumstances of the proposed remedial action and are well suited to the conditions of the site. A requirement must be determined to be both relevant and appropriate in order to be considered an ARAR.

The criteria for determining relevance and appropriateness are listed at 40 C.F.R. § 300.400(g)(2) and include the following:

- The purpose of the requirement and the purpose of the CERCLA action
- The medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site
- The substances regulated by the requirement and the substances found at the CERCLA site
- Any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site
- The type of place regulated and the type of place affected by the release or CERCLA action
- The type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action
- Any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resources at the CERCLA site

According to CERCLA ARARs guidance (EPA 1988), a requirement may be "applicable" or "relevant and appropriate," but not both. Identification of ARARs must be done on a site-specific basis and involves a two-part analysis: first, a determination whether a given requirement is applicable; then, if it is not applicable, a determination whether it is nevertheless both relevant and appropriate. It is important to explain that some regulations may be applicable or, if not applicable, may still be relevant and appropriate. When the analysis determines that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable.

Tables included in this appendix present each potential ARAR with a determination of theirARAR status (that is, applicable; relevant and appropriate; not an ARAR; or to be considered [TBC]). For the determination of relevance and appropriateness, the pertinent criteria were examined to determine whether the requirements addressed problems or situations sufficiently similar to the circumstances of the release or remedial action contemplated, and whether the requirement was well suited to the site.

To qualify as a state ARAR under CERCLA and the NCP, a state requirement must be:

- A state law
- An environmental or facility siting law

- Promulgated (of general applicability and legally enforceable)
- Substantive (not procedural or administrative)
- More stringent than the federal requirement
- Identified in a timely manner
- Consistently applied

To constitute an ARAR, a requirement must be substantive. Therefore, only the substantive provisions of requirements identified as ARARs in this EE/CA are considered to be ARARs. Permits are considered to be procedural or administrative requirements. Provisions of generally relevant federal and state statutes and regulations that were determined to be procedural or non-environmental, including permit requirements, are not considered to be ARARs. CERCLA 121(e)(1), 42 U.S.C. § 9621(e)(1), states that "No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely on-site, where such remedial action is selected and carried out in compliance with this section." The term *on-site* is defined for purposes of this ARARs discussion as "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action" (40 C.F.R. § 300.5).

Nonpromulgated advisories or guidance issued by federal or state governments are not legally binding and do not have the status of ARARs. Such requirements may, however, be useful, and are TBC. TBC (40 C.F.R. § 300.400[g][3]) requirements complement ARARs but do not override them. They are useful for guiding decisions regarding cleanup levels or methodologies when regulatory standards are not available.

As the lead federal agency, the Navy has primary responsibility for identifying federal ARARs at Treasure Island. The Cal/EPA is responsible for identifying and advising the Navy of state ARARs relating to the site.

## CHEMICAL-SPECIFIC ARARS

Chemical-specific ARARs are generally health- or risk-based numerical values or methodologies applied to site-specific conditions that result in the establishment of a cleanup level. Many potential ARARs associated with particular response alternatives (such as closure or discharge) can be characterized as action-specific but include numerical values or methodologies to establish them so they fit in both categories (chemical- and action-specific). Soil is the only medium of concern for this removal action at Site 12. Chemical-specific ARARs are presented in Table E-1.

The only potential chemical-specific ARARs are those requirements applicable to the identification and land disposal of hazardous waste. Whenever a contaminated medium is being excavated, waste materials are generated. The applicability of RCRA hazardous waste management requirements depends on whether the waste is a RCRA hazardous waste; whether the waste was initially treated, stored, or disposed of after the effective date of the particular RCRA requirement; and whether the activity at the site constitutes treatment, storage, or disposal as defined by RCRA. RCRA requirements may be relevant and appropriate even if they are not applicable. Examples include activities that are similar to the definition of RCRA treatment, storage, or disposal of waste that is similar to RCRA hazardous waste.

The determination of whether a waste is a RCRA hazardous waste can be made by comparing the site waste to the definition of RCRA hazardous waste. The RCRA requirements at Title 22 of the California Code of Regulations (CCR) §66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100 are potential ARARs because they define RCRA hazardous waste. A waste can meet the definition of hazardous waste if it has the toxicity characteristic of hazardous waste. This determination is made by using the toxicity characteristic leaching procedure (TCLP). The maximum concentrations allowable for the TCLP listed in §66261.24(a)(1)(B) are potential federal ARARs for determining whether a waste is hazardous waste. If the waste has concentrations exceeding these values, it is determined to be a characteristic RCRA hazardous waste. If site waste is found to contain hazardous waste, it will be managed in accordance with EPA's "contained-in" policy until it no longer contains hazardous waste.

Site waste may also contain non-RCRA hazardous waste under California law. Therefore, non-RCRA, state-regulated waste definition requirements at 22 CCR §66261.24(a)(2) are potential state ARARs for determining whether other RCRA requirements are potential state ARARs.

RCRA land disposal restrictions (LDR) at 22 CCR §66268.1(f) are also potential federal ARARs for discharging waste to land. The LDRs prohibit the disposal of hazardous waste to land unless (1) it is treated in accordance with the treatment standards of §66268.40, and the underlying hazardous constituents meet the Universal Treatment Standards at §66268.48; (2) it is treated to meet the alternative treatment standards at §66268.49; or (3) a treatability variance is obtained under §66268.44. These are potentially applicable federal ARARs because they are part of the state-approved RCRA program. RCRA treatment standards for non-RCRA, state-regulated waste are not potentially applicable federal ARARs but they may be relevant and appropriate state ARARs.

The Navy has identified a potential chemical-specific TBC for lead for human receptors. The EPA Region 9 risk-based PRG for lead in residential soil, 400 mg/kg (EPA 1999), has been accepted by the Navy and the California Department of Toxic Substances Control (DTSC) as the cleanup goal for lead concentrations for prior Site 12 removal actions and will be used for this removal action.

## LOCATION-SPECIFIC ARARS

Location-specific ARARs are restrictions placed on the concentrations of hazardous substances or the conduct of activities as a result of the characteristics of the site or its immediate environment. For example, location of the site or proposed removal action in a flood plain, wetland, historic place, or sensitive ecosystem may trigger location-specific ARARs. The

Endangered Species Act, the Migratory Bird Treaty Act, the National Historic Preservation Act, the Archeological and Historic Preservation Act, and the Coastal Zone Management Act (CZMA) were considered as potential location-specific ARARs. Site 12 does not provide any critical habitat for threatened or endangered species. Additionally, Site 12 does not encompass any historic properties included or eligible for inclusion on the National Register of Historic Places. No scientific, prehistoric, or archeological data have been identified at Site 12.

Section 307 (c)(1) of the CZMA (Title 16 of the *U.S. Code* 1456[c][1]) and the implementing regulations in Title 15 of the CFR 930 and 923.45 require that federal agencies conducting or supporting activities directly affecting the coastal zone conduct or support those activities in a manner that is consistent with the approved state coastal zone management programs. A state coastal zone management program (developed under state law and guided by the CZMA) sets forth objectives, policies, and standards to guide public and private uses of lands and water in the coastal zone. California's approved coastal management program includes the "San Francisco Bay Plan" (Bay Plan) developed by the San Francisco Bay Conservation and Development Commission (BCDC) (BCDC 1968). The BCDC was formed under authority of the McAteer-Petris Act (*California Government Code* Section 66600 *et seq*.), which authorizes the BCDC to regulate activities within San Francisco Bay and the shoreline (100 feet landward from the shoreline) in conformity with the policies of the Bay Plan. The Bay Plan's policies include limiting Bay filling, maintaining marshes and mudflats to the fullest extent possible to conserve wildlife and abate pollution, and protecting the beneficial uses of the Bay. Since Site 12 is located adjacent to the coastal zone, this removal action could affect the coastal zone. As a result, all removal action alternatives will be consistent with the goals of the Bay Plan and will conform to the substantive requirements of the state management program. Location-specific ARARs are presented in Table E-2.

## ACTION-SPECIFIC ARARS

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular removal activities selected and suggest how a selected removal alternative should be achieved. These action-specific requirements do not in themselves determine the removal alternative; rather, they indicate how a selected alternative must be conducted. The following discussion addresses potential action-specific ARARs for the alternatives under consideration in this EE/CA. Action-specific ARARs are summarized in Table E-3.

### RESOURCE CONSERVATION AND RECOVERY ACT

The Navy identified potential chemical-specific ARARs for characterizing hazardous waste in media pursuant to RCRA. Whenever contaminated media are being excavated, waste is generated. The applicability of RCRA hazardous waste management requirements depends on whether the generated waste is a RCRA hazardous waste;, whether the waste initially underwent treatment, storage, or disposal after the effective date of the particular RCRA requirement; and whether the activity at the site constitutes treatment, storage, or disposal as defined by RCRA. If this removal action generates contaminated media that meet the definition of RCRA hazardous waste, then RCRA requirements are potentially applicable.

Any on-site management activities of hazardous waste generated as a result of the removal action, based on the chemical-specific ARARs discussed previously for classifying hazardous waste, must meet the appropriate, substantive RCRA requirements codified in 22 CCR, Division 4.5, Chapter 14. As long as the excavated material remains inside the area of contamination, however, it is not newly generated and will not be subject to RCRA generator, treatment, or other waste management requirements. Should excavated material be moved outside the area of contamination, the substantive RCRA requirements of 22 CCR for managing hazardous waste (including LDRs as described under the chemical-specific discussion above) would be applicable.

Any hazardous waste accumulated on site, including waste contained in soil and contaminated groundwater, must comply with the RCRA requirements set forth at California Code of Regulations, Title 22, §66262.34. This section permits on-site hazardous waste accumulation for up to 90 days as long as the waste is properly stored and labeled. For hazardous waste sent off site for disposal at a disposal facility, the following RCRA requirements are ARARs: the RCRA pretransport regulations at Title 22 §§ 66262.30 (packaging), 66262.31(labeling), 66262.32 (marking) and 66262.33 (placarding) and RCRA manifest requirements at §§ 66262.20, 66262.21, 66252.22, and 66262.23.

The regulations implementing the RCRA LDRs, including applicable LDR treatment standards at California Code of Regulations, Title 22 § 66268.7 are also ARARs. Prior to sending any waste off site, the Navy will determine whether the waste is subject to LDRs and will provide the required notices and certifications of § 66268.7.

### CLEAN AIR ACT

The following Bay Area Air Quality Management District (BAAQMD) regulations are potential ARARs for excavation activities applicable to each alternative:

- Regulation 6-301: Ringelmann No. 1 Limitation (regulating emissions that are as dark as or darker than No. 1 on the Ringelmann Chart)

- Regulation 6-302: Opacity Limitation (prohibiting emissions for a period aggregating more than 3 minutes in any hour an emission equal to or greater than 20 percent opacity)

- Regulation 6-305: Visible Particles (prohibiting the emissions of particles in sufficient number to cause annoyance)

- Regulation 8, Rule 40: Aeration of Contaminated Soil and Removal of Underground Storage Tanks (setting forth standards for maintaining, covering, and stockpiling soil)

### California Code of Regulations, Title 27

Action-specific ARARs for capping the backyards include portions of 27 CCR that relate to intermediate cover of solid waste disposal areas (27 CCR Section 20700(a)-(d)), dust control (27 CCR Section 20800), drainage (27 CCR Section 20820(a)(1)-(3)), litter (27 CCR 20830), gas (27 CCR Section 20919), final cover (27 CCR Section 21140(a)-(c)(1)-(3), final grading (27 CCR Section 21142(a)-(b)(1)-(2)), slope stability (27 CCR Section 21145(a)-(b)), postclosure drainage (27 CCR Section 21150(a)-(c)), and postclosure land use (27 CCR Section 21180(a)-(c)). Although capping of backyards is similar to landfill capping, the RCRA landfill closure requirements at 22 CCR Section 66264.110 et seq are not relevant and appropriate because there is no beneficial use of the groundwater at Site 12.

### National Pollutant Discharge Elimination System (NPDES) Permit Requirements

The State Water Resources Control Board and the Regional Water Resources Control Board can issue general permits in accordance with the Clean Water Act for discharges to surface water. CERCLA response actions are not subject to permit requirements as provided under CERCLA Section 121(e) (42 U.S.C. Section 9621[e]). The Navy will comply with the substantive effluent limitations of appropriate NPDES requirements. Therefore the substantive provisions of requirements under NPDES are TBCs for this response action.

## REFERENCES

San Francisco Bay Conservation and Development Commission (BCDC). 1968. "San Francisco Bay Plan." Adopted by the BCDC in 1968; Incorporated in 1969 into the *McAteer-Petris Act*, which was signed into law on August 7, 1969.

## TABLE E-1: CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS TREASURE ISLAND, INSTALLATION RESTORATION SITE 12

| Requirement | Prerequisite | Citation | Preliminary ARAR Determination | Comments |
|---|---|---|---|---|
| **Resource Conservation and Recovery Act (42 U.S.C., Chapter 82, §§ 6901-6991[i])** | | | | |
| Definition of RCRA hazardous waste | Soil and water | California Code of Regulations, Title 22 (22 CCR) §§§ 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1) and 66261.100 | Applicable | The requirements of 22 CCR, Division 4.5, Chapter 14 are applicable to all alternatives for determining whether excavated material contains hazardous waste. These requirements may be relevant and appropriate to excavated material that is similar or identical to RCRA hazardous waste or non-RCRA hazardous waste. |
| Land disposal restrictions (LDR) prohibit disposal of hazardous waste unless treatment standards are met. | Hazardous waste land disposal | Cal.Code Regs, tit. 22 § 99268.1(f) | Applicable | These requirements are applicable if hazardous waste is to be disposed of on land. |
| **U.S. EPA Preliminary Remediation Goals (PRG)** | | | | |
| Preliminary remediation goal for lead in residential land-use areas. | Lead contamination in soil | EPA Region 9 PRGs (EPA 1999) | To be considered | This guidance is useful for setting cleanup goals for protecting human health from lead-contaminated soil. |

Notes:

ARAR Applicable or relevant and appropriate requirement
PRG Preliminary Remediation Goal
RCRA Resource Conservation and Recovery Act
U.S.C. U.S. Code

## TABLE E-2: LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS TREASURE ISLAND, INSTALLATION RESTORATION SITE 12

| Location | Requirement | Prerequisite | Citation | Preliminary ARAR Determination | Comments |
|---|---|---|---|---|---|
| **Coastal Zone Management Act (16 U.S.C. §§ 1451–1464)** | | | | | |
| Within coastal zone | Conduct activities in a manner consistent with approved state management programs. | Activities affecting the coastal zone including lands thereunder and adjacent shore land. | 16 U.S.C. § 1456(c)<br>15 C.F.R. § 930 | Applicable | The removal action will comply with the Coastal Zone Management Act and Bay Plan. |

Notes:

ARAR Applicable or relevant and appropriate requirement
Bay Plan San Francisco Bay Plan
C.F.R. Code of Federal Regulations
U.S.C. U.S. Code

## TABLE E-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS TREASURE ISLAND, INSTALLATION RESTORATION SITE 12

| Action | Requirement | Prerequisite | Citation | Preliminary ARAR Determination | Comments |
|---|---|---|---|---|---|
| **Resource Conservation and Recovery Act (42 U.S.C., Chapter 82, §§ 6901-6991[i])** | | | | | |
| Excavation | Definition of RCRA hazardous waste | Soil and water | California Code of Regulations, Title 22 (22 CCR) §§§ 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1) and 66261.100 | Applicable | The requirements of 22 CCR, Division 4.5, Chapter 14 are applicable to all alternatives for determining whether excavated material contains hazardous waste. These requirements may be relevant and appropriate to excavated material that is similar or identical to RCRA hazardous waste or non-RCRA hazardous waste. |
| Hazardous waste accumulation | On-site hazardous waste accumulation is allowed for up to 90 days as long as the waste is stored in containers or tanks, on drip pads or inside buildings, and is labeled and dated. | Accumulation of hazardous waste | 22 CCR § 66262.34 | Applicable | These requirements are applicable to all alternatives if hazardous waste is generated and accumulated on site before transport. |
| Pretransport requirements | Hazardous waste must be packaged in accordance with Department of Transportation (DOT) regulations prior to transporting | Any operation where hazardous waste is generated | 22 CCR § 66262.30 | Applicable | These requirements are applicable to all alternatives if hazardous waste is to be transported. |
| Pretransport requirements | Hazardous waste must be labeled in accordance with DOT regulations prior to transporting | Any operation where hazardous waste is generated | 22 CCR § 66262.31 | Applicable | These requirements are applicable to all alternatives if hazardous waste is to be transported. |
| Pretransport requirements | Provides requirements for marking hazardous waste prior to transporting. | Any operation where hazardous waste is generated | 22 CCR § 66262.32 | Applicable | These requirements are applicable to all alternatives if hazardous waste is to be transported. |

## TABLE E-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS TREASURE ISLAND, INSTALLATION RESTORATION SITE 12 (Continued)

| Action | Requirement | Prerequisite | Citation | Preliminary ARAR Determination | Comments |
|---|---|---|---|---|---|
| Pretransport requirements | A generator must ensure that the transport vehicle is correctly placarded prior to transport of hazardous waste. | Any operation where hazardous waste is generated | 22 CCR § 66262.33 | Applicable | These requirements are applicable to all alternatives if hazardous waste is to be transported. |
| Pretransport requirements | Requires preparation of a manifest for transport of hazardous waste off site. | Any operation where hazardous waste is generated | 22 CCR § 66262.20-66262.23 | Applicable | These requirements are applicable to all alternatives if hazardous waste is to be transported. |
| Land disposal | Generators of hazardous waste are required to determine if waste must be treated before land disposal. Generators are required to notify treatment facility if a waste is subject to land disposal restrictions (LDR) and does not meet applicable treatment standards. If the waste meets treatment standards, generators must sign a certification. | Hazardous waste land disposal | 22 CCR § 66268.7 | Applicable | These requirements are applicable to all alternatives if hazardous waste is to be disposed of land. |
| **Clean Air Act (42 U.S.C. § 7401 et seq.)** | | | | | |
| Excavation | Prohibits emissions which are as dark as or darker than No.1 on the Ringelmann Chart and sets forth opacity limitations. | Soil excavation | Bay Area Air Quality Management District (BAAQMD) Regulations 6, Regulations 6-301 and 6-302 | Applicable | These requirements are applicable to all alternatives for excavation activities. |
| Excavation | Prohibits the emission of particles in sufficient number to cause annoyance, | Release of particles | BAAQMD Regulation 6-305 | Applicable | This requirement is applicable to all alternatives for excavation activities. |

## TABLE E-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS TREASURE ISLAND, INSTALLATION RESTORATION SITE 12 (Continued)

| Action | Requirement | Prerequisite | Citation | Preliminary ARAR Determination | Comments |
|---|---|---|---|---|---|
| Excavation | Provides requirements for maintaining, covering, and stockpiling excavated soil. | Soil stockpile | Regulation 8, Rule 40 | Applicable | These requirements are applicable to all alternatives for excavation activities. |
| **State Water Resources Control Board/Integrated Waste Management Board Requirements** | | | | | |
| Intermediate cover | Requires compacted earthen material of at least 12 inches on all surfaces of the fill where no additional solid waste will be deposited within 180 days. | Discharge of waste to land | 27CCR, §§ 20700 | Relevant and appropriate | The substantive requirements of this section are relevant and appropriate for closing disposal and landfill sites |
| Dust Control | The operator shall take adequate measures to minimize the creation of dust and prevent safety hazards due to obscured visibility. | Discharge of waste to land | 27 CCR, §§ 20800 | Relevant and appropriate | The substantive requirements of this section are relevant and appropriate for closing disposal and landfill sites. |
| Drainage and erosion control | The drainage system shall be designed and maintained to ensure integrity of roads, structures, and gas monitoring and control systems; prevent safety hazards; and prevent exposure of waste. | Discharge of waste to land | 27 CCR, §§ 20820 | Relevant and appropriate | The substantive requirements of this section are relevant and appropriate for closing disposal and landfill sites. |
| Litter | Litter and loose materials shall be routinely collected and disposed of properly. | Discharge of waste to land | 27 CCR, §§ 20830 | Relevant and appropriate | The substantive requirements of this section are relevant and appropriate for closing disposal and landfill sites. |
| Gas control | The operator shall cause the site to be monitored for the presence and movement of landfill gas and take any necessary action to control such gas in the event that the gas causes a hazard or nuisance. | Discharge of waste to land | 27 CCR, §§ 20700 | Relevant and appropriate | The substantive requirements of this section are relevant and appropriate for closing disposal and landfill sites. |

**TABLE E-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS TREASURE ISLAND, INSTALLATION RESTORATION SITE 12 (Continued)**

| Action | Requirement | Prerequisite | Citation | Preliminary ARAR Determination | Comments |
|---|---|---|---|---|---|
| Final cover | The final cover shall function with minimum maintenance and provide waste containment to protect public health and safety by controlling at a minimum, vectors, fire, odor, litter and landfill gas migration. The final cover shall also be compatible with postclosure land use. | Discharge of waste to land | 27 CCR, §§ 21140 | Applicable | The substantive requirements of this section are applicable for closing disposal and landfill sites. |
| Final grading | Final grades must be designed and maintained to reduce impacts to health and safety and take into consideration any postclosure land use. | Discharge of waste to land | 27 CCR, §§ 21142 | Applicable | The substantive requirements of this section are applicable for closing disposal and landfill sites. |
| Slope stability | The operator shall ensure the integrity of final slopes under both static and dynamic conditions to protect public health and safety and prevent damage to postclosure land uses, roads, structures, utilities, gas monitoring and control systems, leachate collection and control systems to prevent public contact with leachate and prevent exposure of waste. | Discharge of waste to land | 27 CCR, § 21245(a)(b) | Applicable | The substantive requirements of this section are applicable for closing disposal and landfill sites. |

## TABLE E-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS TREASURE ISLAND, INSTALLATION RESTORATION SITE 12 (Continued)

| Action | Requirement | Prerequisite | Citation | Preliminary ARAR Determination | Comments |
|---|---|---|---|---|---|
| Drainage and erosion control | The drainage and erosion control system shall be designed and maintained to ensure integrity of postclosure land uses, roads, and structures; to prevent public contact with waste and leachate; to ensure integrity of gas monitoring and control systems; to prevent safety hazards; and to prevent exposure of waste. | Discharge of waste to land | 27 CCR, § 21150(a)-(c) | Applicable | The substantive requirements of this section are applicable for closing disposal and landfill sites. |
| Postclosure land use | The landfill must be maintained and monitored for no less than 30 years following closure. | Discharge of waste to land | 27 CCR, § 21180(a)-(c) | Applicable | The substantive requirements of this section are applicable for closing disposal and landfill sites. |
| **National Pollutant Discharge Elimination System (NPDES) Requirements** | | | | | |
| Runoff control and discharge. | NA | NA | 40 CFR Section 122.41 | TBC | The substantive portions of this section are TBC for discharge of pollutants. |

Notes:

ARAR Applicable or relevant and appropriate requirement
BAAQMD Bay Area Air Quality Management District
CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R. Code of Federal Regulations
CCR California Code of Regulations
DOT Department of Transportation
LDR Land disposal restriction
NA Not applicable
NPDES National Pollutant Discharge Elimination System
RCRA Resource Conservation and Recovery Act
U.S.C. U.S. Code

# APPENDIX F
# DETAILED COST OPINIONS

**TABLE F-1**
**ALTERNATIVE 1A - COST OPINION**
**CAPPING BACKYARDS (Poured Slab)**
**AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| A | **CAPITAL COSTS** | | | | | | | | | |
| | **DIRECT COSTS** | | | | | | | | | |
| 1 | **Mobilization** | | | | | | | | | |
| | Locate utilities | LS | 1 | $20,000 | $20,000 | $20,000.00 | | | | Assumed |
| | Mobilize heavy equipment (2 hydraulic excavators, 1 wheel loader) | LS | 1 | $ 3,639 | $3,639 | 2,935 | 1.24 | | 3 Trailer Trips of 1 day each + 2 laborers for one week | Means 2000., #33 01 0111 & #99 01 06, Envir. Remed. Cost Data - Unit Price (Truck, 2 axle, Highway, 33,000 GVW, 6 x 2 and General-purpose laborer) |
| | Truck scale rental | MO | 4 | $ 3,720 | $14,880 | 3,000 | 1.24 | | Estimated time for excavation | Means 2000., #33 01 0462, Envir. Remed. Cost Data - Unit Price |
| | HiVol Samplers (Continuous Monitoring and Recording of Air Flow) | EA | 3 | $ 6,200 | $18,600 | 5,000 | 1.24 | | 3 HiVols | Means 2000., #33 02 1507, Envir. Remed. Cost Data - Unit Price |
| | Instrument Shelter | EA | 3 | $ 1,031 | $3,092 | 831 | 1.24 | | 3 shelters for HiVols | Means 2000, #33 02 0338, Envir. Remed. Cost Data - Unit Price |
| | Baseline data (lead, PAHs, pesticides, PCBs) | Day | 21 | $ 726 | $15,242 | 585 | 1.24 | | 3 HiVols for 1 week to establish baseline | Means 2000, #33 02 1813, #33 02 1812, and #33 02 1810, Envir. Remed. Cost Data - Unit Price (Metals by ICP, PAHs, Pesticides/PCBs) |
| | Daily results of air monitoring from HiVols (lead, PAHs, pesticides, PCBs) | Day | 462 | $ 726 | $335,324 | 585 | 1.24 | | 3 HiVols for 22 weeks | Means 2000, #33 02 1813, #33 02 1812, and #33 02 1810, Envir. Remed. Cost Data - Unit Price (Metals by ICP, PAHs, Pesticides/PCBs) |
| | Health & safety program | LS | 1 | $50,000 | $50,000 | $50,000 | | | | Assumed |
| | **Mobilization Subtotal** | | | | **$460,777** | | | | | |
| 2 | **Fencing** | | | | | | | | | |
| | **Identified SWDA A & B** | | | | | | | | | |
| | Remove wood fence | LF | 836 | $ 2.33 | $1,949 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 836 | $ 15.77 | $13,186 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Identified SWDA 1207/1209/1211/1213** | | | | | | | | | |
| | Remove wood fence | LF | 792 | $ 2.33 | $1,846 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 792 | $ 15.77 | $12,492 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Identified SWDA 1231/1233** | | | | | | | | | |
| | Remove wood fence | LF | 487 | $ 2.33 | $1,135 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 487 | $ 15.77 | $7,681 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Identified SWDA Bigelow** | | | | | | | | | |

**TABLE F-1**
**ALTERNATIVE 1A - COST OPINION**
**CAPPING BACKYARDS (Poured Slab)**
**AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Remove wood fence | LF | 600 | $ 2.33 | $1,399 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 600 | $ 15.77 | $9,464 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Identified SWDA 1235/1237** | | | | | | | | | |
| | Remove wood fence | LF | 515 | $ 2.33 | $1,201 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 515 | $ 15.77 | $8,123 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Fencing Subtotal** | | | | **$58,476** | | | | | |
| **3** | **Capping Backyards** | | | | | | | | | |
| | **Identified SWDA A & B** | | | | | | | | | |
| | *Total Backyard Area* | *SF* | *5,800* | | | | | | SF calculated using Microstation | |
| | *Number of Backyards* | *#* | *12* | | | | | | Counted using ArcView | |
| | Clearing backyard vegetation (light brush without grub) | ACRE | 0.1 | $ 86.22 | $9 | $69.53 | 1.24 | | Assume vegetation is 3/4 of backyard area | Means 2000., #17 01 0101, Level D, Envir. Remed. Cost Data - Assemblies |
| | Demolish existing backyard pavement (unreinforced concrete, 6" thick) with air equipment | CY | 27 | $ 67.99 | $1,826 | $54.83 | 1.24 | | Assume pavement is 6" thick and 1/4 of backyard area | Means 2000., #17 02 0205, Level D, Envir. Remed. Cost Data - Assemblies |
| | Fine grading, hand | SY | 644 | $ 2.57 | $1,654 | $2.07 | 1.24 | | | Means 2000., #17 03 0105, Level D, Envir. Remed. Cost Data - Assemblies |
| | Cap using 4" mesh reinforced slab on grade | SF | 5,800 | $ 3.87 | $22,439 | $3.12 | 1.24 | | Assume 1 crews | Means 2000., #18 02 0330, Level E, Envir. Remed. Cost Data - Unit Price |
| | Planter box | EA | 12 | $200.00 | $2,400 | $200.00 | | | | Assumed |
| | **Identified SWDA 1207/1209/1211/1213** | | | | | | | | | |
| | *Total Backyard Area* | *SF* | *7,621* | | | | | | SF calculated using Microstation | |
| | *Number of Backyards* | *#* | *16* | | | | | | Counted using ArcView | |
| | Clearing backyard vegetation (light brush without grub) | ACRE | 0.1 | $ 86.22 | $11 | $69.53 | 1.24 | | Assume vegetation is 3/4 of backyard area | Means 2000., #17 01 0101, Level D, Envir. Remed. Cost Data - Assemblies |
| | Demolish existing backyard pavement (unreinforced concrete, 6" thick) with air equipment | CY | 35 | $ 67.99 | $2,399 | $54.83 | 1.24 | | Assume pavement is 6" thick and 1/4 of backyard area | Means 2000., #17 02 0205, Level D, Envir. Remed. Cost Data - Assemblies |
| | Fine grading, hand | SY | 847 | $ 2.57 | $2,174 | $2.07 | 1.24 | | | Means 2000., #17 03 0105, Level D, Envir. Remed. Cost Data - Assemblies |
| | Cap using 4" mesh reinforced slab on grade | SF | 7,621 | $ 3.87 | $29,484 | $3.12 | 1.24 | | Assume 1 crews | Means 2000., #18 02 0330, Level E, Envir. Remed. Cost Data - Unit Price |
| | Planter box | EA | 16 | $200.00 | $3,200 | $200.00 | | | | Assumed |
| | **Identified SWDA Bigelow** | | | | | | | | | |
| | *Total Backyard Area* | *SF* | *4,082* | | | | | | SF calculated using Microstation | |
| | *Number of Backyards* | *#* | *8* | | | | | | Counted using ArcView | |

**TABLE F-1**
**ALTERNATIVE 1A - COST OPINION**
**CAPPING BACKYARDS (Poured Slab)**
**AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Clearing backyard vegetation (light brush without grub) | ACRE | 0.1 | $ 86.22 | $6 | $69.53 | 1.24 | | Assume vegetation is 3/4 of backyard area | Means 2000., #17 01 0101, Level D, Envir. Remed. Cost Data - Assemblies |
| | Demolish existing backyard pavement (unreinforced concrete, 6" thick) with air equipment | CY | 19 | $ 67.99 | $1,285 | $54.83 | 1.24 | | Assume pavement is 6" thick and 1/4 of backyard area | Means 2000., #17 02 0205, Level D, Envir. Remed. Cost Data - Assemblies |
| | Fine grading, hand | SY | 454 | $ 2.57 | $1,164 | $2.07 | 1.24 | | | Means 2000., #17 03 0105, Level D, Envir. Remed. Cost Data - Assemblies |
| | Cap using 4" mesh reinforced slab on grade | SF | 4,082 | $ 3.87 | $15,792 | $3.12 | 1.24 | | Assume 1 crews | Means 2000., #18 02 0330, Level E, Envir. Remed. Cost Data - Unit Price |
| | Planter box | EA | 8 | $200.00 | $1,600 | $200.00 | | | | Assumed |
| | **Identified SWDA 1231/1233/1235/1237** | | | | | | | | | |
| | *Total Backyard Area* | *SF* | *9,954* | | | | | | SF calculated using Microstation | |
| | *Number of Backyards* | *#* | *24* | | | | | | Counted using ArcView | |
| | Clearing backyard vegetation (light brush without grub) | ACRE | 0.2 | $ 86.22 | $15 | $69.53 | 1.24 | | Assume vegetation is 3/4 of backyard area | Means 2000., #17 01 0101, Level D, Envir. Remed. Cost Data - Assemblies |
| | Demolish existing backyard pavement (unreinforced concrete, 6" thick) with air equipment | CY | 46 | $ 67.99 | $3,133 | $54.83 | 1.24 | | Assume pavement is 6" thick and 1/4 of backyard area | Means 2000., #17 02 0205, Level D, Envir. Remed. Cost Data - Assemblies |
| | Fine grading, hand | SY | 1,106 | $ 2.57 | $2,839 | $2.07 | 1.24 | | | Means 2000., #17 03 0105, Level D, Envir. Remed. Cost Data - Assemblies |
| | Cap using 4" mesh reinforced slab on grade | SF | 9,954 | $ 3.87 | $38,510 | $3.12 | 1.24 | | Assume 1 crews | Means 2000., #18 02 0330, Level E, Envir. Remed. Cost Data - Unit Price |
| | Planter box | EA | 24 | $200.00 | $4,800 | $200.00 | | | | Assumed |
| | **Topsoil Removal & Replacement with Subgrade Soil for Paving** | | | | | | | | | |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 254 | $ 13.52 | $3,438 | $10.90 | 1.24 | | Assume topsoil is 4-inch over 75% of backyard area | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Backfill with off-site unclassified fill (includes delivery, spreading, and compaction) | CY | 254 | $ 20.03 | $5,093 | $18.09 | 1.24 | | Assume same volume as removed topsoil | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | **Capping Backyards Subtotal** | | | | **$143,270** | | | | | |
| 4 | **Excavation to 2 ft bgs in Common Areas** | | | | | | | | | |
| | **Identified SWDA A & B** | | | | | | | | | |
| | *Total Common Area* | *SF* | *56,584* | | | | | | SF calculated using Microstation | |
| | *Total Common Area Volume* | *CY* | *4,191* | | | | | | | |

**TABLE F-1**
**ALTERNATIVE 1A - COST OPINION**
**CAPPING BACKYARDS (Poured Slab)**
**AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sprayed water dust suppressant | SY | 2,816,626 | $ 0.01 | $34,926 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 32 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 419 | $ 13.52 | $5,667 | $10.90 | 1.24 | | Use for 10% of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 2,934 | $ 10.72 | $31,440 | $8.64 | 1.24 | | Use for 70 % of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 419 | $ 48.93 | $20,507 | $39.46 | 1.24 | 10% | Use for 10 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 419 | $ 72.95 | $30,573 | $58.83 | 1.24 | 10% | Use for 10 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 4,191 | $ 5.44 | $22,814 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 56,584 | 0.62 | $35,082 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 4,191 | $ 20.03 | $83,952 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 1.3 | 17,526 | $22,766 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Identified SWDA 1207/1209/1211/1213** | | | | | | | | | |
| | *Total Common Area* | *SF* | *19,956* | | | | | | SF calculated using Microstation | |
| | *Total Common Area Volume* | *CY* | *1,478* | | | | | | | |
| | Sprayed water dust suppressant | SY | 993,365 | $ 0.01 | $12,318 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 32 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 148 | $ 13.52 | $1,998 | $10.90 | 1.24 | | Use for 10 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Standby, crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | Hr | 111 | $ 123.31 | $13,668 | $99.44 | 1.24 | | Standby for 90 % of excavation | Means 2000., #17 03 0438, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 1,035 | $ 10.72 | $11,087 | $8.64 | 1.24 | | Use for 70 % of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 148 | $ 48.93 | $7,232 | $39.46 | 1.24 | 10% | Use for 10 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |

**TABLE F-1**
**ALTERNATIVE 1A - COST OPINION**
**CAPPING BACKYARDS (Poured Slab)**
**AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Hand excavation for utilities and edge of buildings | CY | 148 | $ 72.95 | $10,782 | $58.83 | 1.24 | 10% | Use for 10 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 1,478 | $ 5.44 | $8,046 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 19,956 | 0.62 | $12,373 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 1,478 | $ 20.03 | $29,607 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 0.5 | 17,526 | $8,029 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Identified SWDA Bigelow** | | | | | | | | | |
| | *Total Common Area* | *SF* | *14,804* | | | | | | SF calculated using Microstation | |
| | *Total Common Area Volume* | *CY* | *1,097* | | | | | | | |
| | Sprayed water dust suppressant | SY | 736,910 | $ 0.01 | $9,138 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 32 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 110 | $ 13.52 | $1,483 | $10.90 | 1.24 | | Use for 10 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 768 | $ 10.72 | $8,229 | $8.64 | 1.24 | | Use for 70% of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 110 | $ 48.93 | $5,368 | $39.46 | 1.24 | 10% | Use for 10 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 110 | $ 72.95 | $8,003 | $58.83 | 1.24 | 10% | Use for 10 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 1,097 | $ 5.44 | $5,972 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 14,804 | 0.62 | $9,178 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 1,097 | $ 20.03 | $21,975 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |

**TABLE F-1**
**ALTERNATIVE 1A - COST OPINION**
**CAPPING BACKYARDS (Poured Slab)**
**AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Seeding, vegetative cover | ACRE | 0.3 | 17,526 | $5,956 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Identified SWDA 1231/1233/1235/1237** | | | | | | | | | |
| | *Total Common Area* | *SF* | *38,244* | | | | | | SF calculated using Microstation | |
| | *Total Common Area Volume* | *CY* | *2,833* | | | | | | | |
| | Sprayed water dust suppressant | SY | 1,903,701 | $ 0.01 | $23,606 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 32 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 283 | $ 13.52 | $3,831 | $10.90 | 1.24 | | Use for 10 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 1,983 | $ 10.72 | $21,252 | $8.64 | 1.24 | | Use for 70% of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 283 | $ 48.93 | $13,862 | $39.46 | 1.24 | 10% | Use for 10 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 283 | $ 72.95 | $20,667 | $58.83 | 1.24 | 10% | Use for 10 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 2,833 | $ 5.44 | $15,422 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 38,244 | 0.62 | $23,711 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 2,833 | $ 20.03 | $56,750 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 0.9 | 17,526 | $15,387 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Excavation of Common Areas** | | | | **$678,450** | | | | | |
| **5** | **Confirmation Sampling** | | | | | | | | | |
| | *Excavation wall length* | *LF* | *9,800* | | | | | | Length estimated using Microstation | |
| | Lead analysis (EPA 6010B) with 24 hour TAT | EA | 245 | $28.00 | $6,860 | $28.00 | | | 1 sample every 40 LF of wall length | Curtis & Tompkins with 24-hour turn around time |

**TABLE F-1**
**ALTERNATIVE 1A - COST OPINION**
**CAPPING BACKYARDS (Poured Slab)**
**AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | QC samples for lead analysis (EPA 6010B) with 24 hour TAT | EA | 62 | $28.00 | $1,736 | $28.00 | | | 1 field dup. and 1 equip. rinsate sample for every 10 C.S.; 1 matrix spike/lab dup. for every 20 C.S. | Curtis & Tompkins with 24-hour turn around time |
| | PAH soil analysis (modified EPA 8270) with 7 working day TAT | EA | 62 | $375.00 | $23,250 | $375.00 | | | 1 sample for every 4 lead samples | EMAX with 7-working-day turn around time |
| | QC samples for PAH soil analysis (modified EPA 8270) with 7 working day TAT | EA | 15 | $375.00 | $5,625 | $375.00 | | | 1 field dup. and 1 equip. rinsate sample for every 10 C.S.; 1 matrix spike/lab dup. for every 20 C.S. | EMAX with 7-working-day turn around time |
| | Pesticides (EPA 8081) /PCBs (EPA 8082) soil analysis with 7 working day TAT | EA | 62 | $200.00 | $12,400 | $200.00 | | | 1 sample for every 4 lead samples | EMAX with 7-working-day turn around time |
| | QC samples for pesticides (EPA 8081)/PCBs (EPA 8082) soil analysis with 7 working day TAT | EA | 15 | $200.00 | $3,000 | $200.00 | | | 1 field dup. and 1 equip. rinsate sample for every 10 C.S.; 1 matrix spike/lab dup. for every 20 C.S. | EMAX with 7-working-day turn around time |
| | Subcontracted sampling, one-man crew | DAY | 46 | $ 546 | $25,152 | $440.00 | 1.24 | | Assume 10 samples/day | Means 2000., #33 02 9907, Envir. Remed. Cost Data - Unit Price |
| | Surveying, 2-man crew | DAY | 46 | $ 825 | $38,030 | $665.28 | 1.24 | | Same as sampling crew | Means 2000, #99 24 1204, Envir. Remed. Cost Data - Unit Price |
| | **Confirmation Sampling Subtotal** | | | | **$116,053** | | | | | |
| **6** | **Transportation & Disposal of Excavated Material** | | | | | | | | | |
| | *Volume of demolished concrete and excavated waste* | *CY* | *9,980* | | | | | | Total summation of excavated waste volume | |
| | Waste Profile Sampling & Analysis | | 20 | $1,200.00 | $24,000 | | | | | |
| | **Kettleman Hills Facility Class I** | | | | | | | | | |
| | Disposal fee (includes Kings county and BOE tax) | TON | 15,270 | $31.12 | $475,200 | $25.52 | | | Assume 1.8 tons/cy and 85% of excavated waste | Quote from Waste Management for Kettleman Hills Facility |
| | Transportation via end dumps | TON | 15,270 | $31.50 | $481,003 | $30.50 | $ 1.00 | | 23 ton minimum | Quote from Waste Management for Kettleman Hills Facility |
| | **Altamont Landfill Class II** | | | | | | | | | |
| | Disposal fee | TON | 2,695 | $29.72 | $80,086 | $32.00 | | | Assume 1.8 tons/cy and 15% of excavated waste | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | Transportation via end dumps | TON | 2,695 | $13.25 | $35,705 | $13.00 | $0.25 | | 23 ton minimum, 3 trips/day | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | **Transportation & Disposal Subtotal** | | | | **$1,095,994** | | | | | |
| **7** | **Demobilize** | | | | | | | | | |

**TABLE F-1**
**ALTERNATIVE 1A - COST OPINION**
**CAPPING BACKYARDS (Poured Slab)**
**AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Demobilize heavy equipment | LS | 1 | $ 3,639 | $3,639 | $2,935 | 1.24 | | 3 Trailer Trips of 1 day each + 2 laborers for one week | Means 2000., #33 01 0111 & #99 01 06, Envir. Remed. Cost Data - Unit Price (Truck, 2 axle, Highway, 33,000 GVW, 6 x 2 and General-purpose laborer) |
| | General area cleanup | ACRE | 3.6 | $ 342 | $1,233 | $275.84 | 1.24 | | Common areas and backyards | Means 2000., #17 04 0101, Envir. Remed. Cost Data - Unit Price |
| | **Demobilize Subtotal** | | | | **$4,872** | | | | | |
| | Total Direct Costs | | | | $2,557,893 | | | | | Unit prices obtained from Means 2000 were adjusted with a location multiplier of 1.24 |
| | Scope contingencies (15% of Subtotal Direct) | | | | $383,683.88 | | | | | |
| | Bid contingency for Disposal (10% of subtotal transport & disposal costs) | | | | $109,599 | | | | | Potential disposal fee increase at facility with increased energy costs, and changes in market |
| | Bid contingency for administrative (5% of direct cost) | | | | $127,895 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | Insurance (5% of direct cost) | | | | $127,895 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **TOTAL DIRECT COSTS** | | | | **$3,306,965** | | | | | |
| | **INDIRECT COSTS** | | | | | | | | | |
| | Construction Management Staff | WK | 22 | | | | | | Assume 1 wk mob., 2 wks paving, 20 wks excavating,1 wk demob | 19 |
| | Construction Manager | WK | 22 | $ 2,122 | $46,683 | $1,711.25 | 1.24 | | 8 hour days | Means 2000., #99 01 0102, Envir. Remed. Cost Data - Unit Price (Site Project Manager, average cost) |
| | Field Supervisor | WK | 22 | $ 1,989 | $43,750 | $1,603.75 | 1.24 | | 8 hour days | Means 2000., #99 01 0202, Envir. Remed. Cost Data - Unit Price (Superintendent, average cost) |
| | QC Engineer | WK | 22 | $ 1,533 | $33,718 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |
| | Site H&S officer | WK | 22 | $ 1,533 | $33,718 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0702, Envir. Remed. Cost Data - Unit Price (Safety Engineer, average cost) |
| | **Construction Management Staff Subtotal** | | | | **$157,869** | | | | | |
| | Office Overhead (5% of construction management staff cost) | | | | $7,893 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | General & Administration (5% of construction management staff cost) | | | | $395 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |

**TABLE F-1**
**ALTERNATIVE 1A - COST OPINION**
**CAPPING BACKYARDS (Poured Slab)**
**AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Home Office Expenses (5% of construction management staff cost) | | | | $7,893 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Total Construction Management Costs** | | | | **$174,051** | | | | | |
| | Other Costs | | | | | | | | | |
| | Design (10% of direct cost) | | | | $330,697 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Other Costs Subtotal** | | | | **$330,697** | | | | | |
| | **TOTAL INDIRECT COSTS** | | | | **$504,747** | | | | | |
| | **Total Direct & Indirect Costs** | | | | **$3,811,713** | | | | | |
| | Profit (10% of Subtotal Direct & Indirect Costs) | | | | $381,171.26 | | | | | |
| | **TOTAL CAPITAL COSTS** | | | | **$4,192,884** | | | | | |

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| **B.** | **ANNUAL & PERIODIC COSTS** | | | | | | | | | |
| **1** | **Annual Costs** | | | | | | | | | |
| | Monitoring changes in post-closure landuse | WK | 1 | $ 1,533 | $1,533 | | | | Contractor annual inspections for 1 week duration | "(1)Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |
| | Maintaining drainage and erosion control systems for vegetative cover in disposal area and backyards (P/A, 30, 5.61) | | | | | | | | | |
| | Excavator | CY | 60 | $ 13.52 | $811 | $10.90 | 1.24 | 0% | Excavator, 5% of surface area to depth of 3-inches/ annually | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding & Mulching | ACRE | 0.30 | 17,526 | $5,214 | $14,134.00 | 1.24 | | seeding 10% of surface area/annually | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | Subtotal Annual Costs | | | | $7,558 | | | | | |
| | Contingency (0%) | | | | $0.00 | | | | | |
| | Subtotal Annual Costs | | | | $7,558 | | | | | |
| | Technical Support & Project Management (20% of annual costs) | | | | $1,511.55 | | | | | |
| | **Total Annual Costs** | | | | **$9,069** | | | | | |
| **2** | **Periodic Costs** | | | | | | | | | |
| | Five Year Review Reports [every 5 years] | EA | 1 | $12,000 | $12,000 | | | | Assumed | Assumed |
| | Contingency (0%) | | | | $0.00 | | | | | |
| | Subtotal Periodic Costs | | | | $12,000 | | | | | |
| | Technical Support & Project Management (20% ) | | | | $2,400.00 | | | | | |
| | **Subtotal Periodic Costs** | | | | **$14,400** | | | | | |

**TABLE F-1**
**ALTERNATIVE 1A - COST OPINION**
**CAPPING BACKYARDS (Poured Slab)**
**AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Replacing damaged pavement covering backyards & common areas (every 10 years) | LS | 1 | **$10,445.74** | $10,446 | | | | | |
| | Technical Support & Project Management (20% of replacing pavement) | | | | $2,089.15 | | | | | |
| | **Subtotal Periodic Costs** | | | | **$12,535** | | | | | |

| Phase | Item/Description | Year | Total Cost Non Discounted | Total Cost per Year | Present Value | | | | Discount Factor | Period & Discount Rate Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| **C** | **PRESENT VALUE ANALYSIS** | | | | | | | | | |
| | Capital Costs | 0 | $ 4,192,884 | $ 4,192,884 | **$ 4,192,884** | | | | 1 | |
| | Annual O&M costs | 1-30 | $ 453,465 | $ 9,069 | $ 130,225 | | | | 5.61% | "(1) 30 years until buildings ar replaced with new structures, and (2) Discount rate: U.S. Government Treasury Bonds, April 12th, 2001, 30 year bond, 5.61%, |
| | Periodic Costs (every 5 years, year 5 through 30) | 5-30 | $ 86,400 | $ 14,400 | 36,967 | | | | 5.61% | |
| | Periodic Costs (every 10 years) | 10,20 | $25,070 | $12,535 | 11,470 | | | | 5.61% | Assume replace paving every 10 years |
| | | | $ 4,757,818 | | $ 4,371,545 | | | | | |
| **D** | **TOTAL PRESENT VALUE OFALTERNATIVE 1A** | | | | **$ 4,371,545** | | | | | |

**Notes:**

| | |
|---|---|
| bgs | Below ground surface |
| BOE | Board of Equilization |
| CS | Confirmation sample |
| CY | Cubic yard |
| EA | Each |
| EPA | Environmental Protection Agency |
| ft | Feet |
| GVW | Gross vehicle weight |
| H&S | Health and safety |
| H:V | Horizontal to vertical |
| HR | Hour |
| WDA | Solid Waste Disposal Area |
| in | Inch |
| LF | Linear feet |
| LS | Lump sum |
| MO | Month |
| PAH | Polynuclear aromatic hydrocarbon |
| PCB | Polychlorinated biphenyl |
| QC | Quality control |
| SF | Square feet |
| SY | Square yard |
| TAT | Turn around time |
| WK | Week |

**TABLE F-2**
**ALTERNATIVE 2A - COST OPINION**
**CAPPING BACKYARDS (Precast) AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| A | **CAPITAL COSTS** | | | | | | | | | |
| | **DIRECT COSTS** | | | | | | | | | |
| 1 | **Mobilization** | | | | | | | | | |
| | Locate utilities | LS | 1 | $20,000 | $20,000 | $20,000.00 | | | | Assumed |
| | Mobilize heavy equipment (2 hydraulic excavators, 1 wheel loader) | LS | 1 | $ 3,639 | $3,639 | 2,935 | 1.24 | | 3 Trailer Trips of 1 day each + 2 laborers for one week | Means 2000., #33 01 0111 & #99 01 06, Envir. Remed. Cost Data - Unit Price (Truck, 2 axle, Highway, 33,000 GVW, 6 x 2 and General-purpose laborer) |
| | Truck scale rental | MO | 4 | $ 3,720 | $14,880 | 3,000 | 1.24 | | Estimated time for excavation | Means 2000., #33 01 0462, Envir. Remed. Cost Data - Unit Price |
| | HiVol Samplers (Continuous Monitoring and Recording of Air Flow) | EA | 3 | $ 6,200 | $18,600 | 5,000 | 1.24 | | 3 HiVols | Means 2000., #33 02 1507, Envir. Remed. Cost Data - Unit Price |
| | Instrument Shelter | EA | 3 | $ 1,031 | $3,092 | 831 | 1.24 | | 3 shelters for HiVols | Means 2000, #33 02 0338, Envir. Remed. Cost Data - Unit Price |
| | Baseline data (lead, PAHs, pesticides, PCBs) | Day | 21 | $ 726 | $15,242 | 585 | 1.24 | | 3 HiVols for 1 week to establish baseline | Means 2000, #33 02 1813, #33 02 1812, and #33 02 1810, Envir. Remed. Cost Data - Unit Price (Metals by ICP, PAHs, Pesticides/PCBs) |
| | Daily results of air monitoring from HiVols (lead, PAHs, pesticides, PCBs) | Day | 462 | $ 726 | $335,324 | 585 | 1.24 | | 3 HiVols for 22 weeks | Means 2000, #33 02 1813, #33 02 1812, and #33 02 1810, Envir. Remed. Cost Data - Unit Price (Metals by ICP, PAHs, Pesticides/PCBs) |
| | Health & safety program | LS | 1 | $50,000 | $50,000 | $50,000 | | | | Assumed |
| | **Mobilization Subtotal** | | | | **$460,777** | | | | | |
| 2 | **Fencing** | | | | | | | | | |
| | **Identified SWDA A & B** | | | | | | | | | |
| | Remove wood fence | LF | 836 | $ 2.33 | $1,949 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 836 | $ 15.77 | $13,186 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Identified SWDA 1207/1209/1211/1213** | | | | | | | | | |
| | Remove wood fence | LF | 792 | $ 2.33 | $1,846 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 792 | $ 15.77 | $12,492 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Identified SWDA 1231/1233** | | | | | | | | | |
| | Remove wood fence | LF | 487 | $ 2.33 | $1,135 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 487 | $ 15.77 | $7,681 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |

**TABLE F-2**
**ALTERNATIVE 2A - COST OPINION**
**CAPPING BACKYARDS (Precast) AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Identified SWDA Bigelow** | | | | | | | | | |
| | Remove wood fence | LF | 600 | $ 2.33 | $1,399 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 600 | $ 15.77 | $9,464 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Identified SWDA 1235/1237** | | | | | | | | | |
| | Remove wood fence | LF | 515 | $ 2.33 | $1,201 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 515 | $ 15.77 | $8,123 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Fencing Subtotal** | | | | **$58,476** | | | | | |
| **3** | **Capping Backyards** | | | | | | | | | |
| | **Identified SWDA A & B** | | | | | | | | | |
| | *Total Backyard Area* | *SF* | *5,800* | | | | | | SF calculated using Microstation | |
| | *Number of Backyards* | *#* | *12* | | | | | | Counted using ArcView | |
| | Clearing backyard vegetation (light brush without grub) | ACRE | 0.1 | $ 86.22 | $9 | $69.53 | 1.24 | | Assume vegetation is 3/4 of backyard area | Means 2000., #17 01 0101, Level D, Envir. Remed. Cost Data - Assemblies |
| | Demolish existing backyard pavement (unreinforced concrete, 6" thick) with air equipment | CY | 27 | $ 67.99 | $1,826 | $54.83 | 1.24 | | Assume pavement is 6" thick and 1/4 of backyard area | Means 2000., #17 02 0205, Level D, Envir. Remed. Cost Data - Assemblies |
| | Fine grading, hand (compact & grade gravel layer, and grade sand layer) | SY | 644 | $ 3.22 | $2,078 | $2.60 | 1.24 | | Assume fine grade backyards twice, with walk-behind vibrating plate once over gravel. | Means 2000., #17 03 0105, Level D, Envir. Remed. Cost Data - Assemblies+Means 023153 300 7000 |
| | Precast concrete paving slabs, 4 inches thick, 36 inch x 36 inch | SF | 5,510 | $ 10.29 | $56,709 | $8.30 | 1.24 | | Assume 95% of Backyard area | Local Vendor Estimate |
| | Pour in-place concrete 6" wide perimeter edging | SF | 290 | $ 3.87 | $1,122 | $3.12 | 1.24 | | Assume 5% of Backyard area | Means 2000., #18 02 0330, Level E, Envir. Remed. Cost Data - Unit Price |
| | Planter box | EA | 12 | $200.00 | $2,400 | $200.00 | | | | Assumed |
| | **Identified SWDA 1207/1209/1211/1213** | | | | | | | | | |
| | *Total Backyard Area* | *SF* | *7,621* | | | | | | SF calculated using Microstation | |
| | *Number of Backyards* | *#* | *16* | | | | | | Counted using ArcView | |
| | Clearing backyard vegetation (light brush without grub) | ACRE | 0.1 | $ 86.22 | $11 | $69.53 | 1.24 | | Assume vegetation is 3/4 of backyard area | Means 2000., #17 01 0101, Level D, Envir. Remed. Cost Data - Assemblies |

**TABLE F-2**
**ALTERNATIVE 2A - COST OPINION**
**CAPPING BACKYARDS (Precast) AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Demolish existing backyard pavement (unreinforced concrete, 6" thick) with air equipment | CY | 35 | $ 67.99 | $2,399 | $54.83 | 1.24 | | Assume pavement is 6" thick and 1/4 of backyard area | Means 2000., #17 02 0205, Level D, Envir. Remed. Cost Data - Assemblies |
| | Fine grading, hand (compact & grade gravel layer, and grade sand layer) | SY | 847 | $ 3.22 | $2,730 | $2.60 | 1.24 | | Assume fine grade backyards twice, with walk-behind vibrating plate once over gravel. | Means 2000., #17 03 0105, Level D, Envir. Remed. Cost Data - Assemblies+Means 023153 300 7000 |
| | Precast concrete paving slabs, 4 inches thick, 36 inch x 36 inch | SF | 7,240 | $ 10.29 | $74,514 | $8.30 | 1.24 | | Assume 95% of Backyard area | Local Vendor Estimate |
| | Pour in-place concrete 6" wide perimeter edging | SF | 381 | $ 3.87 | $1,474 | $3.12 | 1.24 | | Assume 5% of Backyard area | Means 2000., #18 02 0330, Level E, Envir. Remed. Cost Data - Unit Price |
| | Planter box | EA | 16 | $200.00 | $3,200 | $200.00 | | | | Assumed |
| | **Identified SWDA Bigelow** | | | | | | | | | |
| | *Total Backyard Area* | *SF* | *4,082* | | | | | | SF calculated using Microstation | |
| | *Number of Backyards* | *#* | *8* | | | | | | Counted using ArcView | |
| | Clearing backyard vegetation (light brush without grub) | ACRE | 0.1 | $ 86.22 | $6 | $69.53 | 1.24 | | Assume vegetation is 3/4 of backyard area | Means 2000., #17 01 0101, Level D, Envir. Remed. Cost Data - Assemblies |
| | Demolish existing backyard pavement (unreinforced concrete, 6" thick) with air equipment | CY | 19 | $ 67.99 | $1,285 | $54.83 | 1.24 | | Assume pavement is 6" thick and 1/4 of backyard area | Means 2000., #17 02 0205, Level D, Envir. Remed. Cost Data - Assemblies |
| | Fine grading, hand (compact & grade gravel layer, and grade sand layer) | SY | 454 | $ 3.22 | $1,462 | $2.60 | 1.24 | | | Means 2000., #17 03 0105, Level D, Envir. Remed. Cost Data - Assemblies+Means 023153 300 7000 |
| | Precast concrete paving slabs, 4 inches thick, 36 inch x 36 inch | SF | 3,878 | $ 10.29 | $39,911 | $8.30 | 1.24 | | Assume 95% of Backyard area | Local Vendor Estimate |
| | Pour in-place concrete 6" wide perimeter edging | SF | 204 | $ 3.87 | $790 | $3.12 | 1.24 | | Assume 5% of Backyard area | Means 2000., #18 02 0330, Level E, Envir. Remed. Cost Data - Unit Price |
| | Planter box | EA | 8 | $200.00 | $1,600 | $200.00 | | | | Assumed |
| | **Identified SWDA 1231/1233/1235/1237** | | | | | | | | | |
| | *Total Backyard Area* | *SF* | *9,954* | | | | | | SF calculated using Microstation | |
| | *Number of Backyards* | *#* | *24* | | | | | | Counted using ArcView | |
| | Clearing backyard vegetation (light brush without grub) | ACRE | 0.2 | $ 86.22 | $15 | $69.53 | 1.24 | | Assume vegetation is 3/4 of backyard area | Means 2000., #17 01 0101, Level D, Envir. Remed. Cost Data - Assemblies |
| | Demolish existing backyard pavement (unreinforced concrete, 6" thick) with air equipment | CY | 46 | $ 67.99 | $3,133 | $54.83 | 1.24 | | Assume pavement is 6" thick and 1/4 of backyard area | Means 2000., #17 02 0205, Level D, Envir. Remed. Cost Data - Assemblies |
| | Fine grading, hand (compact & grade gravel layer, and grade sand layer) | SY | 1,106 | $ 3.22 | $3,566 | $2.60 | 1.24 | | | Means 2000., #17 03 0105, Level D, Envir. Remed. Cost Data - Assemblies+Means 023153 300 7000 |

**TABLE F-2**
**ALTERNATIVE 2A - COST OPINION**
**CAPPING BACKYARDS (Precast) AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Precast concrete paving slabs, 4 inches thick, 36 inch x 36 inch | SF | 9,456 | $ 10.29 | $97,324 | $8.30 | 1.24 | | Assume 95% of Backyard area | Local Vendor Estimate |
| | Pour in-place concrete 6" wide perimeter edging | SF | 498 | $ 3.87 | $1,926 | $3.12 | 1.24 | | Assume 5% of Backyard area | Means 2000., #18 02 0330, Level E, Envir. Remed. Cost Data - Unit Price |
| | Planter box | EA | 24 | $200.00 | $4,800 | $200.00 | | | | Assumed |
| | **Topsoil Removal & Replacement with Subgrade Soil for Paving** | | | | | | | | | |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 254 | $ 13.52 | $3,438 | $10.90 | 1.24 | | Assume topsoil is 4-inch over 75% of backyard area | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Backfill with off-site unclassified fill (includes delivery, spreading, and compaction) | CY | 254 | $ 20.03 | $5,093 | $18.09 | 1.24 | | Assume same volume as removed topsoil | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | **Capping Backyards Subtotal** | | | | **$312,818** | | | | | |
| **4** | **Excavation to 2 ft bgs in Common Areas** | | | | | | | | | |
| | **Identified SWDA A & B** | | | | | | | | | |
| | *Total Common Area* | *SF* | *56,584* | | | | | | SF calculated using Microstation | |
| | *Total Common Area Volume* | *CY* | *4,191* | | | | | | | |
| | Sprayed water dust suppressant | SY | 2,816,626 | $ 0.01 | $34,926 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 32 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 419 | $ 13.52 | $5,667 | $10.90 | 1.24 | | Use for 10% of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 2,934 | $ 10.72 | $31,440 | $8.64 | 1.24 | | Use for 70 % of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 419 | $ 48.93 | $20,507 | $39.46 | 1.24 | 10% | Use for 10 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 419 | $ 72.95 | $30,573 | $58.83 | 1.24 | 10% | Use for 10 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 4,191 | $ 5.44 | $22,814 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 56,584 | 0.62 | $35,082 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 4,191 | $ 20.03 | $83,952 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |

**TABLE F-2**
**ALTERNATIVE 2A - COST OPINION**
**CAPPING BACKYARDS (Precast) AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Seeding, vegetative cover | ACRE | 1.3 | 17,526 | $22,766 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Identified SWDA 1207/12091211/1213** | | | | | | | | | |
| | *Total Common Area* | *SF* | *19,956* | | | | | | SF calculated using Microstation | |
| | *Total Common Area Volume* | *CY* | *1,478* | | | | | | | |
| | Sprayed water dust suppressant | SY | 993,365 | $ 0.01 | $12,318 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 32 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 148 | $ 13.52 | $1,998 | $10.90 | 1.24 | | Use for 10 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 1,035 | $ 10.72 | $11,087 | $8.64 | 1.24 | | Use for 70 % of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 148 | $ 48.93 | $7,232 | $39.46 | 1.24 | 10% | Use for 10 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 148 | $ 72.95 | $10,782 | $58.83 | 1.24 | 10% | Use for 10 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 1,478 | $ 5.44 | $8,046 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 19,956 | 0.62 | $12,373 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 1,478 | $ 20.03 | $29,607 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 0.5 | 17,526 | $8,029 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Identified SWDA Bigelow** | | | | | | | | | |
| | *Total Common Area* | *SF* | *14,804* | | | | | | SF calculated using Microstation | |
| | *Total Common Area Volume* | *CY* | *1,097* | | | | | | | |
| | Sprayed water dust suppressant | SY | 736,910 | $ 0.01 | $9,138 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 32 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 110 | $ 13.52 | $1,483 | $10.90 | 1.24 | | Use for 10 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 | CY | 768 | $ 10.72 | $8,229 | $8.64 | 1.24 | | Use for 70% of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |

**TABLE F-2**
**ALTERNATIVE 2A - COST OPINION**
**CAPPING BACKYARDS (Precast) AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Hand excavation for utilities and edge of buildings | CY | 110 | $ 48.93 | $5,368 | $39.46 | 1.24 | 10% | Use for 10 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 110 | $ 72.95 | $8,003 | $58.83 | 1.24 | 10% | Use for 10 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 1,097 | $ 5.44 | $5,972 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 14,804 | 0.62 | $9,178 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 1,097 | $ 20.03 | $21,975 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 0.3 | 17,526 | $5,956 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Identified SWDA 1231/1233/1235/1237** | | | | | | | | | |
| | *Total Common Area* | *SF* | *38,244* | | | | | | SF calculated using Microstation | |
| | *Total Common Area Volume* | *CY* | *2,833* | | | | | | | |
| | Sprayed water dust suppressant | SY | 1,903,701 | $ 0.01 | $23,606 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 32 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 283 | $ 13.52 | $3,831 | $10.90 | 1.24 | | Use for 10 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 1,983 | $ 10.72 | $21,252 | $8.64 | 1.24 | | Use for 70% of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 283 | $ 48.93 | $13,862 | $39.46 | 1.24 | 10% | Use for 10 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 283 | $ 72.95 | $20,667 | $58.83 | 1.24 | 10% | Use for 10 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 2,833 | $ 5.44 | $15,422 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 38,244 | 0.62 | $23,711 | $0.50 | 1.24 | | | Assumed. |

**TABLE F-2**
**ALTERNATIVE 2A - COST OPINION**
**CAPPING BACKYARDS (Precast) AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 2,833 | $ 20.03 | $56,750 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 0.9 | 17,526 | $15,387 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Excavation of Common Areas** | | | | **$664,782** | | | | | |
| **5** | **Confirmation Sampling** | | | | | | | | | |
| | *Excavation wall length* | *LF* | *9,800* | | | | | | Length estimated using Microstation | |
| | Lead analysis (EPA 6010B) with 24 hour TAT | EA | 245 | $28.00 | $6,860 | $28.00 | | | 1 sample every 40 LF of wall length | Curtis & Tompkins with 24-hour turn around time |
| | QC samples for lead analysis (EPA 6010B) with 24 hour TAT | EA | 62 | $28.00 | $1,736 | $28.00 | | | 1 field dup. and 1 equip. rinsate sample for every 10 C.S.; 1 matrix spike/lab dup. for every 20 C.S. | Curtis & Tompkins with 24-hour turn around time |
| | PAH soil analysis (modified EPA 8270) with 7 working day TAT | EA | 62 | $375.00 | $23,250 | $375.00 | | | 1 sample for every 4 lead samples | EMAX with 7-working-day turn around time |
| | QC samples for PAH soil analysis (modified EPA 8270) with 7 working day TAT | EA | 15 | $375.00 | $5,625 | $375.00 | | | 1 field dup. and 1 equip. rinsate sample for every 10 C.S.; 1 matrix spike/lab dup. for every 20 C.S. | EMAX with 7-working-day turn around time |
| | Pesticides (EPA 8081) /PCBs (EPA 8082) soil analysis with 7 working day TAT | EA | 62 | $200.00 | $12,400 | $200.00 | | | 1 sample for every 4 lead samples | EMAX with 7-working-day turn around time |
| | QC samples for pesticides (EPA 8081)/PCBs (EPA 8082) soil analysis with 7 working day TAT | EA | 15 | $200.00 | $3,000 | $200.00 | | | 1 field dup. and 1 equip. rinsate sample for every 10 C.S.; 1 matrix spike/lab dup. for every 20 C.S. | EMAX with 7-working-day turn around time |
| | Subcontracted sampling, one-man crew | DAY | 46 | $ 546 | $25,152 | $440.00 | 1.24 | | Assume 10 samples/day | Means 2000., #33 02 9907, Envir. Remed. Cost Data - Unit Price |
| | Surveying, 2-man crew | DAY | 46 | $ 825 | $38,030 | $665.28 | 1.24 | | Same as sampling crew | Means 2000, #99 24 1204, Envir. Remed. Cost Data - Unit Price |
| | **Confirmation Sampling Subtotal** | | | | **$116,053** | | | | | |
| **6** | **Transportation & Disposal of Excavated Material** | | | | | | | | | |
| | *Volume of demolished concrete and excavated waste* | *CY* | *9,980* | | | | | | Total summation of excavated waste volume | |
| | Waste Profile Sampling & Analysis | | 20 | $1,200.00 | $24,000 | | | | | |
| | **Kettleman Hills Facility Class I** | | | | | | | | | |
| | Disposal fee (includes Kings county and BOE tax) | TON | 15,270 | $31.12 | $475,200 | $25.52 | | | Assume 1.8 tons/cy and 85% of excavated waste | Quote from Waste Management for Kettleman Hills Facility |
| | Transportation via end dumps | TON | 15,270 | $31.50 | $481,003 | $30.50 | $ 1.00 | | 23 ton minimum | Quote from Waste Management for Kettleman Hills Facility |

**TABLE F-2**
**ALTERNATIVE 2A - COST OPINION**
**CAPPING BACKYARDS (Precast) AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Altamont Landfill Class II** | | | | | | | | | |
| | Disposal fee | TON | 2,695 | $29.72 | $80,086 | $32.00 | | | Assume 1.8 tons/cy and 15% of excavated waste | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | Transportation via end dumps | TON | 2,695 | $13.25 | $35,705 | $13.00 | $0.25 | | 23 ton minimum, 3 trips/day | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | **Transportation & Disposal Subtotal** | | | | **$1,095,994** | | | | | |
| **7** | **Demobilize** | | | | | | | | | |
| | Demobilize heavy equipment | LS | 1 | $ 3,639 | $3,639 | $2,935 | 1.24 | | 3 Trailer Trips of 1 day each + 2 laborers for one week | Means 2000., #33 01 0111 & #99 01 06, Envir. Remed. Cost Data - Unit Price (Truck, 2 axle, Highway, 33,000 GVW, 6 x 2 and General-purpose laborer) |
| | General area cleanup | ACRE | 3.6 | $ 342 | $1,233 | $275.84 | 1.24 | | Common areas and backyards | Means 2000., #17 04 0101, Envir. Remed. Cost Data - Unit Price |
| | **Demobilize Subtotal** | | | | **$4,872** | | | | | |
| | Total Direct Costs | | | | $2,713,773 | | | | | Unit prices obtained from Means 2000 were adjusted with a location multiplier of 1.24 |
| | Scope contingencies (15% of Subtotal Direct) | | | | $407,065.92 | | | | | |
| | Bid contingency for Disposal (10% of subtotal transport & disposal costs) | | | | $109,599 | | | | | Potential disposal fee increase at facility with increased energy costs, and changes in market |
| | Bid contingency for administrative (5% of direct cost) | | | | $135,689 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | Insurance (5% of direct cost) | | | | $135,689 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **TOTAL DIRECT COSTS** | | | | **$3,501,815** | | | | | |

**TABLE F-2**
**ALTERNATIVE 2A - COST OPINION**
**CAPPING BACKYARDS (Precast) AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | **INDIRECT COSTS** | | | | | | | | | |
| | Construction Management Staff | WK | 22 | | | | | | Assume 1 wk mob., 2 wks paving, 20 wks excavating,1 wk demob | 19 |
| | Construction Manager | WK | 22 | $ 2,122 | $46,683 | $1,711.25 | 1.24 | | 8 hour days | Means 2000., #99 01 0102, Envir. Remed. Cost Data - Unit Price (Site Project Manager, average cost) |
| | Field Supervisor | WK | 22 | $ 1,989 | $43,750 | $1,603.75 | 1.24 | | 8 hour days | Means 2000., #99 01 0202, Envir. Remed. Cost Data - Unit Price (Superintendent, average cost) |
| | QC Engineer | WK | 22 | $ 1,533 | $33,718 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |
| | Site H&S officer | WK | 22 | $ 1,533 | $33,718 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0702, Envir. Remed. Cost Data - Unit Price (Safety Engineer, average cost) |
| | **Construction Management Staff Subtotal** | | | | **$157,869** | | | | | |
| | Office Overhead (5% of construction management staff cost) | | | | $7,893 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | General & Administration (5% of construction management staff cost) | | | | $395 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | Home Office Expenses (5% of construction management staff cost) | | | | $7,893 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Total Construction Management Costs** | | | | **$174,051** | | | | | |
| | Other Costs | | | | | | | | | |
| | Design (10% of direct cost) | | | | $350,182 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Other Costs Subtotal** | | | | **$350,182** | | | | | |
| | **TOTAL INDIRECT COSTS** | | | | **$524,233** | | | | | |
| | **Total Direct & Indirect Costs** | | | | **$4,026,048** | | | | | |
| | Profit (10% of Subtotal Direct & Indirect Costs) | | | | $402,604.79 | | | | | |
| | **TOTAL CAPITAL COSTS** | | | | **$4,428,653** | | | | | |

**TABLE F-2**
**ALTERNATIVE 2A - COST OPINION**
**CAPPING BACKYARDS (Precast) AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| B. | ANNUAL & PERIODIC COSTS | | | | | | | | | |
| 1 | **Annual Costs** | | | | | | | | | |
| | Monitoring changes in post-closure landuse | WK | 1 | $ 1,533 | $1,533 | | | | Contractor annual inspections for 1 week duration | "(1)Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |
| | Maintaining drainage and erosion control systems for vegetative cover in disposal area and backyards (P/A, 30, 5.61) | | | | | | | | | |
| | Excavator | CY | 60 | $ 13.52 | $811 | $10.90 | 1.24 | 0% | Excavator, 5% of surface area to depth of 3-inches/ annually | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding & Mulching | ACRE | 0.30 | 17,526 | $5,214 | $14,134.00 | 1.24 | | seeding 10% of surface area/annually | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | Subtotal Annual Costs | | | | $7,558 | | | | | |
| | Contingency (0%) | | | | $0.00 | | | | | |
| | Subtotal Annual Costs | | | | $7,558 | | | | | |
| | Technical Support & Project Management (20% of annual costs) | | | | $1,511.55 | | | | | |
| | **Total Annual Costs** | | | | **$9,069** | | | | | |
| 2 | **Periodic Costs** | | | | | | | | | |
| | Five Year Review Reports [every 5 years] | EA | 1 | $12,000 | $12,000 | | | | Assumed | Assumed |
| | Contingency (0%) | | | | $0.00 | | | | | |
| | Subtotal Periodic Costs | | | | $12,000 | | | | | |
| | Technical Support & Project Management (20% ) | | | | $2,400.00 | | | | | |
| | **Subtotal Periodic Costs** | | | | **$14,400** | | | | | |
| | Replacing damaged pavement covering backyards & common areas (every 10 years) | LS | 1 | **$24,427.78** | $24,428 | | | | | |
| | Technical Support & Project Management (20% of replacing pavement) | | | | $4,885.56 | | | | | |
| | **Subtotal Periodic Costs** | | | | **$29,313** | | | | | |

**TABLE F-2**
**ALTERNATIVE 2A - COST OPINION**
**CAPPING BACKYARDS (Precast) AND EXCAVATION OF COMMON AREAS (2') IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| C | PRESENT VALUE ANALYSIS | | | | | | | | | |
| | | Year | Total Cost Non-Discounted | Total Cost per Year | Present Value | | | | Discount Factor | Period & Discount Rate Assumptions |
| | Capital Costs | 0 | $ 4,428,653 | $ 4,428,653 | **$ 4,428,653** | | | | 1 | |
| | Annual O&M costs | 1-30 | $ 272,079 | $ 9,069 | $ 130,225 | | | | 5.61% | "(1) 30 years until buildings ar replaced with new structures, and (2) Discount rate: U.S. Government Treasury Bonds, April 12th, 2001, 30 year bond, 5.61%, |
| | Periodic Costs (every 5 years, year 5 through 30) | 5-30 | $ 86,400 | $ 14,400 | 36,967 | | | | 5.61% | |
| | Periodic Costs (every 10 years) | 10,20 | $58,627 | $29,313 | 26,822 | | | | 5.61% | Assume replace paving every 10 years |
| | | | $ 4,845,758 | | $ 4,622,666 | | | | | |

| Phase | Item/Description | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| D | TOTAL PRESENT VALUE OFALTERNATIVE 2A | | | | **$ 4,622,666** | | | | | |

**Notes:**

| | | | |
|---|---|---|---|
| bgs | Below ground surface | in | Inch |
| BOE | Board of Equilization | LF | Linear feet |
| CS | Confirmation sample | LS | Lump sum |
| CY | Cubic yard | MO | Month |
| EA | Each | PAH | Polynuclear aromatic hydrocarbon |
| EPA | Environmental Protection Agency | PCB | Polychlorinated biphenyl |
| ft | Feet | QC | Quality control |
| GVW | Gross vehicle weight | SF | Square feet |
| H&S | Health and safety | SY | Square yard |
| H:V | Horizontal to vertical | TAT | Turn around time |
| HR | Hour | WK | Week |
| WDA | Solid Waste Disposal Area | | |

**TABLE F-3**
**ALTERNATIVE 3A - COST OPINION**
**EXCAVATION OF BACKYARDS (2') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| A | **CAPITAL COSTS** | | | | | | | | | |
| | **DIRECT COSTS** | | | | | | | | | |
| 1 | **Mobilization** | | | | | | | | | |
| | Locate utilities | LS | 1 | $25,000 | $25,000 | $25,000.00 | | | | Assumed |
| | Mobilize heavy equipment (2 hydraulic excavators, 1 wheel loader) | LS | 1 | $ 3,639 | $3,639 | 2,935 | 1.24 | | 3 Trailer Trips of 1 day each + 2 laborers for one week | Means 2000., #33 01 0111 & #99 01 06, Envir. Remed. Cost Data - Unit Price (Truck, 2 axle, Highway, 33,000 GVW, 6 x 2 and General-purpose laborer) |
| | Truck scale rental | MO | 8 | $ 3,720 | $29,760 | 3,000 | 1.24 | | Estimated time for excavation | Means 2000., #33 01 0462, Envir. Remed. Cost Data - Unit Price |
| | HiVol Samplers (Continuous Monitoring and Recording of Air Flow) | EA | 3 | $ 6,200 | $18,600 | 5,000 | 1.24 | | 3 HiVols | Means 2000., #33 02 1507, Envir. Remed. Cost Data - Unit Price |
| | Instrument Shelter | EA | 3 | $ 1,031 | $3,092 | 831 | 1.24 | | 3 shelters for HiVols | Means 2000, #33 02 0338, Envir. Remed. Cost Data - Unit Price |
| | Baseline data (lead, PAHs, pesticides, PCBs) | Day | 21 | $ 726 | $15,242 | 585 | 1.24 | | 3 HiVols for 1 week to establish baseline | Means 2000, #33 02 1813, #33 02 1812, and #33 02 1810, Envir. Remed. Cost Data - Unit Price (Metals by ICP, PAHs, Pesticides/ PCBs) |
| | Daily results of air monitoring from HiVols (lead, PAHs, pesticides, PCBs) | Day | 504 | $ 726 | $365,808 | 585 | 1.24 | | 3 HiVols for 24 weeks | Means 2000, #33 02 1813, #33 02 1812, and #33 02 1810, Envir. Remed. Cost Data - Unit Price (Metals by ICP, PAHs, Pesticides/ PCBs) |
| | Health & safety program | LS | 1 | 75,000 | $75,000 | $75,000 | | | | Assumed |
| | **Mobilization Subtotal** | | | | **$536,141** | | | | | |
| 2 | **Fencing** | | | | | | | | | |
| | **Identified SWDA A & B** | | | | | | | | | |
| | Remove wood fence | LF | 836 | $ 2.33 | $1,949 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 836 | $ 15.77 | $13,186 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Identified SWDA 1207/1209/1211/1213** | | | | | | | | | |
| | Remove wood fence | LF | 792 | $ 2.33 | $1,846 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 792 | $ 15.77 | $12,492 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Identified SWDA 1231/1233** | | | | | | | | | |
| | Remove wood fence | LF | 487 | $ 2.33 | $1,135 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 487 | $ 15.77 | $7,681 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Identified SWDA Bigelow** | | | | | | | | | |
| | Remove wood fence | LF | 600 | $ 2.33 | $1,399 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 600 | $ 15.77 | $9,464 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |

**TABLE F-3**
**ALTERNATIVE 3A - COST OPINION**
**EXCAVATION OF BACKYARDS (2') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Identified SWDA 1235/1237** | | | | | | | | | |
| | Remove wood fence | LF | 515 | $ 2.33 | $1,201 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 515 | $ 15.77 | $8,123 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Fencing Subtotal** | | | | **$58,476** | | | | | |
| **3** | **Excavation to 2 ft bgs in Backyards and 2 ft bgs in Common Areas** | | | | | | | | | |
| | **Identified SWDA A & B** | | | | | | | | | |
| | *Total Backyard and Common Area* | *SF* | *62,384* | | | | | | SF calculated using Microstation | |
| | *Total Backyard and Common Area Volume* | *CY* | *4,621* | | | | | | Assume 2 ft depth | |
| | Sprayed water dust suppressant | SY | 3,687,588 | $ 0.01 | $45,726 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 38 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 3,466 | $ 13.52 | $46,861 | $10.90 | 1.24 | | Use for 75% of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 693 | $ 10.72 | $7,428 | $8.64 | 1.24 | | Use for 15 % of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 231 | $ 48.93 | $11,305 | $39.46 | 1.24 | 5% | Use for 5 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 231 | $ 72.95 | $16,855 | $58.83 | 1.24 | 5% | Use for 5 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 4,621 | $ 5.44 | $25,155 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 62,384 | 0.62 | $38,678 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 4,621 | $ 20.03 | $92,566 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 1.4 | 17,526 | $25,100 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Identified SWDA 1207/1209/1211/1213** | | | | | | | | | |
| | *Total Backyard and Common Area* | *SF* | *27,577* | | | | | | SF calculated using Microstation | |
| | *Total Backyard and Common Area Volume* | *CY* | *2,043* | | | | | | Assume 2 ft depth | |
| | Sprayed water dust suppressant | SY | 1,630,107 | $ 0.01 | $20,213 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 38 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 1,532 | $ 13.52 | $20,718 | $10.90 | 1.24 | | Use for 75 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |

**TABLE F-3**
**ALTERNATIVE 3A - COST OPINION**
**EXCAVATION OF BACKYARDS (2') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 306 | $ 10.72 | $3,284 | $8.64 | 1.24 | | Use for 15 % of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 102 | $ 48.93 | $4,998 | $39.46 | 1.24 | 5% | Use for 5% of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 102 | $ 72.95 | $7,452 | $58.83 | 1.24 | 5% | Use for 5 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 2,043 | $ 5.44 | $11,121 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 27,577 | 0.62 | $17,098 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 2,043 | $ 20.03 | $40,925 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 0.6 | 17,526 | $11,095 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Identified SWDA Bigelow** | | | | | | | | | |
| | *Total Backyard and Common Area* | *SF* | *18,886* | | | | | | SF calculated using Microstation | |
| | *Total Backyard and Common Area Volume* | *CY* | *1,399* | | | | | | Assume 2 ft depth | |
| | Sprayed water dust suppressant | SY | 940,103 | $ 0.01 | $11,657 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 32 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 1,049 | $ 13.52 | $14,187 | $10.90 | 1.24 | | Use for 75 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 210 | $ 10.72 | $2,249 | $8.64 | 1.24 | | Use for 15% of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 70 | $ 48.93 | $3,423 | $39.46 | 1.24 | 5% | Use for 5 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 70 | $ 72.95 | $5,103 | $58.83 | 1.24 | 5% | Use for 5 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 1,399 | $ 5.44 | $7,616 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 18,886 | 0.62 | $11,709 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 1,399 | $ 20.03 | $28,024 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |

**TABLE F-3**
**ALTERNATIVE 3A - COST OPINION**
**EXCAVATION OF BACKYARDS (2') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Seeding, vegetative cover | ACRE | 0.4 | 17,526 | $7,599 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Identified SWDA 1231/1233/1235/1237** | | | | | | | | | |
| | *Total Backyard and Common Area* | *SF* | *48,198* | | | | | | SF calculated using Microstation | |
| | *Total Backyard and Common Area Volume* | *CY* | *3,570* | | | | | | Assume 2 ft depth | |
| | Sprayed water dust suppressant | SY | 2,849,037 | $ 0.01 | $35,328 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 38 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 2,678 | $ 13.52 | $36,203 | $10.90 | 1.24 | | Use for 75 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 536 | $ 10.72 | $5,739 | $8.64 | 1.24 | | Use for 15 % of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 179 | $ 48.93 | $8,734 | $39.46 | 1.24 | 5% | Use for 5 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 179 | $ 72.95 | $13,021 | $58.83 | 1.24 | 5% | Use for 5 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 3,570 | $ 5.44 | $19,434 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 48,198 | 0.62 | $29,883 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 3,570 | $ 20.03 | $71,513 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 1.1 | 17,526 | $19,392 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Excavation of Common Areas Subtotal** | | | | **$783,186** | | | | | |
| **4** | **Confirmation Sampling** | | | | | | | | | |
| | *Excavation wall length* | *LF* | *9,800* | | | | | | Length estimated using Microstation | |
| | Lead analysis (EPA 6010B) with 24 hour TAT | EA | 245 | $28.00 | $6,860 | $28.00 | | | 1 sample every 40 LF of wall length | Curtis & Tompkins with 24-hour turn around time |
| | QC samples for lead analysis (EPA 6010B) with 24 hour TAT | EA | 62 | $28.00 | $1,736 | $28.00 | | | 1 field dup. and 1 equip. rinsate sample for every 10 C.S.; 1 matrix spike/lab dup. for every 20 C.S. | Curtis & Tompkins with 24-hour turn around time |
| | PAH soil analysis (modified EPA 8270) with 7 working day TAT | EA | 62 | $375.00 | $23,250 | $375.00 | | | 1 sample for every 4 lead samples | EMAX with 7-working-day turn around time |

**TABLE F-3**
**ALTERNATIVE 3A - COST OPINION**
**EXCAVATION OF BACKYARDS (2') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | QC samples for PAH soil analysis (modified EPA 8270) with 7 working day TAT | EA | 15 | $375.00 | $5,625 | $375.00 | | | 1 field dup. and 1 equip. rinsate sample for every 10 C.S.; 1 matrix spike/lab dup. for every 20 C.S. | EMAX with 7-working day turn around time |
| | Pesticides (EPA 8081) /PCBs (EPA 8082) soil analysis with 7 working day TAT | EA | 62 | $200.00 | $12,400 | $200.00 | | | 1 sample for every 4 lead samples | EMAX with 7-working-day turn around time |
| | QC samples for pesticides (EPA 8081)/PCBs (EPA 8082) soil analysis with 7 working day TAT | EA | 15 | $200.00 | $3,000 | $200.00 | | | 1 field dup. and 1 equip. rinsate sample for every 10 C.S.; 1 matrix spike/lab dup. for every 20 C.S. | EMAX with 7-working-day turn around time |
| | Subcontracted sampling, one-man crew | DAY | 46 | $ 546 | $25,152 | $440.00 | 1.24 | | Assume 10 samples/day | Means 2000., #33 02 9907, Envir. Remed. Cost Data - Unit Price |
| | Surveying, 2-man crew | DAY | 46 | $ 825 | $38,030 | $665.28 | 1.24 | | Same as sampling crew | Means 2000, #99 24 1204, Envir. Remed. Cost Data - Unit Price |
| | **Confirmation Sampling Subtotal** | | | | **$116,053** | | | | | |
| **5** | **Transportation & Disposal of Excavated Material** | | | | | | | | | |
| | *Volume of demolished concrete and excavated waste* | *CY* | *11,633* | | | | | | Total summation of excavated waste volume | |
| | Waste Profile Sampling & Analysis | | 24 | $1,200.00 | $28,800 | | | | | |
| | **Kettleman Hills Facility Class I** | | | | | | | | | |
| | Disposal fee (includes Kings county and BOE tax) | TON | 17,798 | $31.12 | $553,889 | $25.52 | | | Assume 1.8 tons/cy and 85% of excavated waste | Quote from Waste Management for Kettleman Hills Facility |
| | Transportation via end dumps | TON | 17,798 | $31.50 | $560,652 | $30.50 | $ 1.00 | | 23 ton minimum | Quote from Waste Management ffor Kettleman Hills Facility |
| | **Altamont Landfill Class II** | | | | | | | | | |
| | Disposal fee | TON | 3,141 | $29.72 | $93,348 | $32.00 | | | Assume 1.8 tons/cy and 15% of excavated waste | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | Transportation via end dumps | TON | 3,141 | $13.25 | $41,617 | $13.00 | $0.25 | | 23 ton minimum, 3 trips/day | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | **Transportation & Disposal Subtotal** | | | | **$1,278,306** | | | | | |

**TABLE F-3**
**ALTERNATIVE 3A - COST OPINION**
**EXCAVATION OF BACKYARDS (2') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | **Demobilize** | | | | | | | | | |
| | Demobilize heavy equipment | LS | 1 | $ 3,639 | $3,639 | $2,935 | 1.24 | | 3 Trailer Trips of 1 day each + 2 laborers for one week | Means 2000., #33 01 0111 & #99 01 06, Envir. Remed. Cost Data - Unit Price (Truck, 2 axle, Highway, 33,000 GVW, 6 x 2 and General-purpose laborer) |
| | General area cleanup | ACRE | 3.6 | $ 342 | $1,233 | $275.84 | 1.24 | | Common areas and backyards | Means 2000., #17 04 0101, Envir. Remed. Cost Data - Unit Price |
| | **Demobilize Subtotal** | | | | **$4,872** | | | | | |
| | Total Direct Costs | | | | $2,777,035 | | | | | Unit prices obtained from Means 2000 were adjusted with a location multiplier of 1.24 |
| | Scope contingencies (10% of Subtotal Direct) | | | | $277,703.52 | | | | | |
| | Bid contingency for Disposal (10% of subtotal transport & disposal costs) | | | | $127,831 | | | | | |
| | Bid contingency for administrative (5% of direct cost) | | | | $138,852 | | | | | |
| | Insurance (5% of direct cost) | | | | $138,852 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **TOTAL DIRECT COSTS** | | | | **$3,460,273** | | | | | |
| | **INDIRECT COSTS** | | | | | | | | | |
| | Construction Management Staff | WK | 24 | | | | | | Assume 1 wk mob., 22 wks excavating,1 wk demob | 22 |
| | Construction Manager | WK | 24 | $ 2,122 | $50,927 | $1,711.25 | 1.24 | | 8 hour days | Means 2000., #99 01 0102, Envir. Remed. Cost Data - Unit Price (Site Project Manager, average cost) |
| | Field Supervisor | WK | 24 | $ 1,989 | $47,728 | $1,603.75 | 1.24 | | 8 hour days | Means 2000., #99 01 0202, Envir. Remed. Cost Data - Unit Price (Superintendent, average cost) |
| | QC Engineer | WK | 24 | $ 1,533 | $36,783 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |
| | Site H&S officer | WK | 24 | $ 1,533 | $36,783 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0702, Envir. Remed. Cost Data - Unit Price (Safety Engineer, average cost) |
| | **Construction Management Staff Subtotal** | | | | **$172,221** | | | | | |
| | Office Overhead (5% of construction management staff cost) | | | | $8,611 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | General & Administration (5% of construction management staff cost) | | | | $431 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | Home Office Expenses (5% of construction management staff cost) | | | | $8,611 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Total Construction Management Costs** | | | | **$189,874** | | | | | |
| | **Other Costs** | | | | | | | | | |

**TABLE F-3**
**ALTERNATIVE 3A - COST OPINION**
**EXCAVATION OF BACKYARDS (2') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Design (10% of direct cost) | | | | $346,027.29 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Other Costs Subtotal** | | | | **$346,027** | | | | | |
| | **TOTAL INDIRECT COSTS** | | | | **$535,901** | | | | | |
| | **Total Direct & Indirect Costs** | | | | **$3,996,174** | | | | | |
| | Profit (10% of Subtotal Direct & Indirect Costs) | | | | $399,617.39 | | | | | |
| | **TOTAL CAPITAL COSTS** | | | | **$4,395,791** | | | | | |
| **B.** | **ANNUAL & PERIODIC COSTS** | | | | | | | | | |
| **1** | **Annual Costs** | | | | | | | | | |
| | Monitoring changes in post-closure landuse | WK | 1 | $ 1,533 | $1,533 | | | | Contractor annual inspections for 1 week duration | "(1)Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |
| | Maintaining drainage and erosion control systems for vegetative cover in disposal area and backyards (P/A, 30, 5.61) | | | | | | | | | |
| | Excavator | CY | 64 | $ 13.52 | $865 | $10.90 | 1.24 | 0% | Excavator, 5% of surface area to depth of 3-inches/ annually | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding & Mulching | ACRE | 0.32 | 17,526 | $5,561 | $14,134.00 | 1.24 | | seeding 10% of surface area/annually | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | Subtotal Annual Costs | | | | $7,959 | | | | | |
| | Contingency (0%) | | | | $0.00 | | | | | |
| | Subtotal Annual Costs | | | | $7,959 | | | | | |
| | Technical Support & Project Management (20% of annual costs) | | | | $1,591.80 | | | | | |
| | **Total Annual Costs** | | | | **$9,551** | | | | | |
| **2** | **Periodic Costs** | | | | | | | | | |
| | Five Year Review Reports [every 5 years] | EA | 1 | $12,000 | $12,000 | | | | Assumed | Assumed |
| | Subtotal Periodic Costs | | | | $12,000 | | | | | |
| | Technical Support & Project Management (20% ) | | | | $2,400.00 | | | | | |
| | | | | | | | | | | |
| | **Subtotal Periodic Costs** | | | | **$14,400** | | | | | |
| | Technical Support & Project Management (20% of replacing pavement) | | | | $0.00 | | | | | |
| | **Subtotal Periodic Costs** | | | | **$0** | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **C** | **PRESENT VALUE ANALYSIS** | | | | | | | | | |
| | | **Year** | **Total Cost Non-Discounted** | **Total Cost per Year** | **Present Value** | | | | **Discount Factor** | **Period & Discount Rate Assumptions** |

**TABLE F-3**
**ALTERNATIVE 3A - COST OPINION**
**EXCAVATION OF BACKYARDS (2') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Capital Costs | 0 | $ 4,395,791 | $ 4,395,791 | **$ 4,395,791** | | | | 1 | |
| | Annual O&M costs | 1-30 | $ 286,524 | $ 9,551 | $ 137,138 | | | | 5.61% | "(1) 30 years until buildings ar replaced with new structures, and (2) Discount rate: U.S. Government Treasury Bonds, April 12th, 2001, 30 year bond, 5.61%, |
| | Periodic Costs (every 5 years, year 5 through 30) | 5-30 | $ 86,400 | $ 14,400 | 36,967 | | | | 5.61% | |
| | | | $ 4,768,715 | | $ 4,569,896 | | | | | |
| **D** | **TOTAL PRESENT VALUE OFALTERNATIVE 3A** | | | | **$ 4,569,896** | | | | | |

**Notes:**

| | |
|---|---|
| bgs | Below ground surface |
| BOE | Board of Equilization |
| CS | Confirmation sample |
| CY | Cubic yard |
| EA | Each |
| EPA | Environmental Protection Agency |
| ft | Feet |
| GVW | Gross vehicle weight |
| H&S | Health and safety |
| H:V | Horizontal to vertical |
| HR | Hour |
| WDA | Solid Waste Disposal Area |
| in | Inch |
| LF | Linear feet |
| LS | Lump sum |
| MO | Month |
| PAH | Polynuclear aromatic hydrocarbon |
| PCB | Polychlorinated biphenyl |
| QC | Quality control |
| SF | Square feet |
| SY | Square yard |
| TAT | Turn around time |
| WK | Week |

**TABLE F-4**
**ALTERNATIVE 4A - COST OPINION**
**EXCAVATION OF BACKYARDS (4') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| A | CAPITAL COSTS | | | | | | | | | |
| | DIRECT COSTS | | | | | | | | | |
| 1 | Mobilization | | | | | | | | | |
| | Locate utilities | LS | 1 | $25,000 | $25,000 | $25,000.00 | | | | Assumed |
| | Mobilize heavy equipment (2 hydraulic excavators, 1 wheel loader) | LS | 1 | $ 3,639 | $3,639 | 2,935 | 1.24 | | 3 Trailer Trips of 1 day each + 2 laborers for one week | Means 2000., #33 01 0111 & #99 01 06, Envir. Remed. Cost Data - Unit Price (Truck, 2 axle, Highway, 33,000 GVW, 6 x 2 and General-purpose laborer) |
| | Truck scale rental | MO | 8 | $ 3,720 | $29,760 | 3,000 | 1.24 | | Estimated time for excavation | Means 2000., #33 01 0462, Envir. Remed. Cost Data - Unit Price |
| | HiVol Samplers (Continuous Monitoring and Recording of Air Flow) | EA | 3 | $ 6,200 | $18,600 | 5,000 | 1.24 | | 3 HiVols | Means 2000., #33 02 1507, Envir. Remed. Cost Data - Unit Price |
| | Instrument Shelter | EA | 3 | $ 1,031 | $3,092 | 831 | 1.24 | | 3 shelters for HiVols | Means 2000, #33 02 0338, Envir. Remed. Cost Data - Unit Price |
| | Baseline data (lead, PAHs, pesticides, PCBs) | Day | 21 | $ 726 | $15,242 | 585 | 1.24 | | 3 HiVols for 1 week to establish baseline | Means 2000, #33 02 1813, #33 02 1812, and #33 02 1810, Envir. Remed. Cost Data - Unit Price (Metals by ICP, PAHs, Pesticides/ PCBs) |
| | Daily results of air monitoring from HiVols (lead, PAHs, pesticides, PCBs) | Day | 567 | $ 726 | $411,534 | 585 | 1.24 | | 3 HiVols for 27 weeks | Means 2000, #33 02 1813, #33 02 1812, and #33 02 1810, Envir. Remed. Cost Data - Unit Price (Metals by ICP, PAHs, Pesticides/ PCBs) |
| | Health & safety program | LS | 1 | 75,000 | $75,000 | $75,000 | | | | Assumed |
| | **Mobilization Subtotal** | | | | **$581,867** | | | | | |
| 2 | Fencing | | | | | | | | | |
| | **Identified SWDA A & B** | | | | | | | | | |
| | Remove wood fence | LF | 836 | $ 2.33 | $1,949 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 836 | $ 15.77 | $13,186 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Identified SWDA 1207/1209/1211/1213** | | | | | | | | | |
| | Remove wood fence | LF | 792 | $ 2.33 | $1,846 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 792 | $ 15.77 | $12,492 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Identified SWDA 1231/1233** | | | | | | | | | |
| | Remove wood fence | LF | 487 | $ 2.33 | $1,135 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 487 | $ 15.77 | $7,681 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Identified SWDA Bigelow** | | | | | | | | | |
| | Remove wood fence | LF | 600 | $ 2.33 | $1,399 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 600 | $ 15.77 | $9,464 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |

**TABLE F-4**
**ALTERNATIVE 4A - COST OPINION**
**EXCAVATION OF BACKYARDS (4') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Identified SWDA 1235/1237** | | | | | | | | | |
| | Remove wood fence | LF | 515 | $ 2.33 | $1,201 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 515 | $ 15.77 | $8,123 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Fencing Subtotal** | | | | **$58,476** | | | | | |
| **3** | **Excavation to 4 ft bgs in Backyards and 2 ft bgs in Common Areas** | | | | | | | | | |
| | **Identified SWDA A & B** | | | | | | | | | |
| | *Total Backyard and Common Area* | *SF* | *62,384* | | | | | | SF calculated using Microstation | |
| | *Total Backyard and Common Area Volume* | *CY* | *5,051* | | | | | | | |
| | Sprayed water dust suppressant | SY | 3,687,588 | $ 0.01 | $45,726 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 38 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 3,536 | $ 13.52 | $47,807 | $10.90 | 1.24 | | Use for 70 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 505 | $ 10.72 | $5,413 | $8.64 | 1.24 | | Use for 10 % of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 505 | $ 48.93 | $24,715 | $39.46 | 1.24 | 10% | Use for 10 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 505 | $ 72.95 | $36,847 | $58.83 | 1.24 | 10% | Use for 10 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 5,051 | $ 5.44 | $27,496 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 62,384 | 0.62 | $38,678 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 5,051 | $ 20.03 | $101,180 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 1.4 | 17,526 | $25,100 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Identified SWDA 1207/1209/1211/1213** | | | | | | | | | |
| | *Total Backyard and Common Area* | *SF* | *27,577* | | | | | | SF calculated using Microstation | |
| | *Total Backyard and Common Area Volume* | *CY* | *2,607* | | | | | | | |
| | Sprayed water dust suppressant | SY | 1,630,107 | $ 0.01 | $20,213 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 38 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 1,825 | $ 13.52 | $24,675 | $10.90 | 1.24 | | Use for 70 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |

**TABLE F-4**
**ALTERNATIVE 4A - COST OPINION**
**EXCAVATION OF BACKYARDS (4') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 261 | $ 10.72 | $2,794 | $8.64 | 1.24 | | Use for 10 % of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 261 | $ 48.93 | $12,756 | $39.46 | 1.24 | 10% | Use for 10% of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 261 | $ 72.95 | $19,018 | $58.83 | 1.24 | 10% | Use for 10 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 2,607 | $ 5.44 | $14,191 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 27,577 | 0.62 | $17,098 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 2,607 | $ 20.03 | $52,222 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 0.6 | 17,526 | $11,095 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Identified SWDA Bigelow** | | | | | | | | | |
| | *Total Backyard and Common Area* | *SF* | *18,886* | | | | | | SF calculated using Microstation | |
| | *Total Backyard and Common Area Volume* | *CY* | *1,701* | | | | | | | |
| | Sprayed water dust suppressant | SY | 940,103 | $ 0.01 | $11,657 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 32 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 170 | $ 13.52 | $2,300 | $10.90 | 1.24 | | Use for 10 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 1,191 | $ 10.72 | $12,760 | $8.64 | 1.24 | | Use for 70% of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 170 | $ 48.93 | $8,323 | $39.46 | 1.24 | 10% | Use for 10 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 170 | $ 72.95 | $12,409 | $58.83 | 1.24 | 10% | Use for 10 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 1,701 | $ 5.44 | $9,260 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 18,886 | 0.62 | $11,709 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 1,701 | $ 20.03 | $34,074 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |

**TABLE F-4**
**ALTERNATIVE 4A - COST OPINION**
**EXCAVATION OF BACKYARDS (4') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Seeding, vegetative cover | ACRE | 0.4 | 17,526 | $7,599 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Identified SWDA 1231/1233/1235/1237** | | | | | | | | | |
| | *Total Backyard and Common Area* | *SF* | *48,198* | | | | | | SF calculated using Microstation | |
| | *Total Backyard and Common Area Volume* | *CY* | *4,308* | | | | | | | |
| | Sprayed water dust suppressant | SY | 2,849,037 | $ 0.01 | $35,328 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 38 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 3,016 | $ 13.52 | $40,774 | $10.90 | 1.24 | | Use for 70 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 431 | $ 10.72 | $4,617 | $8.64 | 1.24 | | Use for 10 % of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 431 | $ 48.93 | $21,079 | $39.46 | 1.24 | 10% | Use for 10 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 431 | $ 72.95 | $31,427 | $58.83 | 1.24 | 10% | Use for 10 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 4,308 | $ 5.44 | $23,451 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 48,198 | 0.62 | $29,883 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 4,308 | $ 20.03 | $86,296 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 1.1 | 17,526 | $19,392 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Excavation of Common Areas Subtotal** | | | | **$935,156** | | | | | |
| 4 | **Confirmation Sampling** | | | | | | | | | |
| | *Excavation wall length* | *LF* | *9,800* | | | | | | Length estimated using Microstation | |
| | Lead analysis (EPA 6010B) with 24 hour TAT | EA | 245 | $28.00 | $6,860 | $28.00 | | | 1 sample every 40 LF of wall length | Curtis & Tompkins with 24-hour turn around time |
| | QC samples for lead analysis (EPA 6010B) with 24 hour TAT | EA | 62 | $28.00 | $1,736 | $28.00 | | | 1 field dup. and 1 equip. rinsate sample for every 10 C.S.; 1 matrix spike/lab dup. for every 20 C.S. | Curtis & Tompkins with 24-hour turn around time |
| | PAH soil analysis (modified EPA 8270) with 7 working day TAT | EA | 62 | $375.00 | $23,250 | $375.00 | | | 1 sample for every 4 lead samples | EMAX with 7-working-day turn around time |

**TABLE F-4**
**ALTERNATIVE 4A - COST OPINION**
**EXCAVATION OF BACKYARDS (4') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | QC samples for PAH soil analysis (modified EPA 8270) with 7 working day TAT | EA | 15 | $375.00 | $5,625 | $375.00 | | | 1 field dup. and 1 equip. rinsate sample for every 10 C.S.; 1 matrix spike/lab dup. for every 20 C.S. | EMAX with 7-working day turn around time |
| | Pesticides (EPA 8081) /PCBs (EPA 8082) soil analysis with 7 working day TAT | EA | 62 | $200.00 | $12,400 | $200.00 | | | 1 sample for every 4 lead samples | EMAX with 7-working-day turn around time |
| | QC samples for pesticides (EPA 8081)/PCBs (EPA 8082) soil analysis with 7 working day TAT | EA | 15 | $200.00 | $3,000 | $200.00 | | | 1 field dup. and 1 equip. rinsate sample for every 10 C.S.; 1 matrix spike/lab dup. for every 20 C.S. | EMAX with 7-working-day turn around time |
| | Subcontracted sampling, one-man crew | DAY | 46 | $ 546 | $25,152 | $440.00 | 1.24 | | Assume 10 samples/day | Means 2000., #33 02 9907, Envir. Remed. Cost Data - Unit Price |
| | Surveying, 2-man crew | DAY | 46 | $ 825 | $38,030 | $665.28 | 1.24 | | Same as sampling crew | Means 2000, #99 24 1204, Envir. Remed. Cost Data - Unit Price |
| | **Confirmation Sampling Subtotal** | | | | **$116,053** | | | | | |
| **5** | **Transportation & Disposal of Excavated Material** | | | | | | | | | |
| | *Volume of demolished concrete and excavated waste* | *CY* | *13,667* | | | | | | Total summation of excavated waste volume | |
| | Waste Profile Sampling & Analysis | | 28 | $1,200.00 | $33,600 | | | | | |
| | **Kettleman Hills Facility Class I** | | | | | | | | | |
| | Disposal fee (includes Kings county and BOE tax) | TON | 20,911 | $31.12 | $650,735 | $25.52 | | | Assume 1.8 tons/cy and 85% of excavated waste | Quote from Waste Management for Kettleman Hills Facility |
| | Transportation via end dumps | TON | 20,911 | $31.50 | $658,681 | $30.50 | $ 1.00 | | 23 ton minimum | Quote from Waste Management for Kettleman Hills Facility |
| | **Altamont Landfill Class II** | | | | | | | | | |
| | Disposal fee | TON | 3,690 | $29.72 | $109,669 | $32.00 | | | Assume 1.8 tons/cy and 15% of excavated waste | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | Transportation via end dumps | TON | 3,690 | $13.25 | $48,894 | $13.00 | $0.25 | | 23 ton minimum, 3 trips/day | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | **Transportation & Disposal Subtotal** | | | | **$1,501,579** | | | | | |

**TABLE F-4**
**ALTERNATIVE 4A - COST OPINION**
**EXCAVATION OF BACKYARDS (4') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | **Demobilize** | | | | | | | | | |
| | Demobilize heavy equipment | LS | 1 | $ 3,639 | $3,639 | $2,935 | 1.24 | | 3 Trailer Trips of 1 day each + 2 laborers for one week | Means 2000., #33 01 0111 & #99 01 06, Envir. Remed. Cost Data - Unit Price (Truck, 2 axle, Highway, 33,000 GVW, 6 x 2 and General-purpose laborer) |
| | General area cleanup | ACRE | 3.6 | $ 342 | $1,233 | $275.84 | 1.24 | | Common areas and backyards | Means 2000., #17 04 0101, Envir. Remed. Cost Data - Unit Price |
| | **Demobilize Subtotal** | | | | **$4,872** | | | | | |
| | Total Direct Costs | | | | $3,198,003 | | | | | Unit prices obtained from Means 2000 were adjusted with a location multiplier of 1.24 |
| | Scope contingencies (10% of Subtotal Direct) | | | | $319,800.33 | | | | | |
| | Bid contingency for Disposal (10% of subtotal transport & disposal costs) | | | | $150,158 | | | | | |
| | Bid contingency for administrative (5% of direct cost) | | | | $159,900 | | | | | |
| | Insurance (5% of direct cost) | | | | $159,900 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **TOTAL DIRECT COSTS** | | | | **$3,987,762** | | | | | |
| | **INDIRECT COSTS** | | | | | | | | | |
| | Construction Management Staff | WK | 27 | | | | | | Assume 1 wk mob., 25 wks excavating,1 wk demob | 25 |
| | Construction Manager | WK | 27 | $ 2,122 | $57,293 | $1,711.25 | 1.24 | | 8 hour days | Means 2000., #99 01 0102, Envir. Remed. Cost Data - Unit Price (Site Project Manager, average cost) |
| | Field Supervisor | WK | 27 | $ 1,989 | $53,694 | $1,603.75 | 1.24 | | 8 hour days | Means 2000., #99 01 0202, Envir. Remed. Cost Data - Unit Price (Superintendent, average cost) |
| | QC Engineer | WK | 27 | $ 1,533 | $41,381 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |
| | Site H&S officer | WK | 27 | $ 1,533 | $41,381 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0702, Envir. Remed. Cost Data - Unit Price (Safety Engineer, average cost) |
| | **Construction Management Staff Subtotal** | | | | **$193,749** | | | | | |
| | Office Overhead (5% of construction management staff cost) | | | | $9,687 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | General & Administration (5% of construction management staff cost) | | | | $484 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | Home Office Expenses (5% of construction management staff cost) | | | | $9,687 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Total Construction Management Costs** | | | | **$213,608** | | | | | |
| | **Other Costs** | | | | | | | | | |

**TABLE F-4**
**ALTERNATIVE 4A - COST OPINION**
**EXCAVATION OF BACKYARDS (4') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Design (10% of direct cost) | | | | $398,776.19 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Other Costs Subtotal** | | | | **$398,776** | | | | | |
| | **TOTAL INDIRECT COSTS** | | | | **$612,384** | | | | | |
| | **Total Direct & Indirect Costs** | | | | **$4,600,146** | | | | | |
| | Profit (10% of Subtotal Direct & Indirect Costs) | | | | $460,014.61 | | | | | |
| | **TOTAL CAPITAL COSTS** | | | | **$5,060,161** | | | | | |
| **B.** | **ANNUAL & PERIODIC COSTS** | | | | | | | | | |
| **1** | **Annual Costs** | | | | | | | | | |
| | Monitoring changes in post-closure landuse | WK | 1 | $ 1,533 | $1,533 | | | | Contractor annual inspections for 1 week duration | "(1)Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |
| | Maintaining drainage and erosion control systems for vegetative cover in disposal area and backyards (P/A, 30, 5.61) | | | | | | | | | |
| | Excavator | CY | 73 | $ 13.52 | $983 | $10.90 | 1.24 | 0% | Excavator, 5% of surface area to depth of 3-inches/ annually | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding & Mulching | ACRE | 0.36 | 17,526 | $6,319 | $14,134.00 | 1.24 | | seeding 10% of surface area/annually | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | Subtotal Annual Costs | | | | $8,834 | | | | | |
| | Contingency (0%) | | | | $0.00 | | | | | |
| | Subtotal Annual Costs | | | | $8,834 | | | | | |
| | Technical Support & Project Management (20% of annual costs) | | | | $1,766.87 | | | | | |
| | **Total Annual Costs** | | | | **$10,601** | | | | | |
| **2** | **Periodic Costs** | | | | | | | | | |
| | Five Year Review Reports [every 5 years] | EA | 1 | $12,000 | $12,000 | | | | Assumed | Assumed |
| | Subtotal Periodic Costs | | | | $12,000 | | | | | |
| | Technical Support & Project Management (20% ) | | | | $2,400.00 | | | | | |
| | | | | | | | | | | |
| | **Subtotal Periodic Costs** | | | | **$14,400** | | | | | |

**TABLE F-4**
**ALTERNATIVE 4A - COST OPINION**
**EXCAVATION OF BACKYARDS (4') AND COMMON AREAS (2')IN KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Ecav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| C | **PRESENT VALUE ANALYSIS** | | | | | | | | | |
| | | **Year** | **Total Cost Non-Discounted** | **Total Cost per Year** | **Present Value** | | | | **Discount Factor** | **Period & Discount Rate Assumptions** |
| | Capital Costs | 0 | $ 5,060,161 | $ 5,060,161 | **$ 5,060,161** | | | | 1 | |
| | Annual O&M costs | 1-30 | $ 318,036 | $ 10,601 | $ 152,221 | | | | 5.61% | "(1) 30 years until buildings ar replaced with new structures, and (2) Discount rate: U.S. Government Treasury Bonds, April 12th, 2001, 30 year bond, 5.61%, |
| | Periodic Costs (every 5 years, year 5 through 30) | 5-30 | $ 86,400 | $ 14,400 | 36,967 | | | | 5.61% | |
| | | | $ 5,464,597 | | $ 5,249,348 | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **D** | **TOTAL PRESENT VALUE OFALTERNATIVE 4A** | | | | **$ 5,249,348** | | | | | |

**Notes:**

| | | | |
|---|---|---|---|
| bgs | Below ground surface | in | Inch |
| BOE | Board of Equilization | LF | Linear feet |
| CS | Confirmation sample | LS | Lump sum |
| CY | Cubic yard | MO | Month |
| EA | Each | PAH | Polynuclear aromatic hydrocarbon |
| EPA | Environmental Protection Agency | PCB | Polychlorinated biphenyl |
| ft | Feet | QC | Quality control |
| GVW | Gross vehicle weight | SF | Square feet |
| H&S | Health and safety | SY | Square yard |
| H:V | Horizontal to vertical | TAT | Turn around time |
| HR | Hour | WK | Week |
| WDA | Solid Waste Disposal Area | | |

**TABLE F-5**
**ALTERNATIVE 1B - COST OPINION**
**CAPPING BACKYARDS (Poured Slab) OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| A | **CAPITAL COSTS** | | | | | | | | | |
| | **DIRECT COSTS** | | | | | | | | | |
| 1 | **Mobilization** | | | | | | | | | |
| | Locate utilities | LS | 1 | $5,000.00 | $5,000 | $5,000.00 | | | | Assumed |
| | Mobilize heavy equipment (2 hydraulic excavators, 1 wheel loaders) | LS | 1 | $ 2,000 | $2,000 | 2,935 | 1.24 | | 3 Trailer Trips of 1 day each + 2 laborers for one week | Assumed |
| | Health & safety program | LS | 1 | $50,000 | $50,000 | $50,000 | | | | Assumed |
| | **Mobilization Subtotal** | | | | **$57,000** | | | | | |
| 2 | **Fencing** | | | | | | | | | |
| | **Site 12** | | | | | | | | | |
| | Remove wood fence | LF | 28,800 | $ 2.33 | $67,139 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 29,400 | $ 15.77 | $463,720 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Fencing Subtotal** | | | | **$530,859** | | | | | |
| 3 | **Capping Backyards** | | | | | | | | | |
| | **Site 12** | | | | | | | | | |
| | *Total Backyard Area outside of Solid Waste Disposal Areas* | *SF* | *327,864* | | | | | | SF calculated using Microstation | |
| | *Number of Backyards* | *#* | *685* | | | | | | Counted using ArcView | |
| | Clearing backyard vegetation (light brush without grub) | ACRE | 5.6 | $ 86.22 | $487 | $69.53 | 1.24 | | Assume vegetation is 3/4 of backyard area | Means 2000., #17 01 0101, Level D, Envir. Remed. Cost Data - Assemblies |
| | Demolish existing backyard pavement (unreinforced concrete, 6" thick) with air equipment | CY | 1,518 | $ 67.99 | $103,200 | $54.83 | 1.24 | | Assume pavement is 6" thick and 1/4 of backyard area | Means 2000., #17 02 0205, Level D, Envir. Remed. Cost Data - Assemblies |
| | Fine grading, hand | SY | 36,429 | $ 2.57 | $93,507 | $2.07 | 1.24 | | | Means 2000., #17 03 0105, Level D, Envir. Remed. Cost Data - Assemblies |
| | Cap using 4" mesh reinforced slab on grade | SF | 327,864 | $ 3.87 | $1,268,440 | $3.12 | 1.24 | | Assume 2 crews | Means 2000., #18 02 0330, Level E, Envir. Remed. Cost Data - Unit Price |
| | Planter box | EA | 685 | $200.00 | $137,000 | $200.00 | | | | Assumed |
| | Excavate topsoil using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 3,036 | $ 13.52 | $41,047 | $10.90 | 1.24 | | Assume topsoil is 4-inch over 75% of backyard area | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Backfill with off-site unclassified fill (includes delivery, spreading, and compaction) | CY | 3,036 | $ 20.03 | $60,811 | $18.09 | 1.24 | | Assume same volume as removed topsoil | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | **Capping Backyards Subtotal** | | | | **$1,704,493** | | | | | |
| 6 | **Transportation & Disposal of Excavated Material** | | | | | | | | | |
| | *Volume of demolished concrete and excavated waste* | *CY* | *4,554* | | | | | | Total summation of excavated waste volume | |
| | Waste Profile Sampling & Analysis | | 10 | $1,200.00 | $12,000 | | | | | |
| | **Kettleman Hills Facility Class I** | | | | | | | | | |
| | Disposal fee (includes Kings county and BOE tax) | TON | 1,229 | $31.12 | $38,262 | $25.52 | | | Assume 1.8 tons/cy and 15% of excavated waste | Quote from Waste Management for Kettleman Hills Facility |

**TABLE F-5**
**ALTERNATIVE 1B - COST OPINION**
**CAPPING BACKYARDS (Poured Slab) OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Transportation via end dumps | TON | 1,229 | $31.50 | $38,729 | $30.50 | $ 1.00 | | 23 ton minimum | Quote from Waste Management for Kettleman Hills Facility |
| | **Altamont Landfill Class II** | | | | | | | | | |
| | Disposal fee | TON | 6,967 | $29.72 | $207,063 | $32.00 | | | Assume 1.8 tons/cy and 85% of excavated waste | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | Transportation via end dumps | TON | 6,967 | $13.25 | $92,314 | $13.00 | $0.25 | | 23 ton minimum, 3 trips/day | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | **Transportation & Disposal Subtotal** | | | | **$388,367** | | | | | |
| **7** | **Demobilize** | | | | | | | | | |
| | Demobilize heavy equipment | LS | 1 | $ 2,000 | $2,000 | $2,935 | 1.24 | | 3 Trailer Trips of 1 day each + 2 laborers for one week | assumed |
| | General area cleanup | ACRE | 7.5 | $ 342.04 | $2,574 | $275.84 | 1.24 | | All backyards | Means 2000., #17 04 0101, Envir. Remed. Cost Data - Unit Price |
| | **Demobilize Subtotal** | | | | **$4,574** | | | | | |
| | Subtotal Direct Costs | | | | $2,685,293 | | | | | Unit prices obtained from Means 2000 were adjusted with a location multiplier of 1.24 |
| | Scope contingencies (15% of Subtotal Direct) | | | | $402,793.99 | | | | | |
| | Bid contingency for Disposal (10% of subtotal transport & disposal costs) | | | | **$38,837** | | | | | Potential disposal fee increase at facility with increased energy costs, and changes in market |
| | Bid contingency for administrative (5% of direct cost) | | | | $134,265 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | Insurance (5% of direct cost) | | | | $134,265 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **TOTAL DIRECT COSTS** | | | | **$3,395,453** | | | | | |
| | **INDIRECT COSTS** | | | | | | | | | |
| | Construction Management Staff | WK | 34 | | | | | | Assume 1 wk mob., 32 wks paving, 1 wk demob; Assume 2 paving crews | 7 |
| | Construction Manager | WK | 34 | $ 2,122 | $72,146 | $1,711.25 | 1.24 | | 8 hour days | Means 2000., #99 01 0102, Envir. Remed. Cost Data - Unit Price (Site Project Manager, average cost) |
| | Field Supervisor | WK | 34 | $ 1,989 | $67,614 | $1,603.75 | 1.24 | | 8 hour days | Means 2000., #99 01 0202, Envir. Remed. Cost Data - Unit Price (Superintendent, average cost) |
| | QC Engineer | WK | 34 | $ 1,533 | $52,110 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |

**TABLE F-5**
**ALTERNATIVE 1B - COST OPINION**
**CAPPING BACKYARDS (Poured Slab) OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Site H&S officer | WK | 34 | $ 1,533 | $52,110 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0702, Envir. Remed. Cost Data - Unit Price (Safety Engineer, average cost) |
| | **Construction Management Staff Subtotal** | | | | **$243,980** | | | | | |
| | Office Overhead (5% of construction management staff cost) | | | | $12,199.00 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | General & Administration (5% of construction management staff cost) | | | | $610 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | Home Office Expenses (5% of construction management staff cost) | | | | $12,199.00 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Total Construction Management Costs** | | | | **$268,988** | | | | | |
| | **Other Costs** | | | | | | | | | |
| | Design (10% of direct cost) | | | | $339,545.33 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Other Costs Subtotal** | | | | **$339,545** | | | | | |
| | **TOTAL INDIRECT COSTS** | | | | **$608,533** | | | | | |
| | **Total Direct & Indirect Costs** | | | | **$4,003,987** | | | | | |
| | Profit (10% of Subtotal Direct & Indirect Costs) | | | | $400,398.65 | | | | | |
| | **TOTAL CAPITAL COSTS** | | | | **$4,404,385** | | | | | |

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| **B.** | **ANNUAL & PERIODIC COSTS** | | | | | | | | | |
| **1** | **Annual Costs** | | | | | | | | | |
| | Monitoring changes in post-closure landuse | WK | 1 | $ 1,533 | $1,533 | | | | Contractor annual inspections for 1 week duration | "(1)Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |
| | Subtotal Annual Costs | | | | $1,533 | | | | | |
| | Subtotal Annual Costs | | | | $1,533 | | | | | |
| | Technical Support & Project Management (20% of annual costs) | | | | $306.53 | | | | | |
| | **Total Annual Costs** | | | | **$1,839** | | | | | |
| **2** | **Periodic Costs** | | | | | | | | | |
| | Five Year Review Reports [every 5 years] | EA | 1 | $12,000 | $12,000 | | | | Assumed | Assumed |
| | Subtotal Periodic Costs | | | | $12,000 | | | | | |
| | Technical Support & Project Management (20% ) | | | | $2,400.00 | | | | | |
| | **Subtotal Periodic Costs** | | | | **$14,400** | | | | | |
| | Replacing damaged pavement covering backyards & common areas (every 10 years) | LS | 1 | **$146,515** | $146,515 | | | | | Assume 10% of paving costs at 10 and 20 years |
| | Technical Support & Project Management (20% of replacing pavement) | | | | $29,302.94 | | | | | |

**TABLE F-5**
**ALTERNATIVE 1B - COST OPINION**
**CAPPING BACKYARDS (Poured Slab) OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Subtotal Periodic Costs** | | | | **$175,818** | | | | | |
| **C** | **PRESENT VALUE ANALYSIS** | | | | | | | | | |
| | | **Year** | **Total Cost Non-Discounted** | **Total Cost per Year** | **Present Value** | | | | **Discount Factor** | **Period & Discount Rate Assumptions** |
| | Capital Costs | 0 | $ 4,404,385 | $ 4,404,385 | **$ 4,404,385** | | | | 1 | |
| | Annual O&M costs | 1-30 | $ 55,175 | $ 1,839 | $ 26,408 | | | | 5.61% | "(1) 30 years until buildings ar replaced with new structures, and (2) Discount rate: U.S. Government Treasury Bonds, April 12th, 2001, 30 year bond, 5.61% |
| | Periodic Costs (every 5 years, year 5 through 30) | 5-30 | $ 86,400 | $ 14,400 | $ 36,967 | | | | 5.61% | |
| | Periodic Costs (every 10 years) | 10,20 | $ 351,635 | $175,818 | $ 160,877 | | | | 5.61% | |
| | | | $ 4,897,596 | | $ 4,628,637 | | | | | |
| **D** | **TOTAL PRESENT VALUE OFALTERNATIVE 1B** | | | | **$ 4,628,637** | | | | | |

**Notes:**

| | | | |
|---|---|---|---|
| bgs | Below ground surface | in | Inch |
| BOE | Board of Equilization | LF | Linear feet |
| CS | Confirmation sample | LS | Lump sum |
| CY | Cubic yard | MO | Month |
| EA | Each | PAH | Polynuclear aromatic hydrocarbon |
| EPA | Environmental Protection Agency | PCB | Polychlorinated biphenyl |
| ft | Feet | QC | Quality control |
| GVW | Gross vehicle weight | SF | Square feet |
| H&S | Health and safety | SY | Square yard |
| H:V | Horizontal to vertical | TAT | Turn around time |
| HR | Hour | WK | Week |
| WDA | Solid Waste Disposal Area | | |

**TABLE F-6**
**ALTERNATIVE 2B - COST OPINION**
**CAPPING BACKYARDS (Precast) OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| A | CAPITAL COSTS | | | | | | | | | |
| | DIRECT COSTS | | | | | | | | | |
| 1 | Mobilization | | | | | | | | | |
| | Locate utilities | LS | 1 | $5,000.00 | $5,000 | $5,000.00 | | | | Assumed |
| | Mobilize heavy equipment (2 hydraulic excavators, 1 wheel loaders) | LS | 1 | $ 2,000 | $2,000 | 2,935 | 1.24 | | 3 Trailer Trips of 1 day each + 2 laborers for one week | Assumed |
| | Health & safety program | LS | 1 | $50,000 | $50,000 | $50,000 | | | | Assumed |
| | **Mobilization Subtotal** | | | | **$57,000** | | | | | |
| 2 | Fencing | | | | | | | | | |
| | Site 12 | | | | | | | | | |
| | Remove wood fence | LF | 28,800 | $ 2.33 | $67,139 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 29,400 | $ 15.77 | $463,720 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Fencing Subtotal** | | | | **$530,859** | | | | | |
| 3 | Capping Backyards | | | | | | | | | |
| | Site 12 | | | | | | | | | |
| | *Total Backyard Area outside of Solid Waste Disposal Areas* | *SF* | *327,864* | | | | | | SF calculated using Microstation | |
| | *Number of Backyards* | *#* | *685* | | | | | | Counted using ArcView | |
| | Clearing backyard vegetation (light brush without grub) | ACRE | 5.6 | $ 86.22 | $487 | $69.53 | 1.24 | | Assume vegetation is 3/4 of backyard area | Means 2000., #17 01 0101, Level D, Envir. Remed. Cost Data - Assemblies |
| | Demolish existing backyard pavement (unreinforced concrete, 6" thick) with air equipment | CY | 1,518 | $ 67.99 | $103,200 | $54.83 | 1.24 | | Assume pavement is 6" thick and 1/4 of backyard area | Means 2000., #17 02 0205, Level D, Envir. Remed. Cost Data - Assemblies |
| | Fine grading, hand (compact & grade gravel layer, and grade sand layer) | SY | 36,429 | $ 3.22 | $117,448 | $2.60 | 1.24 | | Assume fine grade backyards twice, with walk-behind vibrating plate once over gravel. | Means 2000., #17 03 0105, Level D, Envir. Remed. Cost Data - Assemblies+Means 023153 300 7000 |
| | Precast concrete paving slabs, 4 inches thick, 36 inch x 36 inch | SF | 311,471 | $ 10.33 | $3,217,244 | $8.33 | 1.24 | | Assume 95% of Backyard area | Local Vendor Estimate |
| | Pour in-place concrete 6" wide perimeter edging | SF | 16,393 | $ 3.87 | $63,422 | $3.12 | 1.24 | | Assume 5% of Backyard area | Means 2000., #18 02 0330, Level E, Envir. Remed. Cost Data - Unit Price |
| | Planter box | EA | 685 | $200.00 | $137,000 | $200.00 | | | | Assumed |
| | Excavate topsoil using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 3,036 | $ 13.52 | $41,047 | $10.90 | 1.24 | | Assume topsoil is 4-inch over 75% of backyard area | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Backfill with off-site gravel & concrete sand (includes delivery and spreading) | CY | 4,048 | $ 50.54 | $204,556 | $40.76 | 1.24 | | Assume same volume as removed topsoil (4inches) & removed concrete(4 inches of 6 | Means 2000, #17 03 0417 ($41.70)sand & #17 03 0417 ($40.44) gravel, Level D, Envir. Remed. Cost Data - Assemblies |
| | **Capping Backyards Subtotal** | | | | **$3,884,404** | | | | | |

**TABLE F-6**
**ALTERNATIVE 2B - COST OPINION**
**CAPPING BACKYARDS (Precast) OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | **Transportation & Disposal of Excavated Material** | | | | | | | | | |
| | *Volume of demolished concrete and excavated waste* | *CY* | *4,554* | | | | | | Total summation of excavated waste volume | |
| | Waste Profile Sampling & Analysis | | 10 | $1,200.00 | $12,000 | | | | | |
| | **Kettleman Hills Facility Class I** | | | | | | | | | |
| | Disposal fee (includes Kings county and BOE tax) | TON | 1,229 | $31.12 | $38,262 | $25.52 | | | Assume 1.8 tons/cy and 15% of excavated waste | Quote from Waste Management for Kettleman Hills Facility |
| | Transportation via end dumps | TON | 1,229 | $31.50 | $38,729 | $30.50 | $ 1.00 | | 23 ton minimum | Quote from Waste Management for Kettleman Hills Facility |
| | **Altamont Landfill Class II** | | | | | | | | | |
| | Disposal fee | TON | 6,967 | $29.72 | $207,063 | $32.00 | | | Assume 1.8 tons/cy and 85% of excavated waste | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | Transportation via end dumps | TON | 6,967 | $13.25 | $92,314 | $13.00 | $0.25 | | 23 ton minimum, 3 trips/day | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | **Transportation & Disposal Subtotal** | | | | **$388,367** | | | | | |
| 7 | **Demobilize** | | | | | | | | | |
| | Demobilize heavy equipment | LS | 1 | $ 2,000 | $2,000 | $2,935 | 1.24 | | 3 Trailer Trips of 1 day each + 2 laborers for one week | assumed |
| | General area cleanup | ACRE | 7.5 | $ 342.04 | $2,574 | $275.84 | 1.24 | | All backyards | Means 2000., #17 04 0101, Envir. Remed. Cost Data - Unit Price |
| | **Demobilize Subtotal** | | | | **$4,574** | | | | | |
| | Subtotal Direct Costs | | | | $4,865,205 | | | | | Unit prices obtained from Means 2000 were adjusted with a location multiplier of 1.24 |
| | Scope contingencies (15% of Subtotal Direct) | | | | $729,780.70 | | | | | |
| | Bid contingency for Disposal (10% of subtotal transport & disposal costs) | | | | $38,837 | | | | | Potential disposal fee increase at facility with increased energy costs, and changes in market |
| | Bid contingency for administrative (5% of direct cost) | | | | $243,260 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | Insurance (5% of direct cost) | | | | $243,260 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **TOTAL DIRECT COSTS** | | | | **$6,120,343** | | | | | |

**TABLE F-6**
**ALTERNATIVE 2B - COST OPINION**
**CAPPING BACKYARDS (Precast) OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | **INDIRECT COSTS** | | | | | | | | | |
| | Construction Management Staff | WK | 34 | | | | | | Assume 1 wk mob., 32 wks paving, 1 wk demob; Assume 2 paving crews | |
| | Construction Manager | WK | 34 | $ 2,122 | $72,146 | $1,711.25 | 1.24 | | 8 hour days | Means 2000., #99 01 0102, Envir. Remed. Cost Data - Unit Price (Site Project Manager, average cost) |
| | Field Supervisor | WK | 34 | $ 1,989 | $67,614 | $1,603.75 | 1.24 | | 8 hour days | Means 2000., #99 01 0202, Envir. Remed. Cost Data - Unit Price (Superintendent, average cost) |
| | QC Engineer | WK | 34 | $ 1,533 | $52,110 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |
| | Site H&S officer | WK | 34 | $ 1,533 | $52,110 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0702, Envir. Remed. Cost Data - Unit Price (Safety Engineer, average cost) |
| | **Construction Management Staff Subtotal** | | | | **$243,980** | | | | | |
| | Office Overhead (5% of construction management staff cost) | | | | $12,199.00 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | General & Administration (5% of construction management staff cost) | | | | $610 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | Home Office Expenses (5% of construction management staff cost) | | | | $12,199.00 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Total Construction Management Costs** | | | | **$268,988** | | | | | |
| | **Other Costs** | | | | | | | | | |
| | Design (10% of direct cost) | | | | $612,034.26 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Other Costs Subtotal** | | | | **$612,034** | | | | | |
| | **TOTAL INDIRECT COSTS** | | | | **$881,022** | | | | | |
| | **Total Direct & Indirect Costs** | | | | **$7,001,365** | | | | | |
| | Profit (10% of Subtotal Direct & Indirect Costs) | | | | $700,136.47 | | | | | |
| | **TOTAL CAPITAL COSTS** | | | | **$7,701,501** | | | | | |

**TABLE F-6**
**ALTERNATIVE 2B - COST OPINION**
**CAPPING BACKYARDS (Precast) OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| **B.** | **ANNUAL & PERIODIC COSTS** | | | | | | | | | |
| **1** | **Annual Costs** | | | | | | | | | |
| | Monitoring changes in post-closure landuse | WK | 1 | $ 1,533 | $1,533 | | | | Contractor annual inspections for 1 week duration | "(1)Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |
| | Subtotal Annual Costs | | | | $1,533 | | | | | |
| | Subtotal Annual Costs | | | | $1,533 | | | | | |
| | Technical Support & Project Management (20% of annual costs) | | | | $306.53 | | | | | |
| | **Total Annual Costs** | | | | **$1,839** | | | | | |
| **2** | **Periodic Costs** | | | | | | | | | |
| | Five Year Review Reports [every 5 years] | EA | 1 | $12,000 | $12,000 | | | | Assumed | Assumed |
| | Subtotal Periodic Costs | | | | $12,000 | | | | | |
| | Technical Support & Project Management (20% ) | | | | $2,400.00 | | | | | |
| | **Subtotal Periodic Costs** | | | | **$14,400** | | | | | |
| | Replacing damaged pavement covering backyards & common areas (every 10 years) | LS | 1 | **$339,811** | $339,811 | | | | | Assume 10% of paving costs at 10 and 20 years |
| | Technical Support & Project Management (20% of replacing pavement) | | | | $67,962.29 | | | | | |
| | **Subtotal Periodic Costs** | | | | **$407,774** | | | | | |
| **C** | **PRESENT VALUE ANALYSIS** | | | | | | | | | |
| | | **Year** | **Total Cost Non-Discounted** | **Total Cost per Year** | **Present Value** | | | | **Discount Factor** | **Period & Discount Rate Assumptions** |
| | Capital Costs | 0 | $ 7,701,501 | $ 7,701,501 | **$ 7,701,501** | | | | 1 | |
| | Annual O&M costs | 1-30 | $ 91,958 | $ 1,839 | $ 30,644 | | | | 5.61% | "(1) 30 years until buildings ar replaced with new structures, and (2) Discount rate: U.S. Government Treasury Bonds, April 12th, 2001, 30 year bond, 5.61% |
| | Periodic Costs (every 5 years, year 5 through 50) | 5-30 | $ 144,000 | $ 14,400 | $ 42,895 | | | | 5.61% | |
| | Periodic Costs (every 10 years) | 10,20 | $ 815,547 | $407,774 | $ 373,122 | | | | 5.61% | |
| | | | $ 8,753,007 | | $ 8,148,162 | | | | | |
| **D** | **TOTAL PRESENT VALUE OFALTERNATIVE 2B** | | | | **$ 8,148,162** | | | | | |

**TABLE F-7**
**ALTERNATIVE 3B - COST OPINION**
**EXCAVATION OF BACKYARDS (2') OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| A | CAPITAL COSTS | | | | | | | | | |
| | DIRECT COSTS | | | | | | | | | |
| 1 | Mobilization | | | | | | | | | |
| | Locate utilities | LS | 1 | $50,000 | $50,000 | $50,000.00 | | | | Assumed |
| | Mobilize heavy equipment (4 hydraulic excavators, 2 wheel loaders) | LS | 1 | $ 7,278 | $7,278 | 5,869 | 1.24 | | 6 Trailer Trips of 1 day each + 4 laborers for one week | Means 2000., #33 01 0111 & #99 01 06, Envir. Remed. Cost Data - Unit Price (Truck, 2 axle, Highway, 33,000 GVW, 6 x 2 and General-purpose laborer) |
| | Truck scale rental | MO | 10 | $ 3,720 | $37,200 | 3,000 | 1.24 | | Estimated time for excavation | Means 2000., #33 01 0462, Envir. Remed. Cost Data - Unit Price |
| | HiVol Samplers (Continuous Monitoring and Recording of Air Flow) | EA | 3 | $ 6,200 | $18,600 | 5,000 | 1.24 | | 3 HiVols | Means 2000., #33 02 1507, Envir. Remed. Cost Data - Unit Price |
| | Instrument Shelter | EA | 3 | $ 1,031 | $3,092 | 831 | 1.24 | | 3 shelters for HiVols | Means 2000, #33 02 0338, Envir. Remed. Cost Data - Unit Price |
| | Baseline data (lead, PAHs, pesticides, PCBs) | Day | 21 | $ 726 | $15,242 | 585 | 1.24 | | 3 HiVols for 1 week to establish baseline | Means 2000, #33 02 1813, #33 02 1812, and #33 02 1810, Envir. Remed. Cost Data - Unit Price (Metals by ICP, PAHs, Pesticides/PCBs) |
| | Daily results of air monitoring from HiVols (lead, PAHs, pesticides, PCBs) | Day | 588 | $ 726 | $426,776 | 585 | 1.24 | | 3 HiVols for 28 weeks | Means 2000, #33 02 1813, #33 02 1812, and #33 02 1810, Envir. Remed. Cost Data - Unit Price (Metals by ICP, PAHs, Pesticides/PCBs) |
| | Health & safety program | LS | 1 | 200,000 | $200,000 | $200,000 | | | | Assumed |
| | **Mobilization Subtotal** | | | | **$758,188** | | | | | |
| 2 | Fencing | | | | | | | | | |
| | Site 12 | | | | | | | | | |
| | Remove wood fence | LF | 28,800 | $ 2.33 | $67,139 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 29,400 | $ 15.77 | $463,720 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Fencing Subtotal** | | | | **$530,859** | | | | | |
| 3 | Excavation to 2 ft bgs in Backyards | | | | | | | | | |
| | Site 12 | | | | | | | | | |
| | *Total Backyard Area outside of Solid Waste Disposal Areas* | *SF* | *327,864* | | | | | | SF calculated using Microstation | |
| | *Total Backyard Volume* | *CY* | *24,286* | | | | | | | |
| | Sprayed water dust suppressant | SY | 11,220,235 | $ 0.01 | $139,131 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 22 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 18,215 | $ 13.52 | $246,281 | $10.90 | 1.24 | 75% | Use for 75 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 3,643 | $ 10.72 | $39,040 | $8.64 | 1.24 | 15% | Use for 15 % of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 1,214 | $ 48.93 | $59,416 | $39.46 | 1.24 | 5% | Use for 5 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 1,214 | $ 72.95 | $88,582 | $58.83 | 1.24 | 5% | Use for 5 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |

**TABLE F-7**
**ALTERNATIVE 3B - COST OPINION**
**EXCAVATION OF BACKYARDS (2') OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 24,286 | $ 5.44 | $132,203 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 327,864 | 0.62 | $203,276 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 24,286 | $ 20.03 | $486,487 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 7.5 | 17,526 | $131,915 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Excavation of Backyards Subtotal** | | | | **$1,527,780** | | | | | |
| **6** | **Transportation & Disposal of Excavated Material** | | | | | | | | | |
| | *Volume of demolished concrete and excavated waste* | *CY* | *24,286* | | | | | | Total summation of excavated waste volume | |
| | Waste Profile Sampling & Analysis | | 49 | $1,200.00 | $58,800 | | | | | |
| | **Kettleman Hills Facility Class I** | | | | | | | | | |
| | Disposal fee (includes Kings county and BOE tax) | TON | 14,572 | $31.12 | $453,468 | $25.52 | | | Assume 1.5 tons/cy and 40% of excavated waste | Quote from Waste Management for Kettleman Hills Facility |
| | Transportation via end dumps | TON | 14,572 | $31.50 | $459,005 | $30.50 | $ 1.00 | | 23 ton minimum | Quote from Waste Management for Kettleman Hills Facility |
| | **Altamont Landfill Class II** | | | | | | | | | |
| | Disposal fee | TON | 21,857 | $29.72 | $649,602 | $32.00 | | | Assume 1.5 tons/cy and 60% of excavated waste | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | Transportation via end dumps | TON | 21,857 | $13.25 | $289,611 | $13.00 | $0.25 | | 23 ton minimum, 3 trips/day | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | **Transportation & Disposal Subtotal** | | | | **$1,910,486** | | | | | |
| **7** | **Demobilize** | | | | | | | | | |
| | Demobilize heavy equipment | LS | 1 | $ 7,278 | $7,278 | $5,869 | 1.24 | | 6 Trailer Trips of 1 day each + 4 laborers for one week | Means 2000., #33 01 0111 & #99 01 06, Envir. Remed. Cost Data - Unit Price (Truck, 2 axle, Highway, 33,000 GVW, 6 x 2 and General-purpose laborer) |
| | General area cleanup | ACRE | 7.5 | $ 342 | $2,574 | $275.84 | 1.24 | | All backyards | Means 2000., #17 04 0101, Envir. Remed. Cost Data - Unit Price |
| | **Demobilize Subtotal** | | | | **$9,852** | | | | | |
| | **Subtotal Direct Costs** | | | | $4,737,165 | | | | | Unit prices obtained from Means 2000 were adjusted with a location multiplier of 1.24 |
| | Scope contingencies (15% of Subtotal Direct) | | | | $710,574.79 | | | | | |
| | Bid contingency for Disposal (15% of subtotal transport & disposal costs) | | | | $286,573 | | | | | |

**TABLE F-7**
**ALTERNATIVE 3B - COST OPINION**
**EXCAVATION OF BACKYARDS (2') OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Bid contingency for administrative (5% of direct cost) | | | | $236,858 | | | | | |
| | Insurance (8% of direct cost) | | | | $378,973 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **TOTAL DIRECT COSTS** | | | | **$6,350,144** | | | | | |
| | **INDIRECT COSTS** | | | | | | | | | |
| | Construction Management Staff | WK | 28 | | | | | | Assume 1 wk mob., 26 wks excavating,1 wk demob; Assume 2 excavation crews | 25.5 |
| | Construction Manager | WK | 28 | $ 2,122 | $58,354 | $1,711.25 | 1.24 | | 8 hour days | Means 2000., #99 01 0102, Envir. Remed. Cost Data - Unit Price (Site Project Manager, average cost) |
| | Field Supervisor | WK | 28 | $ 1,989 | $54,688 | $1,603.75 | 1.24 | | 8 hour days | Means 2000., #99 01 0202, Envir. Remed. Cost Data - Unit Price (Superintendent, average cost) |
| | QC Engineer | WK | 28 | $ 1,533 | $42,148 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |
| | Site H&S officer | WK | 28 | $ 1,533 | $42,148 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0702, Envir. Remed. Cost Data - Unit Price (Safety Engineer, average cost) |
| | **Subtotal Construction Management Staff** | | | | **$197,337** | | | | | |
| | Office Overhead (5% of construction management staff cost) | | | | $9,867 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | General & Administration (5% of construction management staff cost) | | | | $9,867 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | Home Office Expenses (5% of construction management staff cost) | | | | $9,867 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Total Construction Management Costs** | | | | **$226,937** | | | | | |
| | **Other Costs** | | | | | | | | | |
| | Design (10% of direct cost) | | | | $635,014.45 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Other Costs Subtotal** | | | | **$635,014** | | | | | |
| | **TOTAL INDIRECT COSTS** | | | | **$861,952** | | | | | |
| | Total Direct & Indirect Costs | | | | $7,212,096 | | | | | |
| | Profit (10% of Subtotal Direct & Indirect Costs) | | | | $721,209.61 | | | | | |
| | **TOTAL CAPITAL COSTS** | | | | **$7,933,306** | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **B.** | **ANNUAL & PERIODIC COSTS** | | | | | | | | | |
| **1** | **Annual Costs** | | | | | | | | | |
| | Monitoring changes in post-closure landuse | WK | 1 | $ 1,533 | $1,533 | | | | Contractor annual inspections for 1 week duration | "(1)Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |

**TABLE F-7**
**ALTERNATIVE 3B - COST OPINION**
**EXCAVATION OF BACKYARDS (2') OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Maintaining drainage and erosion control systems for vegetative cover in disposal area and backyards (P/A, 30, 5.61) | | | | | | | | | |
| | Excavator | CY | 152 | $ 13.52 | $2,052 | $10.90 | 1.24 | 0% | Excavator, 5% of surface area to depth of 3-inches/annually | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding & Mulching | ACRE | 2 | 17,526 | $26,383 | $14,134.00 | 1.24 | | seeding 20% of surface area/annually | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | Subtotal Annual Costs | | | | $29,968 | | | | | |
| | Subtotal Annual Costs | | | | $29,968 | | | | | |
| | Technical Support & Project Management (20% of annual costs) | | | | $5,993.58 | | | | | |
| | **Total Annual Costs** | | | | **$35,961** | | | | | |
| **2** | **Periodic Costs** | | | | | | | | | |
| | Five Year Review Reports [every 5 years] | EA | 1 | $12,000 | $12,000 | | | | Assumed | Assumed |
| | Subtotal Periodic Costs | | | | $12,000 | | | | | |
| | Technical Support & Project Management (20% ) | | | | $2,400.00 | | | | | |
| | **Subtotal Periodic Costs** | | | | **$14,400** | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **C** | **PRESENT VALUE ANALYSIS** | | | | | | | | | |
| | | **Year** | **Total Cost Non-Discounted** | **Total Cost per Year** | **Present Value** | | | | **Discount Factor** | **Period & Discount Rate Assumptions** |
| | Capital Costs | 0 | $ 7,933,306 | $ 7,933,306 | **$ 7,933,306** | | | | 1 | |
| | Annual O&M costs | 1-30 | $ 1,078,845 | $ 35,961 | $ 516,366 | | | | 5.61% | "(1) 30 years until buildings ar replaced with new structures, and (2) Discount rate: U.S. Government Treasury Bonds, April 12th, 2001, 30 year bond, 5.61%, |
| | Periodic Costs (every 5 years, year 5 through 30) | 5-30 | $ 86,400 | $ 14,400 | 36,967 | | | | 5.61% | |
| | | | $ 9,098,550 | | $ 8,486,638 | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **D** | **TOTAL PRESENT VALUE OFALTERNATIVE 3B** | | | | **$ 8,486,638** | | | | | |

**TABLE F-8**
**ALTERNATIVE 4B - COST OPINION**
**EXCAVATION OF BACKYARDS (4') OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| **A** | **CAPITAL COSTS** | | | | | | | | | |
| | **DIRECT COSTS** | | | | | | | | | |
| **1** | **Mobilization** | | | | | | | | | |
| | Locate utilities | LS | 1 | $50,000 | $50,000 | $50,000.00 | | | | Assumed |
| | Mobilize heavy equipment (4 hydraulic excavators, 2 wheel loaders) | LS | 1 | $ 7,278 | $7,278 | 5,869 | 1.24 | | 6 Trailer Trips of 1 day each + 4 laborers for one week | Means 2000., #33 01 0111 & #99 01 06, Envir. Remed. Cost Data - Unit Price (Truck, 2 axle, Highway, 33,000 GVW, 6 x 2 and General-purpose laborer) |
| | Truck scale rental | MO | 10 | $ 3,720 | $37,200 | 3,000 | 1.24 | | Estimated time for excavation | Means 2000., #33 01 0462, Envir. Remed. Cost Data - Unit Price |
| | HiVol Samplers (Continuous Monitoring and Recording of Air Flow) | EA | 3 | $ 6,200 | $18,600 | 5,000 | 1.24 | | 3 HiVols | Means 2000., #33 02 1507, Envir. Remed. Cost Data - Unit Price |
| | Instrument Shelter | EA | 3 | $ 1,031 | $3,092 | 831 | 1.24 | | 3 shelters for HiVols | Means 2000, #33 02 0338, Envir. Remed. Cost Data - Unit Price |
| | Baseline data (lead, PAHs, pesticides, PCBs) | Day | 21 | $ 726 | $15,242 | 585 | 1.24 | | 3 HiVols for 1 week to establish baseline | Means 2000, #33 02 1813, #33 02 1812, and #33 02 1810, Envir. Remed. Cost Data - Unit Price (Metals by ICP, PAHs, Pesticides/PCBs) |
| | Daily results of air monitoring from HiVols (lead, PAHs, pesticides, PCBs) | Day | 1,113 | $ 726 | $807,826 | 585 | 1.24 | | 3 HiVols for 53 weeks | Means 2000, #33 02 1813, #33 02 1812, and #33 02 1810, Envir. Remed. Cost Data - Unit Price (Metals by ICP, PAHs, Pesticides/PCBs) |
| | Health & safety program | LS | 1 | 200,000 | $200,000 | $200,000 | | | | Assumed |
| | **Mobilization Subtotal** | | | | **$1,139,238** | | | | | |
| **2** | **Fencing** | | | | | | | | | |
| | **Site 12** | | | | | | | | | |
| | Remove wood fence | LF | 28,800 | $ 2.33 | $67,139 | $1.88 | 1.24 | | LF calculated using Microstation | Means 2000., #17 02 0231, Level E, Envir. Remed. Cost Data - Assemblies |
| | Install privacy fence, 6 ft high, wood | LF | 29,400 | $ 15.77 | $463,720 | $12.72 | 1.24 | | Same as above | Means 2000., #18 04 0103, Level E, Envir. Remed. Cost Data - Assemblies |
| | **Fencing Subtotal** | | | | **$530,859** | | | | | |
| **3** | **Excavation to 4 ft bgs in Backyards** | | | | | | | | | |
| | **Site 12** | | | | | | | | | |
| | *Total Backyard Area outside of Solid Waste Disposal Areas* | *SF* | *327,864* | | | | | | SF calculated using Microstation | |
| | *Total Backyard Volume* | *CY* | *48,572* | | | | | | | |
| | Sprayed water dust suppressant | SY | 11,220,235 | $ 0.01 | $139,131 | $0.01 | 1.24 | | Assume 2 times/day, 7 days/week, for 22 weeks | Means 2000, #33 08 0585, Envir. Remed. Cost Data - Unit Price (Watering by truck) |
| | Excavate using crawler-mounted, 0.5 CY, hydraulic excavator @ 12 cy/hr | CY | 34,000 | $ 13.52 | $459,725 | $10.90 | 1.24 | 70% | Use for 70 % of excavation | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Excavate using crawler-mounted, 1.0 CY, 215 hydraulic excavator @ 12 cy/hr | CY | 4,857 | $ 10.72 | $52,053 | $8.64 | 1.24 | 10% | Use for 10 % of excavation | Means 2000., #17 03 0230, Level D, Envir. Remed. Cost Data - Assemblies |
| | Hand excavation for utilities and edge of buildings | CY | 4,857 | $ 48.93 | $237,665 | $39.46 | 1.24 | 10% | Use for 10 % of excavation at level D | Means 2000., #17 03 0211, Level D, Envir. Remed. Cost Data - Assemblies (Normal soil) |
| | Hand excavation for utilities and edge of buildings | CY | 4,857 | $ 72.95 | $354,329 | $58.83 | 1.24 | 10% | Use for 10 % of excavation at level C | Means 2000., #17 03 0211, Level C, Envir. Remed. Cost Data - Assemblies (Normal soil) |

**TABLE F-8**
**ALTERNATIVE 4B - COST OPINION**
**EXCAVATION OF BACKYARDS (4') OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Load using 931, 1.0 CY, Track Loader @ 12cy/hr | CY | 48,572 | $ 5.44 | $264,407 | $4.39 | 1.24 | | Use entire excavation time | Means 2000., #17 03 0215, Level D, Envir. Remed. Cost Data - Assemblies |
| | Decontaminate heavy equipment | EA | 4 | $ 362 | $1,449 | $292.05 | 1.24 | | 2 hydraulic excavators, 2 track loaders | Means 2000., #33 17 0803, Level D, Envir. Remed. Cost Data - Assemblies |
| | Place marker fabric at bottom of excavation | SF | 327,864 | 0.62 | $203,276 | $0.50 | 1.24 | | | Assumed. |
| | Backfill with off-site unclassified fill, 6-in lifts (includes delivery, spreading, and compaction) | CY | 48,572 | $ 20.03 | $972,975 | $18.09 | 1.24 | | | Purchase ($10/cy)+Means 2000, #17 03 0423, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding, vegetative cover | ACRE | 7.5 | 17,526 | $131,915 | $14,134.00 | 1.24 | | | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | **Excavation of Backyards Subtotal** | | | | **$2,816,923** | | | | | |
| **6** | **Transportation & Disposal of Excavated Material** | | | | | | | | | |
| | *Volume of demolished concrete and excavated waste* | *CY* | *48,572* | | | | | | Total summation of excavated waste volume | |
| | Waste Profile Sampling & Analysis | | 98 | $1,200.00 | $117,600 | | | | | |
| | **Kettleman Hills Facility Class I** | | | | | | | | | |
| | Disposal fee (includes Kings county and BOE tax) | TON | 29,143 | $31.12 | $906,936 | $25.52 | | | Assume 1.5 tons/cy and 40% of excavated waste | Quote from Waste Management for Kettleman Hills Facility |
| | Transportation via end dumps | TON | 29,143 | $31.50 | $918,011 | $30.50 | $ 1.00 | | 23 ton minimum | Quote from Waste Management for Kettleman Hills Facility |
| | **Altamont Landfill Class II** | | | | | | | | | |
| | Disposal fee | TON | 43,715 | $29.72 | $1,299,204 | $32.00 | | | Assume 1.5 tons/cy and 60% of excavated waste | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | Transportation via end dumps | TON | 43,715 | $13.25 | $579,221 | $13.00 | $0.25 | | 23 ton minimum, 3 trips/day | Quote from Waste Management for Altamont Landfill Class II Disposal |
| | **Transportation & Disposal Subtotal** | | | | **$3,820,972** | | | | | |
| **7** | **Demobilize** | | | | | | | | | |
| | Demobilize heavy equipment | LS | 1 | $ 7,278 | $7,278 | $5,869 | 1.24 | | 6 Trailer Trips of 1 day each + 4 laborers for one week | Means 2000., #33 01 0111 & #99 01 06, Envir. Remed. Cost Data - Unit Price (Truck, 2 axle, Highway, 33,000 GVW, 6 x 2 and General-purpose laborer) |
| | General area cleanup | ACRE | 7.5 | $ 342 | $2,574 | $275.84 | 1.24 | | All backyards | Means 2000., #17 04 0101, Envir. Remed. Cost Data - Unit Price |
| | **Demobilize Subtotal** | | | | **$9,852** | | | | | |
| | **Subtotal Direct Costs** | | | | $8,317,844 | | | | | Unit prices obtained from Means 2000 were adjusted with a location multiplier of 1.24 |
| | Scope contingencies (15% of Subtotal Direct) | | | | $1,247,676.63 | | | | | |
| | Bid contingency for Disposal (15% of subtotal transport & disposal costs) | | | | $573,146 | | | | | |

**TABLE F-8**
**ALTERNATIVE 4B - COST OPINION**
**EXCAVATION OF BACKYARDS (4') OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Bid contingency for administrative (5% of direct cost) | | | | $415,892 | | | | | |
| | Insurance (8% of direct cost) | | | | $665,428 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **TOTAL DIRECT COSTS** | | | | **$11,219,986** | | | | | |
| | **INDIRECT COSTS** | | | | | | | | | |
| | Construction Management Staff | WK | 53 | | | | | | Assume 1 wk mob., 51 wks excavating,1 wk demob; Assume 2 excavation crews | 51 |
| | Construction Manager | WK | 53 | $ 2,122 | $112,463 | $1,711.25 | 1.24 | | 8 hour days | Means 2000., #99 01 0102, Envir. Remed. Cost Data - Unit Price (Site Project Manager, average cost) |
| | Field Supervisor | WK | 53 | $ 1,989 | $105,398 | $1,603.75 | 1.24 | | 8 hour days | Means 2000., #99 01 0202, Envir. Remed. Cost Data - Unit Price (Superintendent, average cost) |
| | QC Engineer | WK | 53 | $ 1,533 | $81,230 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |
| | Site H&S officer | WK | 53 | $ 1,533 | $81,230 | $1,236.00 | 1.24 | | 8 hour days | Means 2000., #99 01 0702, Envir. Remed. Cost Data - Unit Price (Safety Engineer, average cost) |
| | **Subtotal Construction Management Staff** | | | | **$380,322** | | | | | |
| | Office Overhead (5% of construction management staff cost) | | | | $19,016 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | General & Administration (5% of construction management staff cost) | | | | $19,016 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | Home Office Expenses (5% of construction management staff cost) | | | | $19,016 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Total Construction Management Costs** | | | | **$437,370** | | | | | |
| | **Other Costs** | | | | | | | | | |
| | Design (10% of direct cost) | | | | $1,121,998.64 | | | | | Means 2000., p. 1-18, Envir. Remed. Cost Data - Assemblies |
| | **Other Costs Subtotal** | | | | **$1,121,999** | | | | | |
| | **TOTAL INDIRECT COSTS** | | | | **$1,559,369** | | | | | |
| | Total Direct & Indirect Costs | | | | $12,779,355 | | | | | |
| | Profit (10% of Subtotal Direct & Indirect Costs) | | | | $1,277,935.49 | | | | | |
| | **TOTAL CAPITAL COSTS** | | | | **$14,057,290** | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **B.** | **ANNUAL & PERIODIC COSTS** | | | | | | | | | |
| **1** | **Annual Costs** | | | | | | | | | |
| | Monitoring changes in post-closure landuse | WK | 1 | $ 1,533 | $1,533 | | | | Contractor annual inspections for 1 week duration | "(1)Means 2000., #99 01 0802, Envir. Remed. Cost Data - Unit Price (Quality Control, average cost) |

**TABLE F-8**
**ALTERNATIVE 4B - COST OPINION**
**EXCAVATION OF BACKYARDS (4') OUTSIDE OF KNOWN SOLID WASTE DISPOSAL AREAS**
**INSTALLATION RESTORATION SITE 12**

| Phase | Item/Description | Unit | Quantity | Unit Cost | Line Item Subtotal | Unit Cost | Location Multiplier | Excav% | Quantity Assumptions | Unit Cost Assumptions |
|---|---|---|---|---|---|---|---|---|---|---|
| | Maintaining drainage and erosion control systems for vegetative cover in disposal area and backyards (P/A, 30, 5.61) | | | | | | | | | |
| | Excavator | CY | 152 | $ 13.52 | $2,052 | $10.90 | 1.24 | 0% | Excavator, 5% of surface area to depth of 3-inches/annually | Means 2000., #17 03 0433, Level D, Envir. Remed. Cost Data - Assemblies |
| | Seeding & Mulching | ACRE | 2 | 17,526 | $26,383 | $14,134.00 | 1.24 | | seeding 20% of surface area/annually | Means 2000., #18 05 0402, Envir. Remed. Cost Data - Unit Price |
| | Subtotal Annual Costs | | | | $29,968 | | | | | |
| | Subtotal Annual Costs | | | | $29,968 | | | | | |
| | Technical Support & Project Management (20% of annual costs) | | | | $5,993.58 | | | | | |
| | **Total Annual Costs** | | | | **$35,961** | | | | | |
| **2** | **Periodic Costs** | | | | | | | | | |
| | Five Year Review Reports [every 5 years] | EA | 1 | $12,000 | $12,000 | | | | Assumed | Assumed |
| | Subtotal Periodic Costs | | | | $12,000 | | | | | |
| | Technical Support & Project Management (20% ) | | | | $2,400.00 | | | | | |
| | **Subtotal Periodic Costs** | | | | **$14,400** | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **C** | **PRESENT VALUE ANALYSIS** | | | | | | | | | |
| | | **Year** | **Total Cost Non-Discounted** | **Total Cost per Year** | **Present Value** | | | | **Discount Factor** | **Period & Discount Rate Assumptions** |
| | Capital Costs | 0 | $ 14,057,290 | $ 14,057,290 | **$ 14,057,290** | | | | 1 | |
| | Annual O&M costs | 1-30 | $ 1,078,845 | $ 35,961 | $ 516,366 | | | | 5.61% | "(1) 30 years until buildings ar replaced with new structures, and (2) Discount rate: U.S. Government Treasury Bonds, April 12th, 2001, 30 year bond, 5.61%, |
| | Periodic Costs (every 5 years, year 5 through 30) | 5-30 | $ 86,400 | $ 14,400 | 36,967 | | | | 5.61% | |
| | | | $ 15,222,535 | | $ 14,610,623 | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **D** | **TOTAL PRESENT VALUE OFALTERNATIVE 4B** | | | | **$ 14,610,623** | | | | | |

## APPENDIX G
## DEVELOPMENT OF SOIL ACTION LEVELS FOR LEAD, POLYCYCLIC AROMATIC HYDROCARBONS, AND POLYCHLORINATED BIPHENYLS

## CONTENTS

## TABLES

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ARAR | Applicable or relevant and appropriate requirement |
| B[a]P | Benzo(a)pyrene |
| CFR | Code of Federal Regulations |
| $cm^2$ | Square centimeter |
| COC | Contaminants of concern |
| Cs | Concentration in soil |
| day/yr | Day per year |
| DTSC | California Department of Toxic Substances Control |
| EPA | U.S. Environmental Protection Agency |
| FC | Fraction contacted |
| $FC_{CA}$ | Fraction contacted in the common areas |
| FI | Fraction ingested |
| $FI_{CA}$ | Fraction ingested in the common areas |
| hr | Hour |
| hr/day | Hour per day |
| IEUBK | Integrated Exposure Uptake Biokinetic Model for Lead in Children |
| kg | Kilogram |
| $m^3$/hr | Cubic meter per hour |
| $m^3$/kg | Cubic meter per kilogram |
| µg/dL | Microgram per deciliter |
| mg | Milligram |
| mg/day | Milligram per day |
| mg/kg | Milligram per kilogram |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |
| Navy | U.S. Department of the Navy |
| PAH | Polycyclic aromatic hydrocarbon |
| PCB | Polychlorinated biphenyl |
| PRG | Preliminary remediation goal |
| TSCA | Toxic Substances Control Act |
| TtEMI | Tetra Tech EM Inc. |
| yr | Year |

# 1.0 INTRODUCTION

The U.S. Department of the Navy (Navy) is planning a non-time-critical removal action for Site 12 at Naval Station Treasure Island, San Francisco, California. The planned removal action will occur (1) in the common areas within the known solid waste disposal areas of Site 12, and (2) within the fenced backyards of the residential apartments throughout Site 12. Except for the backyards, the common areas outside the known solid waste disposal areas are not included in this removal action. These other common areas in Site 12 will be addressed separately. To proceed with the Engineering Evaluation and Cost Analysis for this action, the Navy must establish cleanup levels for contaminants of concern (COC) identified within the known solid waste disposal areas. As part of the removal action, the Navy plans to cap all backyards at Site 12 (thus eliminating the possibility of exposure). The established cleanup levels apply only to the common areas within the known solid waste disposal areas. This document was prepared to establish and provide the technical basis for cleanup levels for lead, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) in soils within the common areas of the known solid waste disposal areas.

Residents at the housing units at Site 12 are expected to spend time in outdoor activities in their backyards, the common areas, and in nearby parks and open spaces outside the boundaries of Site 12. Since the Navy plans to cap the backyards of the residential units, the common areas are the only areas at Site 12 where residents could be exposed to contaminated soils. Although common areas are present throughout Site 12, for the purpose of this paper the term “common area” refers only to the areas between residential housing units within the known solid waste disposal areas. These common areas range in size from marginal landscaped areas nestled between roadways, parking areas, and buildings, to wide open spaces that are centrally located between building units. Because only a portion of a resident’s time would be spent in common areas, the Navy has developed site-specific exposure parameters to evaluate potential exposures to soil in the common areas, and used these parameters to develop site-specific action levels for soil.

Section 2.0 provides a brief history and conceptual model of Site 12, Section 3.0 presents the derivation of the site-specific exposure values, and Section 4.0 presents the equations used to calculate the soil action levels. The site-specific action levels for lead, PAHs, and PCBs are derived in Section 5.0, and a discussion and summary of the action levels is presented in Section 6.0. Section 6.0 is followed by a list of references and an Appendix. The Appendix contains tables of background concentrations of PAHs in soils in California and worldwide.

## 2.0 SITE HISTORY AND CONCEPTUAL MODEL

Past Navy operations in different areas of Site 12 included disposal and incineration of solid waste on land as well as the handling and storage of equipment. These operations resulted in the release of lead, PAHs, and PCBs to surface soils. Based on information to date, the primary areas of release are the identified solid waste disposal areas. As part of the subsequent construction of residential housing units in 1967, construction specifications for the residential units instructed the contractor to prepare the site by mixing the solid waste with fill material. The mixing, spreading, and grading of the solid waste/fill mixture occurred both within and outside the known solid waste disposal areas, and resulted in a highly heterogeneous distribution of solid waste, lead, PAH, and PCB contamination in soil.

## 3.0 DERIVATION OF SITE-SPECIFIC EXPOSURE VALUES

This section describes the derivation of site-specific exposure values for each of the three exposure pathways considered in the development of soil action levels for Site 12. These pathways are the following:

- Incidental ingestion of soil
- Dermal contact with soil
- Inhalation of airborne particulates

### 3.1 INCIDENTAL INGESTION OF SOIL

Individuals may be exposed to COCs by inadvertently ingesting contaminated soil. The intake (dose) is a function of the soil ingestion rate, COC concentration in soil, exposure frequency (number of days per year that exposure occurs), exposure duration (number of years over which exposure occurs), and "fraction ingested" (FI).

The term FI is used to account for the fraction of the total amount of soil ingested that is presumed to be contaminated (U.S. Environmental Protection Agency [EPA] 1989). By definition, FI is a site-specific value that is determined based on the location and size of a contaminated area, current and potential future land use, and population activity patterns. In the absence of site-specific information, the default value for FI is 1, which means that all soil ingested is from the contaminated area.

The following factors were considered in deriving site-specific FI values for child and adult residents potentially exposed to soil in common areas at Site 12:

- Child and adult outdoor activities in a residential setting
- General use of common areas (such as recreational areas and walkways)
- Time spent in fenced backyard areas
- Time spent in common areas within the known solid waste disposal areas
- Time spent outside of the known solid waste disposal areas in Site 12
- Time spent in nearby parks and public recreational areas outside of Site 12

Outdoor activities for child and adult residents at the site are expected to fall within average residential activities of the U.S. population. Outdoor recreational activities for child and adult residents at Site 12 have been observed to occur mostly in the nearby public parks and along the coastal jogging trail (Tetra Tech EM Inc. [TtEMI] 1999-2002). Common areas are typically fully maintained and landscaped. Residents are not expected to congregate in the marginal common areas, as these areas are used mostly as conduits or walkways between apartment units. All apartment units, except the 1400 series units, have backyards (approximately 20 feet by 20 feet) where outdoor activities are expected to occur.

The site-specific FI for common areas was calculated using Equation 1:

$$FI_{CA} = T_{CA} / T_{outdoor} \quad (1)$$

Where:

$FI_{CA}$ = Fraction ingested for the common areas within the known solid waste disposal areas (unitless)

$T_{CA}$ = Time spent in common areas within the known solid waste disposal areas (hours per day [hr/day])

and

$$T_{outdoor} = T_{CA} + T_{yard} + T_{off\text{-}site} + T_{12} \quad (2)$$

Where

$T_{yard}$ = Time spent in fenced backyards (hr/day)

$T_{off\text{-}site}$ = Time spent in off-site recreational areas (hr/day)

$T_{12}$ = Time spent in Site 12 outside of the known solid waste disposal areas (hr/day). (This term is expected to be negligible [that is, $T_{12} = 0$])

Rearranging Equation 2 to solve for $T_{CA}$, yields the following:

$$T_{CA} = T_{outdoor} - T_{yard} - T_{off\text{-}site} - T_{12} \quad (3)$$

Finally, substituting the term for $T_{CA}$ from Equation 3 into Equation 1, yields the following:

$$FI_{CA} = (T_{outdoor} - T_{yard} - T_{off\text{-}site} - T_{12})/T_{outdoor} \quad (4)$$

EPA has compiled information from various studies on activity patterns of children and adults, and has developed recommended values for time spent at different locations or activities for exposure assessment (EPA 1997b). The recommended values for the average or median time spent by children in outdoor activities (not specific to a residential setting) are 5 hr/day on weekdays and 7 hr/day on weekends. The recommended value for adults is 1.5 hr/day (on weekdays and weekends). The recommended average time spent outdoors by adults at a residence is 2 hr/day (EPA 1997b). (The time spent by adults in outdoor activities and outdoors at a residence is based on different studies, accounting for the discrepancy in values.) The higher values of 7 hr/day for children and 2 hr/day for adults were used for $T_{outdoor}$. However, the actual time spent outdoors does not affect the estimates of FI; the basis for the FI is estimated as the relative fraction of time spent by the adult and child resident at each outdoor location, as discussed below.

Due to the small size of the fenced backyards (approximately 20 feet by 20 feet), it is unreasonable to assume that all time spent in outdoor residential activities would be in these backyards. It is also unreasonable to assume that all outdoor activities would occur in the common areas. Time spent by adult residents in backyards is estimated to represent 25 percent of the total time spent in outdoor activities, or 0.5 hr. Younger children (ages 1 to 3) may be reasonably expected to spend 50 percent of their outdoor activity time (3.5 hours) in the fenced backyards compared to other locations, due to ease of parental supervision within the enclosed areas. Older children (4 to 6 years of age) are expected to spend less time in fenced backyards (25 percent of total outdoor time) and more time in the common areas, which are also judged to be within parental fields of vision (TtEMI 1999-2002). Time spent by adult and child residents in Site 12 outside of the known solid waste disposal areas ($T_{12}$) is expected to be negligible compared to the time spent in the common areas adjacent to their residences. This is because residents would likely spend time in areas that are closer to or adjacent to their home. Overall, time spent by child residents in backyards is estimated to represent 35 percent of the total time spent in outdoor activities, or 2.5 hours (approximately the average of the age-specific estimates for younger and older children). On the basis of these considerations, 0.5 hr/day and 2.5 hr/day were used for $T_{yard}$ for adult and child residents, respectively.

Time spent at off-site recreational facilities may vary significantly depending on several factors. As shown in Equation 3, the higher the value of $T_{off\text{-}site}$, the lower the value of $T_{CA}$. As a conservative assumption, the time spent in outdoor activities at off-site recreational areas was assumed to be only 1 hour for adults and children. Time spent within specific common areas would likely vary according to the size and location of the area. It is expected that more time would be spent in the larger, more accessible areas compared to the smaller, less accessible areas. The $T_{CA}$ value developed in this analysis applies to the larger, more accessible common areas where more time would be spent, within the known solid waste disposal areas, and is thus a conservative estimate of FI for the smaller common areas.

Using the above values, the estimated site-specific $FI_{CA}$ values for the common areas calculated using Equation 4 were 0.25 and 0.50 for the adult and child residents, respectively. These values and the values used for the time spent in different outdoor areas are summarized in Table 1. For comparison, the EPA default FI value for both adult and child residents is 1.0.

**TABLE 1**

**SITE-SPECIFIC $FI_{CA}$ VALUES FOR THE COMMON AREAS WITHIN THE KNOWN SOLID WASTE DISPOSAL AREAS**

| Parameter | Adult Resident | Child Resident |
|---|---|---|
| $T_{outdoor}$ (hr/day) | 2 | 7 |
| $T_{CA}$ (hr/day) | 0.5 | 3.5 |
| $T_{yard}$ (hr/day) | 0.5 | 2.5 |
| $T_{off\text{-}site}$ (hr/day) | 1 | 1 |
| $T_{12}$ (hr/day) | 0 | 0 |
| **$FI_{CA}$** | **0.25** | **0.50** |

## 3.2 DERMAL CONTACT WITH SOIL

Individuals may be exposed to COCs in soil by direct contact with the skin. Exposure parameters specific to the dermal contact pathway are the skin surface area (the amount of skin in contact with soil), the soil adherence factor (the amount of soil adhering to the skin), and the chemical absorption fraction (the fraction of chemical in contact with the skin that actually crosses the skin and enters the body).

Similar to the soil ingestion pathway, dermal intake is also a function of the COC concentration in soil, the exposure frequency, the exposure duration, and the fraction contacted (FC). A site-specific value is estimated only for FC.

Similar to the FI term used to evaluate the soil ingestion pathway, FC is used to account for the fraction of the total amount of soil contacted daily that is presumed to be contaminated. In the absence of site-specific information, the default value for FC is 1, which means that all soil contacted is from the contaminated area. Following the same line of reasoning used to develop the site-specific values of $FI_{CA}$ for the adult and child resident, the site-specific values of FC for the common areas ($FC_{CA}$) are 0.5 for the child resident and 0.25 for the adult resident. That is, it is assumed that all activities that involve dermal contact with soil occur outdoors and that the degree of contact with soil is proportional to the time spent at each outdoor location. The default values developed by EPA for child and adult receptors represent the total exposure to soil over the course of the day. The $FC_{CA}$ adjusts that exposure based on the relative fraction of time spent by the adult and child resident at each outdoor location. As discussed previously, those outdoor locations are assumed to be the backyards, the common areas, and nearby parks and open spaces.

### 3.3 INHALATION OF AIRBORNE PARTICLES

Individuals may be exposed to COCs in soil by inhalation of particles released from soil to air. Exposure parameters specific to the inhalation pathway are the exposure time and inhalation rate. Similar to the soil ingestion and dermal contact pathways, inhalation intake is also a function of COC concentrations in soil (soil is the source of airborne particles), the exposure frequency, and the exposure duration. Site-specific values were estimated for the exposure time and inhalation rate.

The site-specific exposure time used to estimate inhalation exposure accounts for the fact that only a portion of a resident's time would be spent in the common areas; it serves the same role as the site-specific $FI_{CA}$ used to evaluate the soil ingestion pathway and the $FC_{CA}$ used to evaluate the dermal contact pathway. The estimates of time spent in the common area presented in Section 3.1 are used as the values for exposure time. That is, the child resident is assumed to spend 3.5 hr/day and the adult is assumed to spend 0.5 hr/day in the common areas.

Inhalation rates depend on the activity level of the receptor. Adults and children would typically be engaged in recreational activities while present in the common areas. An inhalation rate of 1.2 cubic meters per hour ($m^3$/hr) was used for the child receptor and 1.6 $m^3$/hr for the adult receptor. EPA recommends these values for children and adults engaged in "moderate activities." The values were obtained from Table 5-23 of the "Exposure Factors Handbook Volume I" (EPA 1997a).

## 4.0 EQUATIONS FOR CALCULATING SOIL ACTION LEVELS

This section presents the equations used to calculate the soil action levels for PAHs and PCBs. The action level for lead is calculated using a different methodology, as described in Section 5.1.

PAHs and PCBs are both carcinogens. Consistent with the approach used by EPA Region 9 (2000), separate soil action levels are developed based on the cancer and noncancer effects of these chemicals; the lower value is then selected as the soil action level. Action levels developed for the cancer endpoint are based on exposure of a combined child/adult resident (over a period of 30 years), whereas action levels developed for the noncancer endpoint are based on exposures of a child resident (over a period of 6 years). This approach, which is consistent with risk assessment guidance (EPA 1989, 2000), results in the lowest (most health protective) action level for the given health endpoint.

The equations used to calculate the soil action levels for Site 12 are mathematically equivalent to the equations used by EPA Region 9 to develop preliminary remediation goals (PRG) (EPA 2000). For the resident receptor, however, the equation in this document is presented in a slightly different format. The resident receptor evaluated by EPA to derive PRGs for cancer endpoints combines exposures of a child resident and an adult resident. This is because the intake of a child is higher than an adult for some exposure pathways. For example, the child receptor is assumed to weigh 15 kilograms (kg) and ingest a total of 200 milligrams (mg) of soil per day, whereas the adult resident is assumed to weigh 70 kg and ingest 100 mg of soil per day (mg/day). To calculate the PRGs, EPA develops "age-adjusted" exposure parameters to account for these differences in contact rates, body weights, and the exposure duration of a child (6 years) and an adult (24 years).

In this document, the equation used to calculate action levels for carcinogens does not use age-adjusted parameters. Instead, separate parameters are defined for the child and adult and these parameters are used in the equation. Mathematically, these equations are equivalent to the equations used by EPA Region 9 to develop PRGs. However, the site-specific values for $FI_{CA}$, $FC_{CA}$, inhalation rates, and exposure times derived in Section 4.0 can be more easily incorporated into the equations by maintaining separate parameters for the adult and child.

The soil action levels are based on three exposure pathways: incidental ingestion of soil, dermal contact with soil, and inhalation of airborne particles. Equation 5 is the "forward" equation that calculates the total cancer risk for the combined child and adult receptor, and Equation 6 is the forward equation hazard index that calculates the total hazard index for a child for these pathways. These equations are based on equations presented in EPA (1989).

**Cancer risk for the combined child and adult receptor (Equation 5)**

$$Cancer\ risk = \left( \frac{C_S \times IRS_A \times FI_{CA,A} \times EF_A \times ED_A \times CF \times SF_o}{BW_A \times AT_{carc}} \right) + \left( \frac{C_S \times \left[ \frac{1}{PEF} \right] \times IRA_A \times ET_A \times EF_A \times ED_A \times SF_i}{BW_A \times AT_{carc}} \right)$$

$$+ \left( \frac{C_S \times SA_A \times AF_A \times ABS \times FC_{CA,A} \times EF_A \times ED_A \times CF \times SF_o}{BW_A \times AT_{carc}} \right) + \left( \frac{C_S \times IRS_C \times FI_{CA,C} \times EF_C \times ED_C \times CF \times SF_o}{BW_C \times AT_{carc}} \right)$$

$$+ \left( \frac{C_S \times \left[ \frac{1}{PEF} \right] \times IRA_C \times ET_C \times EF_C \times ED_C \times SF_i}{BW_C \times AT_{carc}} \right) + \left( \frac{C_S \times SA_C \times AF_C \times ABS \times FC_{CA,C} \times EF_C \times ED_C \times CF \times SF_o}{BW_C \times AT_{carc}} \right)$$

**Hazard index for the child receptor (Equation 6)**

$$HI = \left( \frac{C_S \times IRS_C \times FI_{CA,C} \times EF_C \times ED_C \times CF}{BW_C \times AT_{ncarc} \times RfD_o} \right) + \left( \frac{C_S \times \left( \frac{1}{PEF} \right) \times IRA_C \times ET_C \times EF_C \times ED_C}{BW_C \times AT_{ncarc} \times RfD_i} \right)$$

$$+ \left( \frac{C_S \times SA_C \times AF_C \times ABS \times FC_{CA,C} \times EF_C \times ED_C \times CF}{BW_C \times AT_{ncarc} \times RfD_o} \right)$$

The equations to calculate soil action levels are obtained by rearranging and solving for $C_s$ (the concentration in soil).

**Soil action level ($C_s$) for a cancer endpoint (Equation 7)**

$$ActionLevel = \left( \frac{Risk \times AT_{carc} \times BW_A}{\left(EF_A \times ED_A\right)\left[ \left[IRS_A \times FI_{CA,A} \times CF \times SF_o\right] + \left[\frac{IRA_A \times ET_A \times SF_i}{PEF}\right] + \left[SA_A \times AF_A \times ABS \times FC_{CA,A} \times CF \times SF_o\right] \right]} \right)$$

$$+ \left( \frac{Risk \times AT_{carc} \times BW_C}{\left(EF_C \times ED_C\right)\left[ \left[IRS_C \times FI_{CA,C} \times CF \times SF_o\right] + \left[\frac{IRA_C \times ET_C \times SF_i}{PEF}\right] + \left[SA_C \times AF_C \times ABS \times FC_{CA,C} \times CF \times SF_o\right] \right]} \right)$$

**Soil action level for noncancer endpoint based on the child resident (Equation 8)**

$$Action\ level = \frac{HI \times BW_C \times AT_{ncarc}}{\left(EF_C\ x\ ED_C\right)\left[ \left(\frac{IRS_C \times FI_{CA,C} \times CF}{RfD_o}\right) + \left(\frac{IRA_C \times ET_C}{PEF \times RfD_i}\right) + \left(\frac{SA_A \times AF_C \times ABS \times FC_{CA,C} \times CF}{RfD_{o,}}\right) \right]}$$

All symbols used in Equations 5 through 8 are defined in Table 2.

**TABLE 2**

**PARAMETERS FOR THE RESIDENT ADULT AND CHILD**

| Parameter | Symbol | Receptor | Site-Specific Value[a] | EPA Default Value[b] | Unit |
|---|---|---|---|---|---|
| **General Exposure Parameters** | | | | | |
| Body weight | $BW_C$ | Child | 15 | 15 | kg |
| | $BW_A$ | Adult | 70 | 70 | kg |
| Exposure frequency | $EF_C$ | Child | 350 | 350 | d/yr |
| | $EF_A$ | Adult | 350 | 350 | d/yr |
| Exposure duration | $ED_C$ | Child | 6 | 6 | yr |
| | $ED_A$ | Adult | 24 | 24 | yr |
| Averaging time for carcinogens | $AT_{carc}$ | Child/adult | 25,550 | 25,550 | yr |
| Averaging time for noncarcinogens | $AT_{ncarc}$ | Child | $ED_C \times 350$ | $ED_C \times 350$ | d |
| | $AT_{ncarc}$ | Adult | $ED_A \times 350$ | $ED_A \times 350$ | day |
| **Soil Ingestion Parameters** | | | | | |
| Soil ingestion rate | $IRS_C$ | Child | 200 | 200 | mg/d |
| | $IRS_A$ | Adult | 100 | 100 | mg/d |
| Fraction ingested | $FI_{CA,C}$<br>$FI_{CA,A}$ | Child<br>Adult | **0.5**[c]<br>**0.25**[c] | 1<br>1 | --<br>-- |
| Mass conversion factor | CF | Child/adult | 0.000001 | 0.000001 | -- |
| **Dermal Contact Parameters** | | | | | |
| Exposed surface area | $SA_C$ | Child | 2,800 | 2,800 | $cm^2$ |
| | $SA_A$ | Adult | 5,700 | 5,700 | $cm^2$ |
| Soil-to-skin adherence factor | $AF_C$<br>$AF_A$ | Child<br>Adult | 0.2<br>0.07 | 0.2<br>0.07 | $mg/cm^2$<br>$mg/cm^2$ |
| Absorption factor<br>PAHs<br>PCBs | ABS | Child/adult | <br>0.13<br>0.14 | <br>0.13<br>0.14 | <br>--<br>-- |
| Fraction contacted | $FC_{CA,C}$<br>$FC_{CA,A}$ | Child<br>Adult | **0.5**[c]<br>**0.25**[c] | 1<br>1 | --<br>-- |
| **Inhalation of Particles Parameters** | | | | | |
| Exposure time | $ET_C$<br>$ET_A$ | Child<br>Adult | **3.5**[c]<br>**0.5**[c] | 24<br>24 | hr/d<br>hr/d |
| Inhalation rate | $IRA_C$<br>$IRA_A$ | Child<br>Adult | **1.2**[c]<br>**1.6**[c] | 0.42<br>0.83 | $m^3/hr$<br>$m^3/hr$ |
| Particulate emission factor | PEF | Child/adult | $1.32 \times 10^9$ | $1.32 \times 10^9$ | $m^3/kg$ |

**TABLE 2 (Continued)**

**PARAMETERS FOR THE RESIDENT ADULT AND CHILD NAVAL STATION TREASURE ISLAND**

| Parameter | Symbol | Receptor | Site-Specific Value[a] | EPA Default Value[b] | Unit |
|---|---|---|---|---|---|
| **Toxicity Values** | | | | | |
| Oral cancer slope factor<br>Benzo(a)pyrene<br>Polychlorinated biphenyls | $SF_o$ | Child/adult | <br>7.3<br>2.0 | <br>7.3<br>2.0 | 1/(mg/kg-d) |
| Inhalation cancer slope factor<br>Benzo(a)pyrene<br>Polychlorinated biphenyls | $SF_i$ | Child/adult | <br>3.1<br>2.0 | <br>3.1<br>2.0 | 1/(mg/kg-d) |
| Oral reference dose<br>Benzo(a)pyrene<br>Polychlorinated biphenyls | $RfD_o$ | Child/adult | <br>--<br>0.00005 | <br>--<br>0.00005 | mg/kg-d |
| Inhalation reference dose<br>Benzo(a)pyrene<br>Polychlorinated biphenyls | $RfD_i$ | Child/adult | <br>--<br>0.00005 | <br>--<br>0.00005 | mg/kg-d |
| **Other Terms** | | | | | |
| Concentration in soil | $C_s$ | Child/adult | Chemical-specific | Chemical-specific | mg/kg |
| Target cancer risk | $Risk_T$ | Child/adult | $1 \times 10^{-5}$ | $1 \times 10^{-5}$ | -- |
| Target hazard index | $HI_T$ | Child/adult | 1 | 1 | -- |

Notes:

**Bolded values indicate site-specific values that differ from default values**

a Values from U.S. Environmental Protection Agency 2000 unless otherwise noted
b Values from U.S. Environmental Protection Agency 2000
c Derivation based on site-specific information

$cm^2$ Square centimeter
day/yr Day per year
kg Kilogram
$m^3$/kg Cubic meter per kilogram
mg/d Milligram per day
mg/kg Milligram per kilogram
mg/kg-d Milligram per kilogram per day
PAHs Polycyclic aromatic hydrocarbon
PCBs Polychlorinated biphenyl
yr Year

## 5.0 SITE-SPECIFIC SOIL ACTION LEVELS

The soil action levels developed for lead, PAHs, and PCBs are presented in the following sections.

### 5.1 SOIL ACTION LEVEL FOR LEAD (400 mg/kg)

The potential for human health effects from exposure to lead is typically estimated based on blood-lead concentrations. Blood-lead concentrations, expressed as micrograms per deciliter (µg/dL) of whole blood, are an integrated measure of an internal dose that reflects exposure from site-related and background sources. The cleanup goal for lead in soil is the EPA Region 9 PRG of 400 mg/kg for residential land use (EPA 2000). EPA developed the PRG to protect a child in a residential setting using the results of a model (referred to as the Integrated Exposure Uptake Biokinetic Model for Lead in Children [IEUBK]) that calculates lead concentrations in soil that correspond to a blood-lead concentration of 10 µg/dL, the threshold level of concern for children (EPA 1994, 1998). A child is more sensitive to the health effects of lead than is an adult; as a result, a PRG that is protective of a child should also afford protection for an adult. EPA (1998) recommends that the IEUBK be used as the primary tool to generate risk-based soil cleanup levels at lead sites for current or future residential land use.

The IEUBK model evaluates exposure from site-related and background sources. When implemented using the model defaults, the exposure pathways evaluated for site-related sources are incidental ingestion of soil and dust; the exposure pathways evaluated for background sources are ingestion of water and food, and inhalation of dusts. Although children could also be exposed to soil through dermal contact, EPA states that uptake of lead from this pathway is generally an insignificant route of exposure for inorganic lead (EPA 1996). The value of 400 mg/kg of lead in soil was derived by implementing the model using default values for the exposure parameters. These default values include daily exposure to lead-contaminated soil and dust and conservative (health-protective) values for other exposure parameters. Based on the results of the model, EPA Region 9 established a PRG for lead of 400 mg/kg as protective of human health in a residential setting.

Both EPA and the California Department of Toxic Substances Control (DTSC) use blood-lead concentrations as the basis for risk management decisions (EPA 1994, 1998; DTSC 1999). Blood-lead concentrations provide a better measure of the potential noncancer health effects of lead than the more traditional hazard index approach used for other toxicants. Although EPA (2002) and the California Environmental Protection Agency (2002) consider lead as a probable carcinogen based on animal studies, cleanup goals based on the threshold blood-lead concentration of 10 μg/dL developed for the noncancer health endpoint are expected to be protective for potential human cancer effects.

It would be reasonable to modify the default exposure values used in the IEUBK model to account for the lower soil $FI_{CA}$ value derived for the common areas at Site 12. As a health protective approach, however, the Navy proposes the EPA Region 9 PRG of 400 mg/kg (which is based on the assumption that all soil contacted is from a contaminated area) as the action level.

The cleanup goal of 400 mg/kg is consistent with the cleanup goal for lead applied in removal actions previously conducted at Site 12. These actions include the time-critical removal of lead-contaminated soil near Building 1133 and near Buildings 1207-1209 (TtEMI 1999a, 1999b).

### 5.2 SOIL ACTION LEVEL FOR PAHs (0.62 mg/kg)

The selection of a site-specific soil action level for PAHs followed a two-step process, consistent with the approach described in the preamble (55 Federal Register March 8, 1990) to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] Part 300). First, the Navy derived a preliminary soil action level corresponding to a "point of departure" cancer risk of $1 \times 10^{-6}$. Second, the Navy considered whether the preliminary action level should be revised to address site-specific or remedy-specific factors. These considerations were then applied to establish the action level for PAHs. This two-step process is described in Sections 5.2.1 and 5.2.2.

PAHs are a group of organic compounds consisting of three or more fused benzene rings that are each composed only of carbon and hydrogen atoms. They are typically formed during the incomplete combustion of organic materials. PAHs originate from natural sources, such as volcanic eruptions and forest fires, and from anthropogenic sources, primarily the incomplete combustion of fuels such as wood, coal, oil, and gas. PAHs are typically released as particulates into the atmosphere where they can be transported long distances and subsequently deposited on soil, water, and sediments. As a result of these deposition processes, low levels of PAHs appear to be widespread in the environment. PAHs have been detected at concentrations of 150 ug/kg in soils in the Arctic, providing evidence of global transport of PAHs (Agency for Toxic Substances Disease Registry 1995).

EPA has classified the following seven PAHs as probable human carcinogens: benzo(a)pyrene (B[a]P), benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Of these, B[a]P is the only carcinogenic PAH for which EPA has established a cancer slope factor and for which cancer risks can be quantitatively evaluated (EPA 2002). In the absence of chemical-specific slope factors, all other carcinogenic PAHs are evaluated according to their toxicity relative to B[a]P (EPA 1993; California Environmental Protection Agency 1999). For this reason, the cleanup goal for PAHs is expressed in terms of "B[a]P equivalents."

### 5.2.1 Preliminary Soil Action Level for PAHs

The Navy derived a preliminary soil action level using site-specific values for select exposure parameters and EPA's "point of departure" of $10^{-6}$ for cancer risks. The NCP (40 CFR Part 300) establishes a cancer risk of $10^{-6}$ as the point of departure for developing final cleanup levels. Although PAHs can also induce adverse health effects other than cancer, an action level based on the cancer endpoint is more conservative (lower) than the action level based on the noncancer endpoint.

The preliminary soil action level for PAHs was derived using Equation 7 and the following conditions:

- Point of departure cancer risk of $1 \times 10^{-6}$
- Site-specific $FI_{CA}$ value of 0.5 for a child resident and 0.25 for an adult resident for evaluation of the soil ingestion pathway
- Site-specific $FC_{CA}$ value of 0.5 for a child resident and 0.25 for an adult resident for evaluation of the dermal contact with soil pathway
- Site-specific inhalation rates (1.2 $m^3$/hr for a child resident and 1.6 $m^3$/hr for an adult resident) and exposure times (3.5 hr/day for a child resident and 0.5 hr/day for an adult resident) for evaluation of the inhalation of particles pathway
- EPA Region 9 (2000) default values for all other exposure parameters

Table 2 presents the values of all exposure parameters used to derive the soil action level.

The preliminary soil action level for PAHs (expressed as B[a]P equivalents) derived using the site-specific exposure parameters is shown in Table 3. The soil concentration corresponding to a $1 \times 10^{-6}$ cancer risk, calculated using EPA's default exposure parameters for residential exposure (Table 2), is also shown for comparison.

**TABLE 3**

**PRELIMINARY SOIL ACTION LEVEL FOR PAHs**

| COC | Soil Concentration Using EPA Defaults (mg/kg) | Preliminary Soil Action Level Using Site-Specific Values (mg/kg) | Health Endpoint |
|---|---|---|---|
| **PAHs (as B[a]P equivalents)** | 0.062 | 0.15 | Corresponds to a cancer risk of $1 \times 10^{-6}$. The hazard index is less than 0.1. |

### 5.2.2 Soil Action Level for PAHs

The preamble to the NCP (55 Federal Register March 8, 1990) states that a PRG corresponding to the point of departure cancer risk of $10^{-6}$ may be revised to a risk level within the target risk range of $10^{-6}$ to $10^{-4}$ based on consideration of site-specific or remedy-specific factors that include exposure factors, uncertainty factors, and technical factors. EPA provides specific examples of each of these categories. The Navy reviewed these factors and identified ambient (background) concentrations of PAHs as a possible site-specific factor requiring consideration in establishing the action level. In general, it is technically infeasible to remediate to concentrations less than ambient levels at a site, even if the ambient levels are anthropogenic.

PAHs were detected in soil samples collected from Site 12 and many other locations at TI where no site-related source has been identified. These detections are not unexpected given that PAHs are ubiquitous, as discussed previously. A formal analysis of ambient (background) concentrations of PAHs at TI has not been conducted. However, a review of the detected concentrations of PAHs at Site 12 and other areas, the absence of a known source for most detections, and a review of ambient concentrations established for PAHs for surface soils in northern California, suggests that the majority of PAH detections at TI represent ambient conditions and not a release.

Pacific Gas and Electric and the Navy supported a study of background levels of carcinogenic PAHs in surface soils in Northern California (Environ Corporation, ENTRIX, and IRIS Environmental 2002). The study was conducted in cooperation and collaboration with a task group of representatives from the Human Health and Ecological Risk Division and Site Mitigation Branches of DTSC. The final background data set contains 86 samples of surface soil collected from background locations at 21 sites across northern California. The B[a]P equivalent values in the final data set were calculated using relative potency values from the California Environmental Protection Agency. The 95th percentile of the final background data set, expressed as B[a]P equivalents was 0.92 mg/kg. Numerous other studies (summarized in Appendix) support the ubiquitous presence of ambient levels of PAHs in soils.

The Navy anticipates that background PAH concentrations in soils at Site 12 would be less than 0.92 mg/kg, but higher than the preliminary action level of 0.15 mg/kg. Based on consideration of the technical limitations and difficulties in implementation of a cleanup to 0.15 mg/kg, the Navy is proposing an action level of 0.62 mg/kg. An action level of 0.62 mg/kg has been successfully achieved during other removal actions at Site 12, including the removal action conducted at the Former Storage Yard in 2000 (TtEMI 2000) and for the Treasure Island Homeless Initiative units in 2001 (Navy 2001). Achievement of an action level of 0.62 mg/kg during these removal actions indicates that excavation of soil to this concentration is technically feasible and can be implemented in the field. The action level for PAHs is shown in Table 4.

**TABLE 4**

**SOIL ACTION LEVEL FOR PAHs**

| COC | Soil Action Level Using Site-Specific Values (mg/kg) | Health Endpoint |
|---|---|---|
| **PAHs (as B[a]P equivalents)** | 0.62 | Corresponds to a cancer risk of $4.2 \times 10^{-6}$. The hazard index is less than 0.1. |

A primary goal of the Navy's Installation Restoration Program is protection of human health. Using Equation 5 and the site-specific values for the exposure assumptions shown in Table 2, the Navy calculated that the cancer risk corresponding to a soil concentration of 0.62 mg/kg B[a]P equivalents is $4.2 \times 10^{-6}$. This cancer risk level is at the lower end of EPA's target risk range of $10^{-6}$ to $10^{-4}$.

## 5.3 SOIL ACTION LEVEL FOR PCBs (1.0 mg/kg)

The selection of an action level for PCBs followed a two-step process. First, the Navy derived a preliminary action level using site-specific values for select exposure parameters. Second, the Navy reviewed cleanup standards for PCBs established under the Toxic Substances Control Act (TSCA).

Similar to the approach used for PAHs, a preliminary site-specific soil action level was derived for PCBs using site-specific values for select exposure parameters and EPA's point of departure of $10^{-6}$ for cancer risks.  Although PCBs can also induce adverse health effects other than cancer, an action level based on the cancer endpoint (and a $10^{-6}$ cancer risk) is more conservative (lower) than the action level based on the noncancer endpoint.

The preliminary soil action level for PCBs was derived using Equation 7 and the following conditions:

- Point of departure cancer risk of $1 \times 10^{-6}$
- Site-specific FI value of 0.5 for a child resident and 0.25 for an adult resident for evaluation of the soil ingestion pathway
- Site-specific FC value of 0.5 for a child resident and 0.25 for an adult resident for evaluation of the dermal contact with soil pathway
- Site-specific inhalation rates (1.2 $m^3$/hr for a child resident and 1.6 $m^3$/hr for an adult resident) and exposure times (3.5 hr/day for a child resident and 0.5 hr/day for an adult resident) for evaluation of the inhalation of particles pathway
- EPA Region 9 (2000) default values for all other exposure parameters

Table 2 presents the values of all exposure parameters used to derive the preliminary soil action level.

The preliminary soil action level for PCBs is shown in Table 5.  The soil concentration corresponding to a cancer risk of $1 \times 10^{-6}$, calculated using EPA's default exposure parameters for residential exposure (Table 2), is also shown for comparison.

**TABLE 5**

**SOIL ACTION LEVEL FOR PCBs**

| COC | Soil Concentration Using EPA Defaults (mg/kg) | Preliminary Soil Action Level Using Site-Specific Values (mg/kg) | Health Endpoint | Action Level (ARAR) (mg/kg) |
|---|---|---|---|---|
| **PCBs** | 0.22 | 0.53 | Corresponds to a cancer risk of $1 \times 10^{-6}$. The hazard index is 0.2. | **1.0** |

The hazard quotient corresponding to the preliminary soil action level of 0.53 mg/kg for PCBs is 0.2.

The preliminary soil action level for PCBs is based on the site-specific values derived for the soil ingestion, dermal, and inhalation pathways.  However, the Navy has identified the TSCA cleanup standard of 1 mg/kg for PCBs in soils (40 CFR 761.61[a][4][I]) as an applicable or relevant and appropriate requirement (ARAR) that is relevant and appropriate. Under TSCA, the cleanup criterion of 1 mg/kg is designated for high-occupancy sites, and the preamble to TSCA states that high-occupancy areas include residential use because in setting the cleanup standard for high-occupancy areas, EPA assumed constant exposure:

> EPA's evaluation of risk assumed unprotected exposure 24 hours a day, 7 days a week (168 hours per week) for the high occupancy scenario. . . . Many outdoor areas will be low occupancy areas; others, such as school playgrounds and residential yards, might be high occupancy areas" (Preamble, 63 Federal Register 35383, 35408 [June 29, 1998]).

A soil concentration of 1.0 mg/kg PCBs corresponds to a site-specific cancer risk of $1.9 \times 10^{-6}$ and a hazard quotient of 0.5, using the site-specific values shown in Table 2. This risk level is at the lower end of EPA's target risk range of $10^{-6}$ to $10^{-4}$ and the corresponding hazard quotient of 0.5 is below 1, the level of concern. The Navy's requirement under CERCLA to use the Federal ARAR of 1 mg/kg for the PCB soil action level is protective of human health. The action level for PCBs is the ARAR of 1 mg/kg.

## 6.0 DISCUSSION AND SUMMARY

The soil action levels for soils in the common areas of the known solid waste disposal areas at Site 12 are summarized in Table 6.

**TABLE 6**

**SOIL ACTION LEVELS**

| COC | Action Level (mg/kg) | Basis | Health Endpoint |
|---|---|---|---|
| Lead | 400 | Region 9 PRG | Blood-lead level less than 10 µg/dL |
| PAHs (B[a]P equivalents) | 0.62 | Site-specific | Corresponds to a cancer risk of $4.2 \times 10^{-6}$. The hazard quotient less is than 0.1 |
| PCBs | 1.0 | ARAR | Corresponds to a cancer risk of $1.9 \times 10^{-6}$. The hazard quotient is 0.5. |

Several considerations indicate that the action levels are protective of human health and that the risks associated with potential exposures to soils in the common areas in the known solid waste disposal areas would be lower than those presented above. These considerations include the following:

- The soil action levels will be applied to all common areas within the known Site 12 solid waste disposal areas, regardless of differences in size and expected usage. The action levels were selected to be protective of the most heavily used common areas.
- The common areas are fully landscaped with sod and other plantings. Sod is an effective barrier and substantially reduces contact with the underlying soil.
- The site-specific $FI_{CA}$ was not applied to the development of the action level for lead. This adjustment would have resulted in a higher action level for lead.

These considerations indicate that the factors considered and process applied by the Navy to develop the action levels likely overestimate the potential for exposure of residents to soils in the common areas. As a result, the action levels represent conservative, health-protective levels for these areas.

## REFERENCES


Agency for Toxic Substances Disease Registry. 1995. "Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAH). http://www.atsdr.cdc.gov/toxprofiles/tp69.html

California Department of Toxic Substances Control (DTSC). 1999. "LeadSpread 7." http://www.dtsc.ca.gov/ScienceTechnology/ledspred.html

California Environmental Protection Agency. 1999. "Air Toxics Hot Spots Program Risk Assessment Guidelines. Part II. Technical Support Document for Describing Available Cancer Potency Factors." April.

California Environmental Protection Agency. 2002. "Toxicity Criteria Database." Office of Environmental Health Hazard Assessment. http://www.oehha.ca.gov/risk/chemicalDB/index.asp

Environ Corporation, ENTRIX, and IRIS Environmental. 2002. "Draft, Background Levels of Polycyclic Aromatic Hydrocarbons in Northern California Surface Soil."

Tetra Tech EM Inc. (TtEMI). 1998. "Draft Technical Memorandum, Estimation of Ambient Concentrations of Polynuclear Aromatic Hydrocarbons in Soil, Mare Island Naval Shipyard, Vallejo, California." July 27.

TtEMI. 1999a. "Revised Final, Site 12 Removal Site Evaluation and Action Memorandum for the Time-Critical Removal of Lead-Contaminated Soil, Naval Station Treasure Island, San Francisco, California. May 27.

TtEMI. 1999b. "Final, Site 12 Removal Site Evaluation and Action Memorandum for the Time-Critical Removal of Lead-Contaminated Soil Near Building 1133, Naval Station Treasure Island, San Francisco, California." November 9.

TtEMI. 1999-2002. Observations by Staff During Investigation and Remediation Work at and in the Vicinity of Site 12, Naval Station Treasure Island.

TtEMI. 2000. "Former Storage Yard Area of Concern Construction Oversight Workplan for the Removal of PCB-Contaminated Soil, Naval Station Treasure Island, San Francisco, California." July.

Tetra Tech, Inc. 1997. "Draft Remedial Action Plan for the Former Alhambra Manufactured Gas Plant Site, Alhambra, California." January 31. (As summarized in TtEMI 1998.)

U.S. Department of the Navy. 2001. "Action Memorandum, Time-Critical Removal Action for Buildings 1246, 1248, 1252, 1254, and 1413, Installation Restoration Site 12, Naval Station Treasure Island, San Francisco, California." October.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response." EPA/540/1-89/002. December.

EPA. 1993. "Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons." EPA/600/R-93/089. Office of Research and Development. Washington, D.C.

EPA. 1994. "Revised Interim Soil Lead (Pb) Guidance for CERCLA Sites and RCRA Corrective Action Facilities. August.

EPA. 1996. "Frequently Asked Questions (FAQs) on the Adult Lead Model." Technical Review Workgroup for Lead. April.

EPA. 1997a. "Exposure Factors Handbook. Volume I." Office of Research and Development. EPA/600/P-95/002Fa. August.

EPA. 1997b. "Exposure Factors Handbook. Volume III. Activity Factors." Office of Research and Development. EPA/600/P-95/002Fc. August.

EPA. 1998. "Clarification to the 1994 Revised Interim Soil Lead (Pb) Guidance for CERCLA Sites and RCRA Corrective Action Facilities. August.

EPA. 2000. "EPA Region IX Preliminary Remediation Goals (PRG) 2000." November 1. http://www.epa.gov/region09/waste/sfund/prg/

EPA. 2002. Integrated Risk Information System. Online Database. Office of Research and Development, National Center for Environmental Assessment. January. http://www.epa.gov/iris

# APPENDIX

# AMBIENT CONCENTRATIONS OF POLYCYCLIC AROMATIC HYDROCARBONS IN SOILS

## TABLE 1

## ESTIMATES OF AMBIENT POLYCYCLIC AROMATIC HYDROCARBON CONCENTRATIONS IN SOILS AT MARE ISLAND (All Concentrations in mg/kg)

| Analyte | Number of Samples | Geometric Mean | 95th Percentile | 99th Percentile |
|---|---|---|---|---|
| 2-Methylnaphthalene | 37 | 0.078 | 0.3 | 0.37 |
| Acenaphthene | 21 | 0.066 | 0.27 | 0.46 |
| Acenaphthylene | 10 | 0.042 | 0.11 | 0.24 |
| Anthracene | 50 | 0.071 | 0.33 | 0.65 |
| Benzo(a)anthracene | 83 | 0.098 | 0.47 | 0.66 |
| Benzo(a)pyrene | 121 | 0.098 | 0.87 | 1.2 |
| Benzo(b)fluoranthene | 129 | 0.097 | 0.62 | 0.8 |
| Benzo(ghi)perylene | 59 | 0.079 | 0.28 | 0.44 |
| Benzo(k)fluoranthene | 66 | 0.126 | 0.82 | 1.4 |
| Chrysene | 182 | 0.116 | 1.1 | 2.3 |
| Dibenz(a,h)anthracene | 18 | 0.116 | 0.59 | 0.76 |
| Fluoranthene | 192 | 0.076 | 0.5 | 0.63 |
| Fluorene | 18 | 0.063 | 0.15 | 0.19 |
| Indeno(1,2,3-cd)pyrene | 53 | 0.073 | 0.3 | 0.52 |
| Naphthalene | 45 | 0.073 | 0.32 | 0.38 |
| Phenanthrene | 145 | 0.121 | 1 | 1.4 |
| Pyrene | 237 | 0.099 | 0.55 | 1.1 |

Source:

Tetra Tech EM Inc. (TtEMI). 1998. “Draft Technical Memorandum, Estimation of Ambient Concentrations of Polynuclear Aromatic Hydrocarbons in Soil, Mare Island Naval Shipyard, Vallejo, California.” July 27.

## TABLE 2

## RESULTS OF LITERATURE SEARCH FOR BACKGROUND CONCENTRATIONS OF POLYCYCLIC AROMATIC HYDROCARBONS IN SOILS WORLDWIDE
**(All Concentrations in mg/kg)**

| Analyte | Rural | | Agricultural | | Urban | |
|---|---|---|---|---|---|---|
| | Low | High | Low | High | Low | High |
| 2-Methylnaphthalene | | | | | 0.017 | 0.64 |
| Acenaphthene | 0.0017 | 0.0429 | 0.006 | 0.006 | 0.024 | 3.4 |
| Acenaphthylene | 0.003 | 0.003 | 0.005 | 0.005 | 0.018 | 1.1 |
| Anthracene | 0.0042 | 0.011 | 0.011 | 0.013 | 0.0126 | 5.7 |
| Benzo(a)anthracene | 0.005 | 0.056 | 0.056 | 0.11 | 0.048 | 59 |
| Benzo(a)pyrene | 0.002 | 1.3 | 0.0046 | 0.9 | 0.038 | 13 |
| Benzo(b)fluoranthene | 0.02 | 0.058 | 0.058 | 0.22 | 0.0405 | 62 |
| Benzo(ghi)perylene | 0.01 | 0.07 | 0.066 | 0.066 | 0.168 | 47 |
| Benzo(k)fluoranthene | 0.01 | 0.11 | 0.058 | 0.25 | 0.043 | 26 |
| Chrysene | 0.0383 | 0.078 | 0.078 | 0.12 | 0.038 | 21 |
| Dibenz(a,h)anthracene | 0.0054 | 0.0054 | 0.0159 | 0.0159 | 0.02 | 2.9 |
| Fluoranthene | 0.0003 | 0.12 | 0.12 | 0.21 | 0.0905 | 166 |
| Fluorene | 0.0429 | 0.0429 | 0.0097 | 0.0097 | 0.022 | 3.3 |
| Indeno(1,2,3-cd)pyrene | 0.01 | 0.063 | 0.063 | 0.1 | 0.093 | 61 |
| Naphthalene | 0.0038 | 0.0462 | | | 0.0113 | 0.66 |
| Phenanthrene | 0.03 | 0.048 | 0.048 | 0.14 | 0.071 | 36 |
| Pyrene | 0.001 | 0.099 | 0.099 | 0.15 | 0.072 | 147 |

Sources:


Canadian Environmental Protection Act. 1994. Priority Substances List Assessment Report – Polycyclic Aromatic Hydrocarbons. Government of Canada.

Bradley, L.J.N., B.H. Magee, and S.L. Allen. 1994. "Background Levels of Polycyclic Aromatic Hydrocarbons (PAH) and Selected Metals in New England Urban Areas." *Journal of Soil Contamination.* Volume 2, Number 4. Pages 1-13.

Butler, J.D., V. Butterworth, S.C. Kellow, and H.G. Robinson. 1984. "Some Observations on the Polycyclic Aromatic Hydrocarbon (PAH) Content of Surface Soils in Urban Areas." *The Science of the Total Environment.* Volume 33. Pages 75 through 85.

Edwards, N.T. 1983. "Polycyclic Aromatic Hydrocarbons (PAH) in the Terrestrial Environment – A Review." *Journal of Environmental Quality.* Volume 12. Number 4.

Jones, C.J., J.A. Stratford, K.S. Waterhouse, E.T. Furlong, W. Giger, R.A. Hites, C. Schaffer, and A.E. Johnston. 1989a. "Increases in the Polynuclear Aromatic Hydrocarbon Content of an Agricultural Soil over the Last Century." *Environmental Science and Technology.* Volume 23. Pages 95 through 101.

## TABLE 2 (Continued)

## RESULTS OF LITERATURE SEARCH FOR BACKGROUND CONCENTRATIONS OF POLYCYCLIC AROMATIC HYDROCARBONS IN SOILS WORLDWIDE

Sources: (Continued)

Jones, C.J., J.A. Stratford, K.S. Waterhouse, and N.B. Vogt. 1989b. "Organic Contaminants in Welsh Soils: Polynuclear Aromatic Hydrocarbons." *Environmental Science and Technology*. Volume 23. Pages 540 through 550.

Massachusetts Department of Environmental Protection. 1997. "Proposed Changes: Supplement to the Guidance for Disposal Site Risk Characterization." May.

PRC Environmental Management (PRC). 1995. "Preliminary Assessment Draft Final Summary Report – Ordnance Sites." May 15.

U.S. Department of Health and Human Services. 1995. "Toxicological Profile for Polycyclic Aromatic Hydrocarbons." Research Triangle Institute. August.

Vogt, N.B., F. Brakstad, K. Thrane, S. Nordenson, J. Krane, E. Aamot, K. Kolset, K. Esbensen, and E. Steinnes. 1986. "Polycyclic Aromatic Hydrocarbons in Soil and Air: Statistical Analysis and Classification by the SIMCA Method." *Environmental Science and Technology*. Volume 21. Pages 35 through 44.

## TABLE 3

## BACKGROUND CONCENTRATIONS OF POLYCYCLIC AROMATIC HYDROCARBONS IN SOILS IN SOUTHERN CALIFORNIA
### (All Concentrations in mg/kg)

| Analyte | Low | High |
|---|---|---|
| Anthracene | 0.03 | 2.2 |
| Benzo(a)anthracene | 0.0007 | 2 |
| Benzo(a)pyrene | 0.0011 | 3 |
| Benzo(b)fluoranthene | 0.001 | 2 |
| Benzo(ghi)perylene | 0.0022 | 3.6 |
| Benzo(k)fluoranthene | 0.0008 | 1.5 |
| Chrysene | 0.00735 | 3.2 |
| Dibenzo(a,h)anthracene | 0.00184 | 2.2 |
| Fluoranthene | 0.0028 | 6 |
| Fluorene | 0.0194 | 0.14 |
| Indeno(1,2,3-cd)pyrene | 0.00734 | 5.9 |
| Naphthalene | 0.0754 | 1.63 |
| Phenanthrene | 0.0131 | 1.93 |
| Pyrene | 0.0027 | 12.1 |

Source:

Tetra Tech EM Inc. 1997. "Draft Remedial Action Plan for the Former Alhambra Manufactured Gas Plant Site, Alhambra, California." January 31. (As summarized in Tetra Tech EMI. 1998)

## APPENDIX H
## STATISTICAL ANALYSIS OF SITE DATA AND BACKYARD SAMPLING APPROACH

## INTRODUCTION

The Navy requested a professional statistician employed by IT Corporation, and technical staff at Tetra Tech EM Inc., to prepare a sampling design and cost analysis for evaluating the presence of hazardous debris and concentrations of lead, polychlorinated biphenyls (PCB), and polycyclic aromatic hydrocarbons (PAH) in soils in 685 backyards outside of the known solid waste disposal areas at Site 12, Treasure Island. Details of the sampling design, and a summary of the estimated costs associated with different remedial alternatives for reducing risk from debris and chemical contaminants, are provided below.

## OVERVIEW OF THE PROPOSED SAMPLING DESIGN

A conceptual model was prepared that outlines a tiered scheme of sampling and analysis that could be used to assess the levels of both debris and chemical contaminants within 685 backyards at Site 12 (see Figure H-1). The main elements presented in the conceptual model are (1) that the design should have a reasonable assurance of detecting some predetermined threshold level of debris (based on either the presence or absence of different types of debris or estimates of their densities), (2) that the size of the largest unsampled area within a backyard be reasonably small (no greater than 4 feet, based on the diameter of a circular target), and (3) that a sufficient number of samples be collected in order to be able to reliably compare the mean concentration of contaminants within individual backyards to a set of appropriate cleanup standards (CS). An auxiliary requirement for comparing the mean concentrations with the CS, is that the maximum concentration within a backyard should not exceed any individual CS by a factor of more than 1.5. The CS evaluated for each contaminant was 400 milligrams per kilogram (mg/kg) for lead; 1 mg/kg for PCBs (as the sum of Aroclors); and 0.62 mg/kg for PAHs (expressed as benzo-α-pyrene equivalents [BAPE]).

A preliminary analysis of existing data on soil concentrations of lead, PCBs, and PAHs from areas within Site 12 was conducted to assess the spatial distribution and variability of the data. This analysis included modeling the relationship between the mean and variance of contaminant concentrations at different spatial scales, as well as the use of a beta-binomial model to estimate the probabilities that either individual samples or the mean of all samples within a backyard would exceed the thresholds established for any CS. The beta-binomial is a mixture distribution obtained by mixing the probability of success for Bernoulli trials over the beta distribution. That is, the beta-binomial assumes independent trials, but with randomly varying probabilities. Two alternative data sets were used in these models to represent a "worst-case" scenario and a "most likely case." The "worst-case" scenario was intended to provide more conservative estimates of the number of backyards that would require remediation following sampling and analysis for debris and soil contaminants. The construction of data sets to evaluate both of these scenarios is described in more detail below.

.

Following the requirements outlined in the conceptual model, three criteria must be met for clearance (that is, concluding that a backyard is "clean" and does not require remediation) of a backyard:

1. Backyards must not contain unacceptable levels of hazardous debris.

2. No individual sample can exceed a CS for chemical contaminants by more than a factor of 1.5 (this is equivalent to testing the maximum concentration in a backyard against 1.5 times the CS).

2. The mean concentrations of contaminants in each backyard must be demonstrably less than their respective CS. The null hypothesis ($H_0$) being tested is that the mean concentration in a backyard is greater than or equal to the CS. The alternative hypothesis ($H_A$) is that the mean concentration in a backyard is less than the CS.

The size of the largest unsampled area is not a decision criterion in this scheme. The maximum target size of 4 feet is treated as a fixed requirement that must be satisfied by the minimum required sample size, calculated based on testing the mean chemical concentrations against the CS. The maximum target size of 4 feet was selected to be protective and reduce the uncertainty associated with the contaminant distribution.

The proposed design includes multiple tiers of testing and analysis, both on site and at an off-site analytical laboratory. The on-site component includes a screen for hazardous debris, as well as a screen for the presence of unacceptable concentrations of lead and PCBs in soil. The off-site component evaluates concentrations of PAHs in soil. Segregating the sampling and analysis into on-site and off-site components is intended to increase the efficiency and lower the overall costs. That is, analysis of samples for debris, lead, and PCBs can be conducted in the field at a relatively low cost. The analysis for PAHs, however, needs to be conducted in an analytical laboratory, and the associated costs are considerably higher. The proposed design minimizes the total number of samples sent for off-site analysis, by only analyzing PAHs in samples from backyards that have already passed the screens for debris, lead, and PCBs.

## CALCULATING THE MINIMUM NUMBER OF SAMPLES REQUIRED

Systematic sampling on a square grid with a random start provides the most efficient design for meeting each of the performance criteria presented in the conceptual model. Sampling will be conducted at three depth intervals within each backyard: 0 to 1.0 foot below ground surface (bgs), 1.0 to 2.0 feet bgs, and 2.0 to 4.0 feet bgs.

The minimum number of samples and grid spacing for the design were selected by first calculating the overall density of samples that would be needed to assure that the largest unsampled area would not exceed a circular target with a diameter of 4 feet. The "hotspot" detection algorithms in Version 1.0 of the software program Visual Sampling Plan (VSP) were used for this purpose (Davidson et al. 2001). VSP was written to support the efficient development of sampling designs under the data quality objectives (DQO) process. The number of samples and grid dimensions that would be required to be able to detect circular targets with diameters ranging from 2.0 to 5.0 feet with a probability of 95 percent are presented in Table H-1 (output from VSP program). For these calculations, an average backyard of 20 by 25 feet (500 square feet) was assumed. For 4-foot circular targets, at least 48 samples would be required for each depth interval. This would require samples to be evenly spaced over a square grid with a distance between adjacent samples of approximately 3.34 feet. The relationship between sample size or grid density and the probability of detecting a circular target of 4 feet is illustrated on Figure H-2.

Once the "fixed" requirement of 48 samples per depth interval per backyard was established, the next step was to ensure that this sample size would be adequate for performing tests of the mean concentration of contaminants against the CS. Sample-size calculations were performed in VSP for a range of scenarios by varying input assumptions concerning the Type I and II decision errors that could be tolerated (decision errors are discussed in more detail below), effect-size (width of gray region), and the underlying variability of the data (Table H-2). The Type I decision error, α, which is the probability of incorrectly concluding that a "dirty" backyard is "clean," was set at 0.05 (probability of 5 percent of committing a "false negative" error). The Type II decision error, β, which is the probability of incorrectly concluding that a "clean" backyard is "dirty," was set at two levels (0.20 and 0.10) for all calculations (probabilities of committing "false positive" errors of 20 and 10 percent). This corresponds to a power (1-β) for testing the mean against the CS using a one-sample t-test of 80 and 90 percent, respectively. Since one important goal of the overall sampling design is to provide a high level of protectiveness, a relatively large effect-size was used in the calculations (30 and 40 percent). The effect-size establishes the width of the gray region shown in DQO decision performance diagrams (see Figure H-3), and is equivalent to the minimum difference that can be detected with some stated probability between the sample mean (hypothesized true mean) and the CS. Increasing the effect-size or gray region can lower the minimum number of samples needed to test the mean against the CS, but at the expense of increasing the false positive error rate (probability of concluding that a "clean" site is "dirty"). Increasing the false positive error rate was judged to be an acceptable tradeoff in order keep the Type I error rate low and at the same time minimize the number of samples that would be required. Lastly, the expected variability in the data was estimated by assuming values for the coefficient of variation (standard deviation expressed as a proportion of the mean) between 0.50 (low variability) to 4.0 (high variability).

Table H-2 presents a range of minimum sample sizes that would be required for various combinations of the input parameters (assumptions) described above. The range of numbers in this table was compared to the minimum sample size of 48 that would be required to detect a 4-foot circular target with a probability of 95 percent. It can be seen that 45 samples would be required to have a power of 90 percent (this is equivalent to having a confidence level of 90 percent) of correctly rejecting $H_0$ when it is false (correctly concluding that a "clean" backyard is "clean"), given a moderately high level of expected variability (coefficient of variation equal to 1.5) and an effect size of 40 percent. Therefore, a minimum sample size of 48 samples per depth interval was considered adequate to satisfy the performance requirements for testing the mean against the CS, as well as to ensure that the size of the largest unsampled area would not be greater than 4 feet.

## DESCRIPTION OF THE TIERED TESTING DESIGN

A flow diagram showing the proposed tiered-testing scheme is provided on Figure H-4. Additional details of the three tiers of testing and analysis for both the on-site and off-site components of the design are provided below.

### ON-SITE TESTING AND ANALYSIS

Tier 1: Screen for unacceptable levels of hazardous debris. A protocol would be developed for establishing threshold levels of debris based on either the presence or absence of different categories of debris or the relative densities (counts) of each debris type. Screening for debris would be conducted as both an initial step (surface screen only) and as part of the screen for chemical contaminants (at depths ranging from 0 to 4 feet bgs).

Tier 2: Comparison of concentrations of lead and PCBs in individual samples against the respective CS for each contaminant. Backyards where at least one sample exceeds the CS by a factor greater than 1.5 would be remediated.

Tier 3: Comparison of the mean for all samples in a backyard to the CS. If the mean of all samples in a backyard exceeds the CS (based on the results of a one-sample t-test), then the backyard is remediated. For backyards that pass the Tier 3 screen, samples are then sent to an off-site analytical laboratory where they are analyzed for PAHs.

### OFF-SITE TESTING AND ANALYSIS

Only those samples that pass the first three tiers described for the on-site component are sent to the off-site laboratory for additional screening of PAHs. Tiers 2 and 3, as described above, are repeated for the PAH screen. The decision criteria for accepting (or rejecting) a backyard as "clean" (or "dirty") are identical to those described for the lead and PCB screen.

## ESTIMATION OF THE NUMBER OF BACKYARDS THAT WOULD REQUIRE REMEDIATION

Figure H-4 provides estimates of the number of backyards that would require remediation based on the results of the screens conducted under each tier of the on-site and off-site testing. These estimates are provided as a range, where the lower bound is the number of backyards estimated to require remediation based on the "most likely case" and the upper bound is the estimate derived under the "worst-case" scenario. The two sets of estimates were obtained by varying the input data used in the computer simulations. For the high-end estimates ("worst-case"), the input data set included samples from the known solid waste disposal areas described in the EE/CA. Estimates for the "most-likely case" were obtained by excluding samples from the known solid waste disposal areas from the input data sets. Both the lower and upper estimates of the number of backyards requiring remediation were used to prepare the cost estimates described at the end this document.

.

## DECISION ERRORS FOR THE PROPOSED DESIGN

The DQO process states that decision errors for sampling designs should be explicitly defined under Step 6 (Specify Tolerable Limits on Decision Errors) as a means of establishing performance goals and for limiting uncertainty in the collected data. Decision errors are generally expressed as the probability of making incorrect decisions based on the implementation of a clearly defined sampling and analysis plan. Detailed discussion of the DQO process and of decision errors is contained in EPA (2000a, 2000b). Definitions of decision errors within the context of the proposed sampling design for Site 12, along with a layman's explanation of the relative importance of each decision error, are provided on Figure H-5 and briefly discussed below.

As shown on Figure H-5, the Type I or "false negative" decision error is considered the more serious error for the present design, as the consequence of falsely concluding that a "dirty" site is "clean" could result in unacceptable risk to human health and the environment. Therefore, to the extent practicable, the tolerable limit on this decision error has been set so as not to exceed 5 percent. The Type II or "false positive" decision error has important economic consequences, as falsely concluding that a "clean" site is "dirty" may result in unnecessary and costly remediation. Based on a detailed evaluation of existing data for Site 12, it was concluded that the high expected underlying variability in the distribution of contaminant concentrations would result in very large predicted Type II error rates for the present design. Moreover, it was concluded that further design enhancements, such as increasing the density of samples, would not result in appreciable reduction of this error rate, at least until the sampling frequency was raised to a point at which the overall costs would clearly be prohibitive.

An additional, but substantially more complicated source of uncertainty to address for any sampling design that might be proposed, is the likelihood that backyards that are cleared (declared to be "clean") would not yield soil concentrations that exceed the CS based on any future analysis of random, grab samples. The probabilities associated with this analysis would be difficult, if not impossible, to calculate with any degree of accuracy. The collection and analysis of a relatively large number of discrete samples, and at a very fine grid-spacing (3.34 feet between samples), is believed to offer an acceptably low probability of failing to detect areas within each backyard that may contain elevated levels of one or more contaminants. However, the possibility that cleared backyards may still pose some unacceptable, albeit poorly quantified, risk was taken into account when drawing conclusions with respect to the technical feasibility and cost-effectiveness of the remedial alternatives discussed in the next section.

.

## COST ANALYSIS FOR THE PROPOSED DESIGN

A cost analysis was performed to evaluate the relative costs of conducting exhaustive sampling and analysis (as shown in Figure H-4) of all 685 backyards within Site 12 versus not sampling and simply conducting a blanket remediation of all backyards. Cost estimates were made for two remedial alternatives: (1) construction of patios (capping), and (2) excavation of backyards. Cost estimates were calculated for two options under both the patio construction and excavation alternatives. For the patio construction alternative the options are: Option 1, concrete would be poured in place, and Option 2, construction using precast concrete. For the excavation alternative the options are: Option 1, excavation down to 2-feet bgs, and Option 2, excavation down to 4-feet bgs. Ranges for the cost estimates in the following table were calculated using the "most likely" and "worst-case" predictions of the number of backyards that would require remediation based on the results of sampling and analysis for debris and chemical contaminants in soil.

A summary of the assumptions used in this cost analysis and estimated total costs are shown in the following table. When a range is given for a cost estimate in the table below, the first amount corresponds to the cost associated with the "most likely case" and the second amount corresponds to the cost associated with the "worst-case" scenario previously described. It should be noted that off-site analytical costs for the "most-likely case" are higher than for the "worst-case," as this reflects the greater number of backyards that pass the first three tiers of the on-site screening. For the patio construction option, the additional costs for the off-site analytical component are also reflected in slightly higher total costs for the "most-likely case" scenario compared to the "worst-case" scenario.

.

| Assumptions Used in Cost Analysis | |
|---|---|
| Number of backyards | 685 |
| Number of depth horizons | 3 |
| Number of samples per depth | 48 |
| Number of samples per backyard | 144 |
| Per Sample Collection Cost (punch auger) | $15 |
| Cost of lead and PCB analysis per sample | $100 |
| Cost of BAPE analysis per sample | $250 |
| Cost of patio construction for one backyard (Option 1) | $6,700 |
| Cost of patio construction for one backyard (Option 2) | $11,900 |
| Cost of excavating one backyard (Option 1- 2-feet bgs) | $12,900 |
| Cost of excavating one backyard (Option 2- 4-feet bgs) | $21,000 |
| **Estimated Total Costs (Option 1- Patio Construction- Poured In Place)** | |
| Cost of sampling 685 backyards | $1,479,600 |
| On-site screening costs for 685 backyards | $9,864,000 |
| Off-site analytical costs for 256-229 backyards | $9,216,000-$8,244,000 |
| Patio construction costs for 469-533 backyards | $3,142,300-$3,571,100 |
| **Total:** | **$23,701,900- $23,158,700** |
| **Estimated Total Costs (Option 2- Patio Construction- Precast)** | |
| Cost of sampling 685 backyards | $1,479,600 |
| On-site screening costs for 685 backyards | $9,864,000 |
| Off-site analytical costs for 256-229 backyards | $9,216,000-$8,244,000 |
| Patio construction costs for 469-533 backyards | $5,581,100-$6,342,700 |
| **Total:** | **$26,140,700- $25,930,300** |
| **Estimated Total Costs (Option 1- Excavation to 2-Feet bgs)** | |
| Cost of sampling 685 backyards | $1,479,600 |
| On-site screening costs for 685 backyards | $9,864,000 |
| Off-site analytical costs for 256-229 backyards | $9,216,000-$8,244,000 |
| Excavation costs for 469-533 backyards | $6,050,100-$6,875,700 |
| **Total:** | **$26,609,700- $26,463,300** |
| **Estimated Total Costs (Option 2- Excavation to 4-Feet bgs)** | |
| Cost of sampling 685 backyards | $1,479,600 |
| On-site screening costs for 685 backyards | $9,864,000 |
| Off-site analytical costs for 256-229 backyards | $9,216,000-$8,244,000 |
| Excavation costs for 469-533 backyards | $9,849,000-$11,193,000 |
| **Total:** | **$30,408,600 - $30,780,600** |

.

The estimated average costs per backyard were calculated by applying the probabilities associated with backyards passing (or failing) each tier of the testing and analysis summarized on Figure H-4. That is, sampling and analytical costs are assessed on a tier-by-tier basis; therefore, costs for tiers beyond tier 1 are contingent upon the number of backyards that successfully pass the screen of the preceding tier(s).

It is estimated that under the proposed sampling and analysis design outlined on Figure H-4, it would still be necessary to remediate between 469 and 533 (68 to 78 percent) of the 685 backyards. The total cost of conducting sampling and analysis for 685 backyards, plus the cost of remediating the 469-533 backyards that fail the screen for hazardous debris or soil chemistry, would range from $23,701,900 to $23,158,700 for patio construction under Option 1 (poured-in-place), and from $26,140,700 to $25,930,300 for patio construction under Option 2 (precast). For the excavation alternative, these same costs would range from $26,609,700 to $26,463,300 under Option 1 (excavation to 2-feet bgs), and from $30,408,600 to $30,780,600 under Option 2 (excavation to 4-feet bgs). The cost of remediating all 685 backyards without conducting any sampling and analysis would be approximately $4,589,500 (685 x $6,700) for patio construction under Option 1 (poured-in-place); $8,151,500 (685 x $11,900) for patio construction under Option 2 (precast); $8,836,500 (685 x $12,900) for excavation under Option 1 (excavation to 2-feet bgs); and $14,385,000 (685 x $21,000) for excavation under Option 2 (excavation to 4-feet bgs).

The option of conducting sampling and analysis plus remediation would, at most, result in 216 to152 backyards that do not require either patio construction or excavation. However, this option would incur from $19,112,400-$18,569,500 to $17,989,200-$17,778,800 in additional costs compared to the alternative of constructing patios under Options 1 and 2, respectively, in all 685 backyards without first conducting sampling and analysis. For the excavation alternative, sampling and analysis plus remediation would cost from $17,773,200-$17,626,800 to $16,023,600-$16,395,600 more under Options 1 and 2, respectively, compared to excavating all backyards without first conducting sampling and analysis. In addition, as mentioned under the discussion of decision errors, for the approximately 216 to152 backyards that would be "cleared" and not remediated under the sampling and analysis option, it cannot be stated with absolute certainty that future random, grab samples collected in these backyards would not yield samples that exceed one or more CS.

## REFERENCES


Davidson Jr., J.R., J.E. Wilson, N.L. Hassig, and R.O. Gilbert. 2001. "Visual Sampling Plan Version 1.0 User's Guide." PNNL-13490. Interim Report. Prepared for the U.S. EPA by the Pacific Northwest National Laboratory. March 2001.

U.S. Environmental Protection Agency (EPA). 2000a. "Data Quality Objectives Process for Hazardous Waste Site Investigations. EPA QA/G-4HW." Office of Environmental Information, Washington, D.C. EPA/600/R-00/007. Final. January 2000.

EPA. 2000b. "Guidance for the Data Quality Objectives Process. EPA QA/G-4." Office of Environmental Information, Washington, D.C. EPA/600/R-96/055. August 2000.

# FIGURE H-1

# CONCEPTUAL MODEL FOR A TIERED DESIGN TO SCREEN FOR PHYSICAL (DEBRIS) AND CHEMICAL HAZARDS

DESIGN OBJECTIVES:

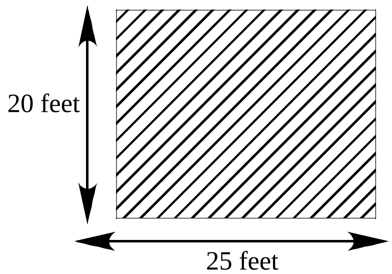
1) Perform Initial Screen of Surface Soil for Debris. Additional Screening of Debris Down to 4 Feet Below Ground Surface Would Occur in Conjunction with Chemical Screening.
2) Assure That the Sampling Density (Grid Spacing) is Adequate to Have a 95 Percent Probability That the Size of the Largest Unsampled Area (Circular Target) is No Greater Than 4.0 Feet in Diameter.
3) Test Hypotheses Concerning the Mean Concentration of Contaminants in Individual Backyards

$H_o$: true mean > cleanup standard

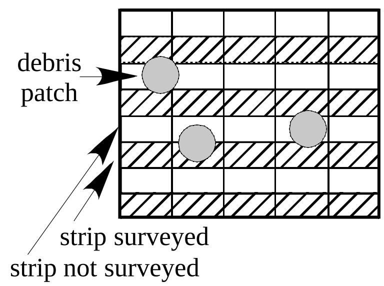
$H_A$: true mean $\leq$ cleanup standard

## Initial Tier to Screen For Debris

Option 1:
Complete Removal of Turf and 100% Screen of Surface Soil



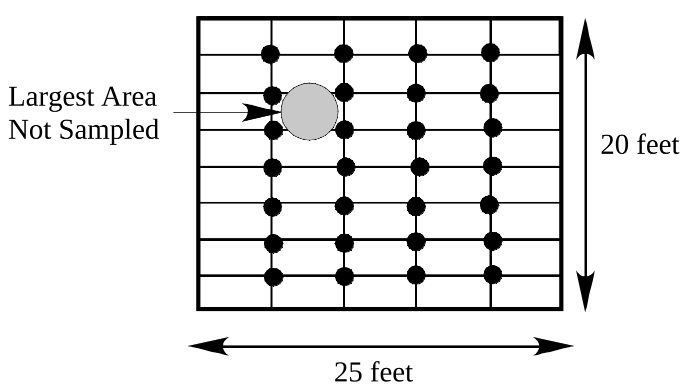

Option 2:
Removal of Turf and Screening of Surface Soil Along Alternating Strips




width and spacing of strips is optimized to assure that 100% of circular targets (debris patches) greater than a specified diameter will be detected

## Additional Tier to Screen for Chemical Contamination

Sampling Based on a Systematic (Square Grid) Design With a Random Starting Position



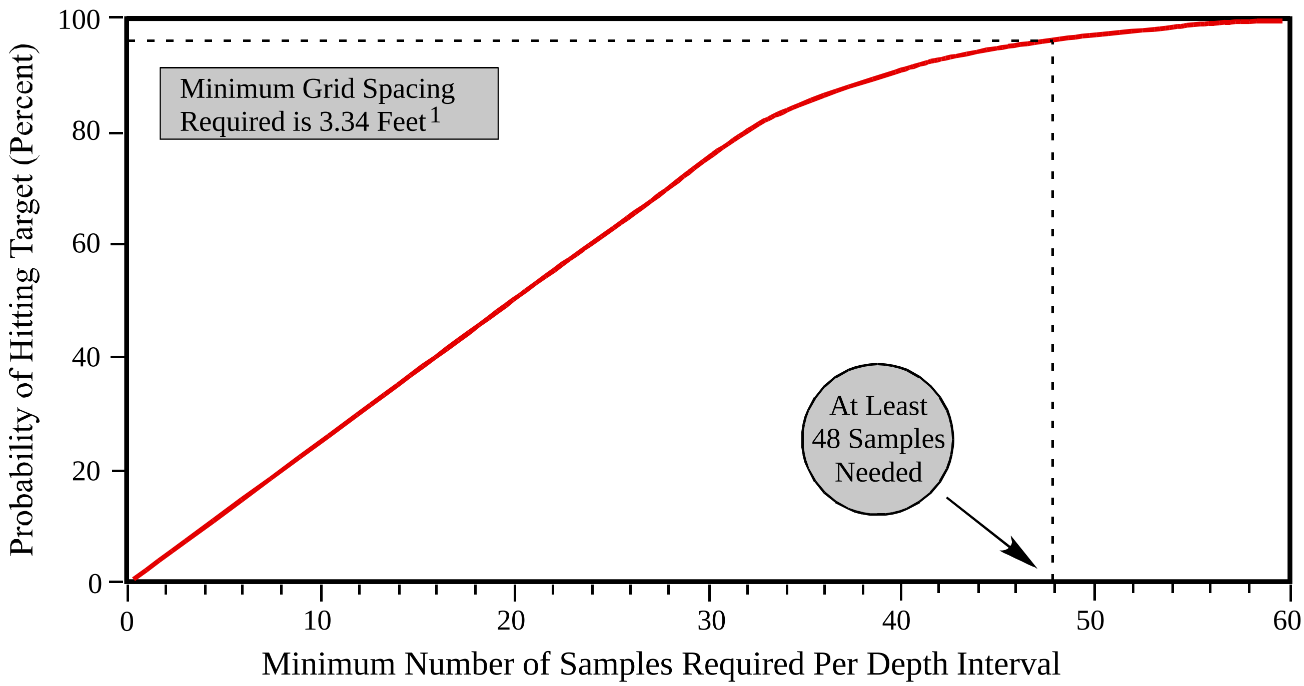

* additional screening of debris (down to 4 feet below ground surface) conducted in conjunction with chemical sampling

Steps:

1. calculate the minimum grid spacing and sample-size required to have a probability of at least 95 percent that the size of the largest unsampled area will be no greater than 4.0 feet (based on a circular target)
2. develop a decision rule for comparing individual samples to the cleanup standards for each chemical
3. determine minimum sample-size required to test the null hypothesis that the true mean concentration in a backyard is greater than the cleanup standard (with fixed Type I & II decision errors and desired effect-size)
4. conduct sampling using cores (punch auger)

**FIGURE H-2**

**PROBABILITY THAT THE LARGEST UNSAMPLED AREA WILL NOT BE GREATER THAN A CIRCULAR TARGET WITH A DIAMETER OF 4.0 FEET**



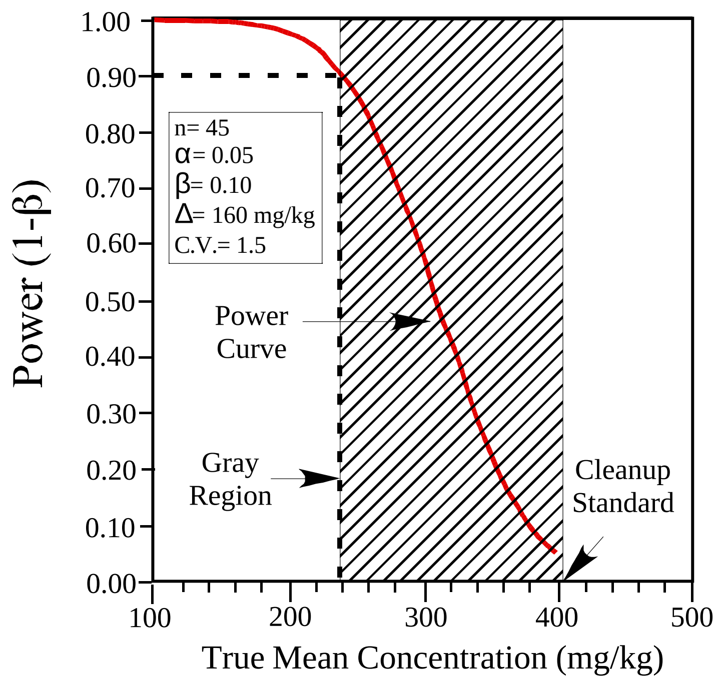

Notes: Dashed line shows the minimum number of samples required to have a probability of 95 percent of detecting a circular target with a diameter of 4.0 feet

[1] One side of a square grid

**FIGURE H-3**

**PROSPECTIVE POWER ANALYSIS TO DETERMINE THE MINIMUM NUMBER OF SAMPLES REQUIRED PER DEPTH INTERVAL TO TEST THE MEAN BACKYARD CONCENTRATION VERSUS THE CLEANUP STANDARD (CS)**

**(EXAMPLE FOR LEAD)**




Notes: Design assumes systematic sampling using a square grid

n is the minimum sample-size required to have a 90 percent probability of correctly rejecting the null hypothesis (mean concentration of lead is greater than the CS) using a one-sample t-test

For mean sample concentrations less than the lower bound of the gray region (240 mg/kg), there is at least a 90 percent chance of rejecting the null hypothesis and concluding that the site concentration is less than the CS. As the mean sample concentration increases above 240 mg/kg, the chance of rejecting the null hypothesis drops precipitously. That is, as values of the sample mean get closer to the CS, it becomes increasingly difficult to declare that the sample mean is statistically lower than the CS.

Δ minimum detectable difference (defines width of gray region)

α alpha, the Type I error rate

β beta, the Type II error rate

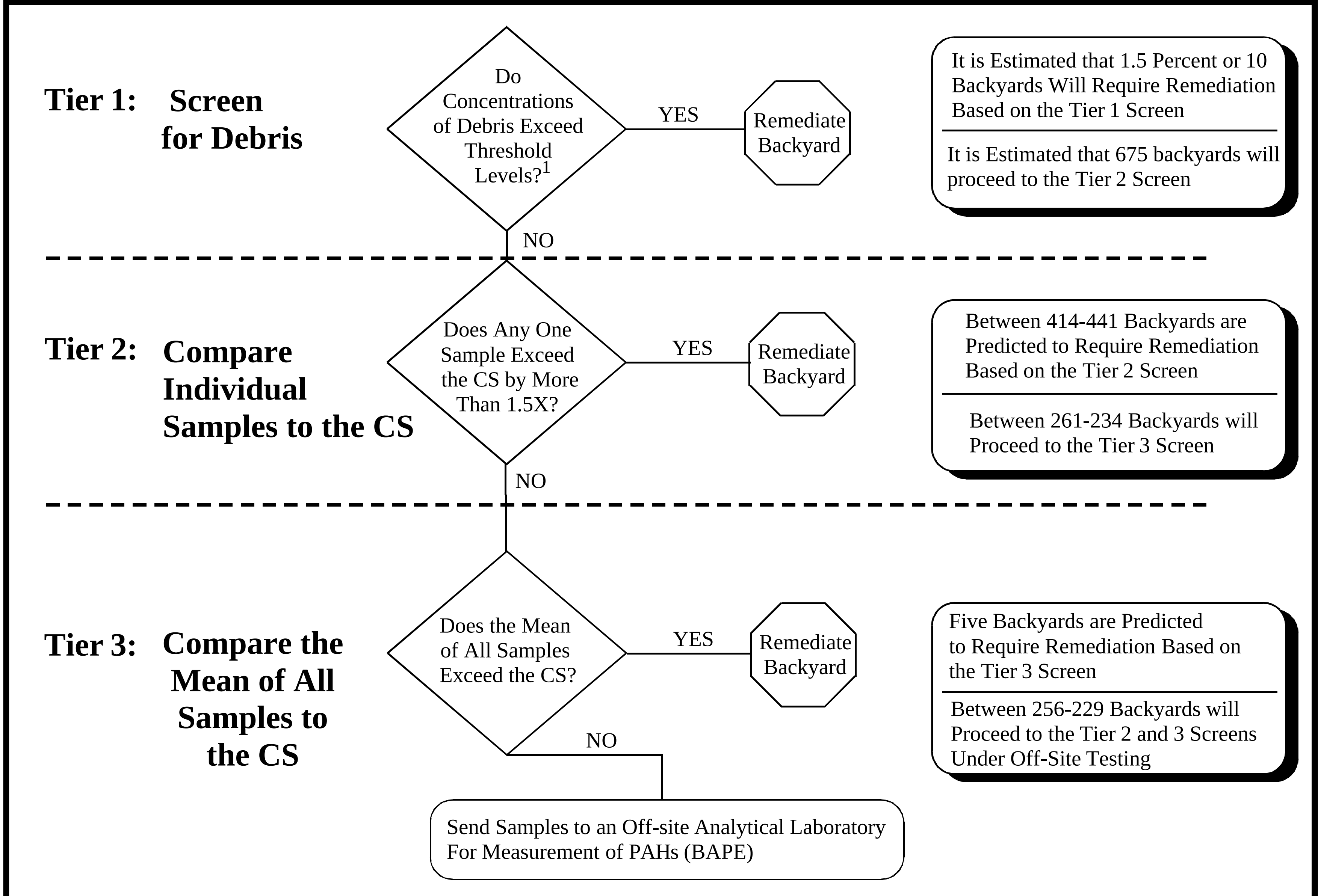
Power (1-β) the probability of correctly rejecting a false null hypothesis

C.V. coefficient of variation (hypothesized standard deviation/ hypothesized mean concentration)

# FIGURE H-4

# TIERED TESTING SCHEME FOR SCREENING SOIL SAMPLES FOR DEBRIS AND CHEMICAL CONTAMINANTS

## ON-SITE TESTING FOR DEBRIS, LEAD, AND PCBs




## OFF-SITE TESTING FOR PAHs (as BAPE)

Off-site Testing of BAPE Would be Accomplished by Repeating Tiers 2 and 3, as Shown Above
The Predicted Outcome of This Screening is Summarized Below:

**Tier 2:** Approximately 38-75 Backyards Would Require Remediation Based on the Tier 2 Screen (Between 218-154 Backyards will Proceed to the Tier 3 Screen)

**Tier 3:** Approximately 2 Backyards Would Require Remediation Based on the Tier 3 Screen (Between 216-152 Backyards will Pass the Tier 3 Screen)

# MAIN CONCLUSIONS

**APPROXIMATELY 469-533 (68-78 PERCENT) OF THE 685 BACKYARDS WOULD REQUIRE REMEDIATION BASED ON THE PROPOSED TIERED-TESTING SCHEME**

**THE APPROXIMATELY 216-152 BACKYARDS THAT PASS THE SCREENS UNDER EACH TIER OF ON-SITE AND OFF-SITE TESTING WOULD NOT REQUIRE FURTHER ACTION**

Notes: [1] A protocol and quantitative decision criteria would be developed for screening debris based on the types and relative concentration (counts) of debris encountered

BAPE Benzo-α-pyrene equivalent

CS Cleanup Standard (lead= 400 mg/kg; PCB= 1 mg/kg; BAPE= 0.62 mg/kg)

PAHs Polycyclic Aromatic Hydrocarbons

PCBs Polychlorinated biphenyl (calculated as the sum of Aroclors)

* estimates provided as ranges give the "most-likely" estimate first, followed by the "worst-case" estimate

# FIGURE H-5
# DECISION ERRORS ADDRESSED THROUGH THE DATA QUALITY OBJECTIVES (DQO) PROCESS

### NULL ($H_0$) AND ALTERNATIVE ($H_A$) HYPOTHESES FOR CONDUCTING THE SCREEN FOR DEBRIS UNDER TIER 1:

| | |
|---|---|
| $H_0$: | Backyard contains unacceptable levels of hazardous debris |
| $H_A$: | Backyard does not contain unacceptable levels of hazardous debris |

### NULL ($H_0$) AND ALTERNATIVE ($H_A$) HYPOTHESES FOR COMPARING THE MEAN CONCENTRATION IN A BACKYARD TO THE CS UNDER TIERS 2 AND 3:

| | |
|---|---|
| $H_0$: | The mean concentration in a backyard > CS[1] |
| $H_A$: | The mean concentration in a backyard ≤ CS |

[1] combined test, where the sample mean is compared to the CS and an auxiliary requirement is that no individual sample exceeds the CS by a factor greater than 1.5

### DECISION ERRORS FOR TESTING $H_0$ AND $H_A$ UNDER TIERS 1-3:

**Conclusion of Test:**

| True State of $H_0$: | Reject $H_0$ | Fail to Reject $H_0$ |
|---|---|---|
| TRUE | Type I Error ($\alpha$) (false negative) | Correct ($1-\alpha$) |
| FALSE | * Correct ($1-\beta$) | Type II Error ($\beta$) (false positive) |

**Interpretation of Decision Errors:**

**Type I Error (false negative):** The probability, $\alpha$, of falsely rejecting a true $H_0$, or incorrectly concluding that a "dirty" backyard is "clean"

**Type II Error (false positive):** The probability, $\beta$, of failing to reject a false $H_0$, or incorrectly concluding that a "clean" backyard is "dirty"

***Power of the Test ($1-\beta$):** The probability of rejecting a false $H_0$, or of correctly declaring that a backyard is "clean" and does not require remediation

**Relative Importance of Type I and II Decision Errors, and Factors that Affect Their Estimation:**

- The Type I (false negative) decision error is considered the more serious decision error under this design, as failure to remediate a "dirty" backyard could result in unacceptable risk to human health. To the extent possible, an attempt has been made to assure that this error rate is no greater than 5 percent.
- The Type II (false positive) decision error has important economic consequences, as falsely concluding that a "clean" backyard is "dirty" results in unnecessary and costly remediation. A technical analysis performed by a professional statistician suggests that very high false positive error rates would be expected for the proposed design.
- The proposed sampling design uses a tiered approach that imposes stringent requirements to assure that the average concentration within a backyard is demonstrably less than the CS before concluding that a backyard is "clean." A further provision of this design, is that the largest unsampled area is reasonably small (less than 4 feet in diameter, based on a circular target).
- The principal factor controlling the false positive error rate for this design is the high expected variability in contaminant concentrations at the spatial scale of an individual backyard. Estimates of the increase in sampling effort (number of samples) needed to reduce the high predicted rate of unnecessary remediation at this site to acceptable levels, suggest that additional sampling and analysis beyond that proposed in the current design could not be justified based on a technical and economic feasibility analysis.

## TABLE H-1

## MINIMUM SAMPLE-SIZES REQUIRED TO ASSURE THAT THE LARGEST UNSAMPLED AREA (TARGET) IS NO GREATER THAN A CIRCLE WITH A SPECIFIED DIAMETER*

| Largest Unsampled Area (Target) (Diameter, Feet) | Grid Length (Feet)[1] | Probability of Detection | Minimum Sample-Size Required[2] |
|---|---|---|---|
| 2.00 | 1.67 | 95 | 180 |
| 2.50 | 2.09 | 95 | 120 |
| 3.00 | 2.50 | 95 | 80 |
| 4.00 | 3.34 | 95 | 48 |
| 5.00 | 4.17 | 95 | 30 |

Notes:

1 One side of a square grid

2 Sampling employs a random start, therefore, a range of sample sizes are possible. Only the maximum estimated sample-sizes are provided. Sample sizes are for each depth interval.

* A hypothetical backyard of 500 square feet (20 X 25 feet) is assumed.

Values were calculated using Version 1.0 of the software package Visual Sampling Plan

## TABLE H-2

## MINIMUM SAMPLE-SIZES REQUIRED FOR SAMPLING BASED ON A SYSTEMATIC GRID AND TESTING THE NULL HYPOTHESIS THAT THE TRUE MEAN CONCENTRATION IN A BACKYARD IS GREATER THAN THE CLEANUP STANDARD

**MINIMUM SAMPLE-SIZES REQUIRED TO DETECT A 30 PERCENT DIFFERENCE IN ANALYTE CONCENTRATION BETWEEN THE TRUE MEAN CONCENTRATION IN A BACKYARD AND THE CLEANUP STANDARD (CS)**

| Minimum Sample-Size Required For Each Sampling Depth Based on One-Sample t-Tests and Specified Power of 80 and 90 Percent | | Coefficient of Variation[1] | Effect Size Expressed in Units of Standard Deviation | Minimum Detectable Difference (Δ) and Assumed Variability in Analyte Concentrations Expressed in Units of Standard Deviation (σ) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Power | | | | Lead (CS= 400 mg/kg) | | PCBs (CS= 1 mg/kg) | | PAHs as BAPE (CS= 0.62 mg/kg) | |
| 0.80 | 0.90 | | Δ/σ | Δ | σ | Δ | σ | Δ | σ |
| 10 | 14 | 0.50 | 0.86 | 120 | 140 | 0.300 | 0.350 | 0.186 | 0.21 |
| 36 | 48 | 1.00 | 0.43 | 120 | 280 | 0.300 | 0.700 | 0.186 | 0.43 |
| 78 | 107 | 1.50 | 0.29 | 120 | 420 | 0.300 | 1.050 | 0.186 | 0.65 |
| 136 | 188 | 2.00 | 0.21 | 120 | 560 | 0.300 | 1.400 | 0.186 | 0.86 |
| 305 | 421 | 3.00 | 0.14 | 120 | 840 | 0.300 | 2.100 | 0.186 | 1.30 |
| 540 | 748 | 4.00 | 0.11 | 120 | 1120 | 0.300 | 2.800 | 0.186 | 1.73 |

**MINIMUM SAMPLE-SIZES REQUIRED TO DETECT A 40 PERCENT DIFFERENCE IN ANALYTE CONCENTRATION BETWEEN THE TRUE MEAN CONCENTRATION IN A BACKYARD AND THE CLEANUP STANDARD (CS)**

| Minimum Sample-Size Required For Each Sampling Depth Based on One-Sample t-Tests and Specified Power of 80 and 90 Percent | | Coefficient of Variation[1] | Effect Size Expressed in Units of Standard Deviation | Minimum Detectable Difference (Δ) and Assumed Variability in Analyte Concentrations Expressed in Units of Standard Deviation (σ) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Power | | | | Lead (CS= 400 mg/kg) | | PCBs (CS= 1 mg/kg) | | PAHs as BAPE (CS= 0.62 mg/kg) | |
| 0.80 | 0.90 | | Δ/σ | Δ | σ | Δ | σ | Δ | σ |
| 5 | 7 | 0.50 | 1.33 | 160 | 120 | 0.400 | 0.300 | 0.248 | 0.18 |
| 16 | 21 | 1.00 | 0.67 | 160 | 240 | 0.400 | 0.600 | 0.248 | 0.37 |
| 33 | 45 | 1.50 | 0.44 | 160 | 360 | 0.400 | 0.900 | 0.248 | 0.55 |
| 57 | 79 | 2.00 | 0.33 | 160 | 480 | 0.400 | 1.200 | 0.248 | 0.74 |
| 127 | 175 | 3.00 | 0.22 | 160 | 720 | 0.400 | 1.800 | 0.248 | 1.11 |
| 224 | 310 | 4.00 | 0.17 | 160 | 960 | 0.400 | 2.400 | 0.248 | 1.48 |

Notes: Null hypothesis (Ho) is that the true mean or median concentration in a backyard is greater than or equal to the CS; alternative hypothesis (HA) is that the mean concentration in a backyard is less than the CS

1 Standard deviation for hypothesized true mean of an individual backyard/hypothesized true mean of an individual backyard

Δ Minimum detectable difference, which is equivalent to the width of the gray region in DQO terminology

σ Standard deviation of the hypothesized true mean concentration within a backyard

BAPE Benzo-α-pyrene equivalent

CS Cleanup standard

DQO Data Quality Objectives

PAHs Polycyclic aromatic hydrocarbons

PCBs Polychlorinated biphenyl (calculated as the sum of Aroclors)