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RISK ASSESSMENT REPORT AND FOCUSED FEASIBILITY STUDY FOR THE DEFENSE REUTILIZATION AND MARKETING OFFICE (DRMO) CNC CHARLESTON SC

02/11/1987

ENVIRONMENTAL SCIENCE AND ENGINEERING. INC.

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AND ENGINEERING, INC.

February 11, 1987
ESE No. 87-212-0100-2150

Naval Facilities Engineering Command
Southern Division
Attn: Gale Evans
Corporate Square 1
Suite 209
2420 Mall Drive
Charleston, SC 29406

Subject: Contract No. N62467-85-D-0268; Amendment #10, Risk Assessment Report and Focused Feasibility Study for the Defense Reutilization and Marketing Office, Charleston, SC

Dear Ms. Evans:

Pursuant to the subject contract, enclosed are five copies of the 100% Draft Feasibility Study and RAR. The document has also been distributed to the individuals indicated in the subject contract. Please send your comments to me at the letterhead address.

Sincerely,

Leonard C. Carter

Leonard C. Carter, P.E.
Staff Engineer

enclosure

cc: Mr. Jim Wheat (DRMO) - 2 copies
NAVSHIPYD Charleston

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DEFENSE REUTILIZATION AND MARKETING OFFICE
FOCUSED FEASIBILITY STUDY

Prepared for:

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SOUTH CAROLINA

Prepared by:

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
Gainesville, Florida

ESE No. 87-212-0100-2150

March 1987

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1.0 INTRODUCTION

This focused feasibility study (FS) was conducted to implement the recommendations presented in the "Contamination and Exposure Assessment for the Lead Contamination Within the Defense Reutilization and Marketing Office" (DRMO) report (1986). The recommendations in that report were based on an assessment of the areal and vertical extent of lead contamination in soils, lead content of dust in the DRMO buildings, and lead content of ambient suspended particulates both indoors and outdoors. The assessment also included an evaluation of the potential for human exposure to the lead and a hazard assessment. The exposure and hazard assessment resulted in a determination of an appropriate response level for remedial decontamination action at the site for the soils and the dust within the buildings.

In accordance with the recommendations in the above referenced study, the remedial alternatives in this FS include soil excavation and offsite disposal, vacuuming of the area of highest contamination in combination with soil excavation, installation of an impervious cover over contaminated areas, and removal of accumulated dust in the DRMO buildings.

2.0 DEFENSE REUTILIZATION AND MARKETING OFFICE (DRMO) FOCUSED FEASIBILITY STUDY (FS)

2.1 OBJECTIVES

The objectives of the focused FS for the DRMO site are to:

1. Evaluate currently available and demonstrated treatment technologies for source control and migration control measures that will meet the response objectives identified in the "Contamination and Exposure Assessment for the Lead Contamination Within the Defense Reutilization and Marketing Office" report (1986),
2. Assemble applicable remedial technologies into remedial action alternatives, and
3. Recommend the most cost-effective remedial alternative based on the screening and detailed development and evaluation of remedial alternatives.

The following steps were conducted in preparing the focused FS:

1. Available treatment technologies were evaluated for remediation applicability based on site characteristics, waste characteristics, and demonstrated performance of the technology. For the focused FS, no innovative technologies, in situ treatment, or direct waste treatment technologies were considered. Only technologies considered applicable to soil remediation were identified.
2. Remediation alternatives based on the identified technologies and actions were assembled.
3. The alternatives were screened for technical, environmental/institutional, and order-of-magnitude cost.
4. Alternatives passing the initial screening were refined and evaluated in detail with respect to safety, engineering, human health and environmental protection, environmental effects, compliance with regulations, and detailed comparative cost.
5. Based on the results of the detailed evaluation, the recommended alternative was identified.

The methods used by Environmental Science and Engineering, Inc. (ESE) for identifying and evaluating remedial alternatives are discussed in subsequent sections of the focused FS report.

2.2 RISK ASSESSMENT

The evaluation of a maximum safe contaminant level for lead is described in Section 5 of the "Contamination and Exposure Assessment for the Lead Contamination Within the Defense Reutilization and Marketing Office" report (1986), and the reader is referred to that report for details of evaluation. The remedial response objectives for the DRMO site are:

1. Upon completion of remediation, workers in the DRMO area should not be exposed to contamination levels which pose a significant health risk;
2. Air quality within the DRMO area should not exceed ambient air quality standards; and
3. Ground water should not exceed water quality criteria.

Table 2.2-1 summarizes the maximum permissible soil lead levels derived for each exposure pathway. The values given in the table are the maximum soil lead levels that would not be expected to result in a potential adverse effect to human health or environmental degradation via the specified exposure pathway. As shown, the lowest recommended soil lead level is approximately 3,000 milligrams (mg) lead/kilogram (kg) soil; therefore, cleanup of contaminated soils containing lead levels greater than 3,000 mg lead/kg soil would eliminate the potential for adverse effects to human health and/or environmental degradation. Based on professional judgment, a concentration of 1,000 mg lead/kg soil is recommended as the response level for remediation of contaminated soils.

The contamination investigation and exposure assessment resulted in a determination that existing lead contamination in soils and dust presents a potential risk to human health and/or environmental degradation. Recommended actions in the report were as follows:

Table 2.2-1. Maximum Permissible Soil Lead Levels Derived for Each Exposure Pathway

Exposure Pathway	Recommended Maximum Permissible Soil Lead Level (mg lead/kg soil)
Occupational Exposure to Workers	
Inhalation	6,500*; 5,000†
Incidental Igestion	7,800
Concurrent Inhalation + Ingestion	3,500
Protection of Ambient Air Criterion	140,000
Protection of Ground Water Criterion	3,100

*Based on workday and acceptable daily intake assumptions.
†Based on ratio of suspended particulate threshold limit value (TLV) and lead TLV.

Source: ESE, 1986.

1. Perform a focused FS to determine the most effective and economical method of remediation. Remedial alternatives should include consideration of the following:
   a. Soil excavation to 1 foot (ft) depth within the area of the 1,000 mg lead/kg soil isopleth. Following testing for hazardous characteristic, soil disposal would be offsite at a hazardous waste disposal facility.
   b. Wet scrubbing/sweeping of the area of highest contamination in front (north) of the former bin storage area. Soil excavation to a depth of 1 ft along the drainage way in back (south) of the bin area.
   c. Installing an impervious covering (e.g., asphalt) over the contaminated area.
2. Based on the focused FS, implement remedial decontamination action of soils having lead concentrations greater than 1,000 mg/kg and accumulated dust in the DRMO buildings.

3.0 DEVELOPMENT OF REMEDIATION ALTERNATIVES

To achieve the remedial response objectives, remedial response actions and applicable, demonstrated technologies were evaluated. Table 3.1-0 lists the technologies capable of achieving the response objectives for remediation based on demonstrated use of the technology; site geological, hydrological, and hydrogeological characteristics; and contaminant characteristics. Based on engineering judgment, selected technologies were assembled to form remediation alternatives for the DRMO focused FS. A description of the available remediation technologies and alternatives assembled for the DRMO site follows.

3.1 APPLICABLE REMEDIAL TECHNOLOGIES

3.1.1 Asphalt Capping

Asphalt cement or other related bituminous membranes can be applied as a cover or cap. Special equipment is required for application. Asphalt membranes are blown with a hot phosphoric catalyst and are solidified by cooling. Asphalt cement must be produced in a kiln, applied with a paving machine, and compacted by a roller. Generally, asphalt is an expensive cover top and subject to attack by petroleum distillates and solvents.

3.1.2 Excavation

Excavation is the process of removing soil, rock, or other materials. Excavation and removal followed by land disposal or treatment are performed extensively in hazardous waste site remediation. Excavation is a common technique used in earth-moving projects. Excavation on a large scale is achieved mechanically by conventional heavy construction equipment.

The three types of excavation machinery used for excavation and loading are:

1. Backhoes,
2. Cranes/shovels, and
3. Bulldozers/loaders.

Table 3.1-0. Applicable Soil and Dust Remediation Technologies

Response Action	Technology
Capping	Asphalt capping
Removal	Excavation Vacuuming
Offsite Disposal	Material transport Secure landfill
Surface Water Controls	Dikes and berms Ditches and trenches Grading and revegetation

Source: ESE, 1987.

Excavation and removal can virtually eliminate contamination at a site and the need for long-term monitoring. Once excavation is begun, the time to achieve beneficial results can be short relative to other alternatives. Excavation and removal can be used in combination with most other remedial technologies.

Several disadvantages associated with excavation, removal, and offsite disposal are worker safety, short-term impacts, cost, and institutional aspects. Where highly hazardous or toxic materials are present, excavation can pose a substantial risk to worker safety. Short-term impacts such as fugitive dust emissions, toxic gases, and contaminated runoff are frequently a major concern, and mitigative measures must be implemented.

3.1.3 Vacuuming

Industrial vacuuming services can be obtained through several waste management contractors. An industrial vacuum (Super-Sucker® type) is typically a self-contained, truck-mounted, dry vacuuming system requiring two to three operators. A standard industrial vacuum system can cover up to 80,000 square feet (ft^2) of paved surfaces a day and can easily vacuum up dust and small debris (up to railroad bed-size gravel). It is estimated that 3 days of onsite vacuuming will be necessary to remove the contaminated dust from the paved area of the DRMO site.

3.1.4 Materials Transport

The transportation of hazardous wastes is regulated by the U.S. Department of Transportation (USDOT), the U.S. Environmental Protection Agency (USEPA), state governments, and, in some instances, local ordinances and codes. In addition, more stringent federal regulations govern the transportation and disposal of highly toxic and hazardous materials such as polychlorinated biphenyls and radioactive wastes. Applicable USDOT regulations include:

1. 49 Code of Federal Regulations (CFR) Parts 172-179,
2. 49 CFR Part 1387 [46 Federal Register (FR) 30974, 47073], and
3. USDOT-E 8876.

USEPA regulations under the Resource Conservation and Recovery Act (RCRA) (40 CFR Parts 262 and 263) adopt USDOT regulations pertaining to labeling, placarding, packaging, and spill reporting. These regulations also impose additional requirements for compliance with the manifest system and recordkeeping.

Vehicles for offsite transport of hazardous wastes must be USDOT approved and must display the proper USDOT placard. Liquid wastes must be hauled in tanker trucks that meet requirements and specifications for the waste types. Contaminated soils are hauled in box trailers and drums in box trailers or flatbed trucks. The trucks should be lined with plastic and/or absorbent materials.

Before a vehicle is allowed to leave the site, it must be rinsed or scrubbed to remove contaminants. Both bulk liquid containers and box trailers should be checked for proper placarding, cleanliness, tractor-to-trailer hitch, and excess waste levels. Bulk liquid containers also should be checked for proper venting, closed valve positions, and secured hatches. Box trailers should be checked to ensure liner installation, secured cover tarpaulin, and locked lift gate.

3.1.5 Secure Landfill

Landfill disposal is the most commonly practiced method for municipal, industrial, and hazardous solid wastes. Secure landfills for hazardous wastes are typically constructed with impermeable bottom and side liners, leachate collection and treatment systems, and impermeable caps incorporating surface water controls. RCRA requirements under 40 CFR Part 264 (Subpart N) and associated guidance describe the proper design,

construction, operation, and maintenance of hazardous waste landfills. Liquids, certain highly toxic and/or highly mobile wastes, and reactive wastes are restricted from landfills by RCRA regulations.

The primary advantage of landfilling is the relative low cost compared to incineration or other technologies capable of handling a high volume of contaminated solids. The implementation time is also much shorter than incineration. Standard equipment and materials are used in landfill construction and operation.

3.1.6 Dikes and Berms

Dikes and berms are earthen ridges which divert runoff away from contaminated sites to manmade or natural drainageways. This provides isolation of areas from erosion, surface water infiltration, and offsite transport of contaminants by runoff. Surface water diversion will be necessary during implementation of remedial alternatives to prevent the discharge of contaminated runoff to the Cooper River.

Standard construction techniques and equipment are used for dikes and berms. Density of these structures is dependent on the desired functions and site-specific conditions to be addressed. Stabilization required (seeding, mulching, chemical soil additives, etc.) is a function of the design life of the structure.

Disadvantages of dikes and berms are the inspections and maintenance required to ensure integrity.

3.1.7 Ditches and Trenches

Ditches and trenches are excavated drainageways generally of V-shaped, trapezoidal, or parabolic cross-section design. Ditches are temporary structures; trenches are more permanent and can be used with dikes to provide better erosion control.

Ditches and trenches control surface erosion and infiltration at disposal sites by diverting incoming runon around a site. When placed downslope of a site, ditches and trenches collect and transport contaminated runoff to basins or treatment facilities.

Frequent inspection and maintenance requirements are the primary disadvantage of this technology.

3.1.8 Grading and Revegetation

Grading is the general term for techniques used to reshape the surface of covered materials in order to manage surface water infiltration and runoff while controlling erosion. The spreading and compaction steps used in grading are standard construction techniques. The equipment and methods used in grading are essentially the same for all covered surfaces, but applications of grading technology vary by site. Grading is often performed in conjunction with surface sealing practices and revegetation as part of closure plan implementation.

Regrading is a relatively inexpensive remedial action when suitable cover materials are available onsite or close to the disposal site. It is usually possible to find contractors and equipment locally, thus expediting the work and avoiding extra expenses.

Surface grading serves several functions:

- Reduces ponding, which minimizes infiltration and subsequent differential settling;
- Reduces runoff velocities and consequent soil erosion; and
- Roughens and loosens soils in preparation for revegetation.

Revegetation decreases erosion by wind and water and contributes to the development of a naturally fertile and stable surface environment. Also, the technique can be used to upgrade the appearance of disposal sites that are being considered for various reuse options. Vegetative stabilization (i.e., on a semiannual or seasonal basis) can also be used as a remedial technique for disposal sites.

3.2 DESCRIPTION OF ALTERNATIVES

Selected technologies have been combined into treatment alternatives for remediation of the soil contamination at the DRMO site. The applicable alternatives are summarized in Table 3.2-0 and described in the following paragraphs.

3.2.1 Alternative 1--Soil Excavation

This alternative involves the excavation of the top 1 ft of contaminated soils from the unpaved area within the 1,000 mg lead/kg soil isopleth (see Figure 3.2-1). Contaminated soils will be excavated and hauled to a licensed hazardous waste disposal facility. A 2-inch-wide strip of soil, located between the crane and tracks and the asphalt in the storage area, will be excavated to a depth of 1 ft for disposal. Following excavation, clean backfill will be placed onsite, graded, and revegetated. Surface water diversion technologies are included to prevent site runon and runoff during remediation. Surface water collected will be diverted to a retention pond for percolation and evaporation. Wash water from a vehicle decontamination station also will be diverted to the retention pond.

Visible dust accumulated within the DRMO buildings (see Figure 3.2-2) will be removed by a 2-step process: (1) wet wiping followed by vacuuming when dry, and (2) collected dust and dust collection materials disposed as a hazardous waste. Dust removal from the DRMO building will be included in each alternative for remediation at the site. All remediation equipment will be decontaminated before leaving the site. A post topographic survey will be done to update facility engineerings' drawings.

3.2.2 Alternative 2--Asphalt Scrubbing and Soil Excavation

In this alternative, asphalt paved areas within the former bin storage area (see Figure 3.2-3) will be vacuumed to remove potentially contaminated dust and debris from the surface and from cracks and holes in the asphalt. Surface soils (to 1-ft depth) contaminated at or above 1,000 mg

Table 3.2-0. Summary of Alternatives for Initial Screening

Alternative Number	Description	Source Control		Migration Control		Post-Closure
		Waste Treatment	Waste Isolation	Treatment	Management	
1	Soil excavation, disposal, dust removal	None- disposal	None	Storm water retention	Reroute storm water runon	Maintain storm water management system
2	Soil excavation, disposal, dust removal, asphalt vacuuming	None- disposal	None	Storm water retention	Reroute storm water runon	Maintain storm water management system
3	Asphalt cap over contaminated areas, dust removal	None	Capping	Storm water retention, waste isolation	Reroute storm water runon	Maintain storm water management system and asphalt cap

Source: ESE, 1987.

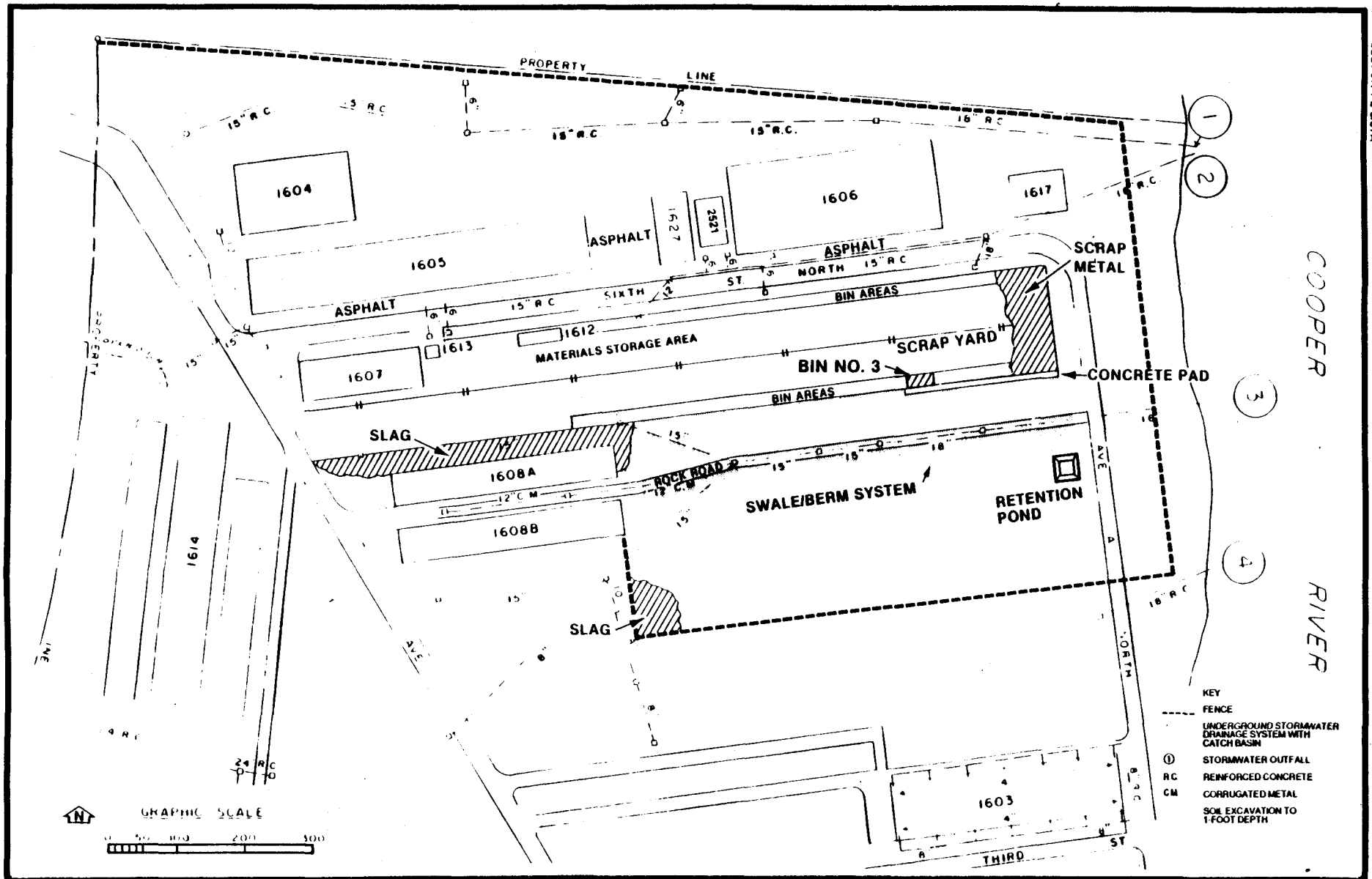

Figure 3.2-1
ALTERNATIVE 1—SOIL EXCAVATION (EXCAVATION TO 1-FOOT DEPTH)

SOURCE: ESE, 1987.

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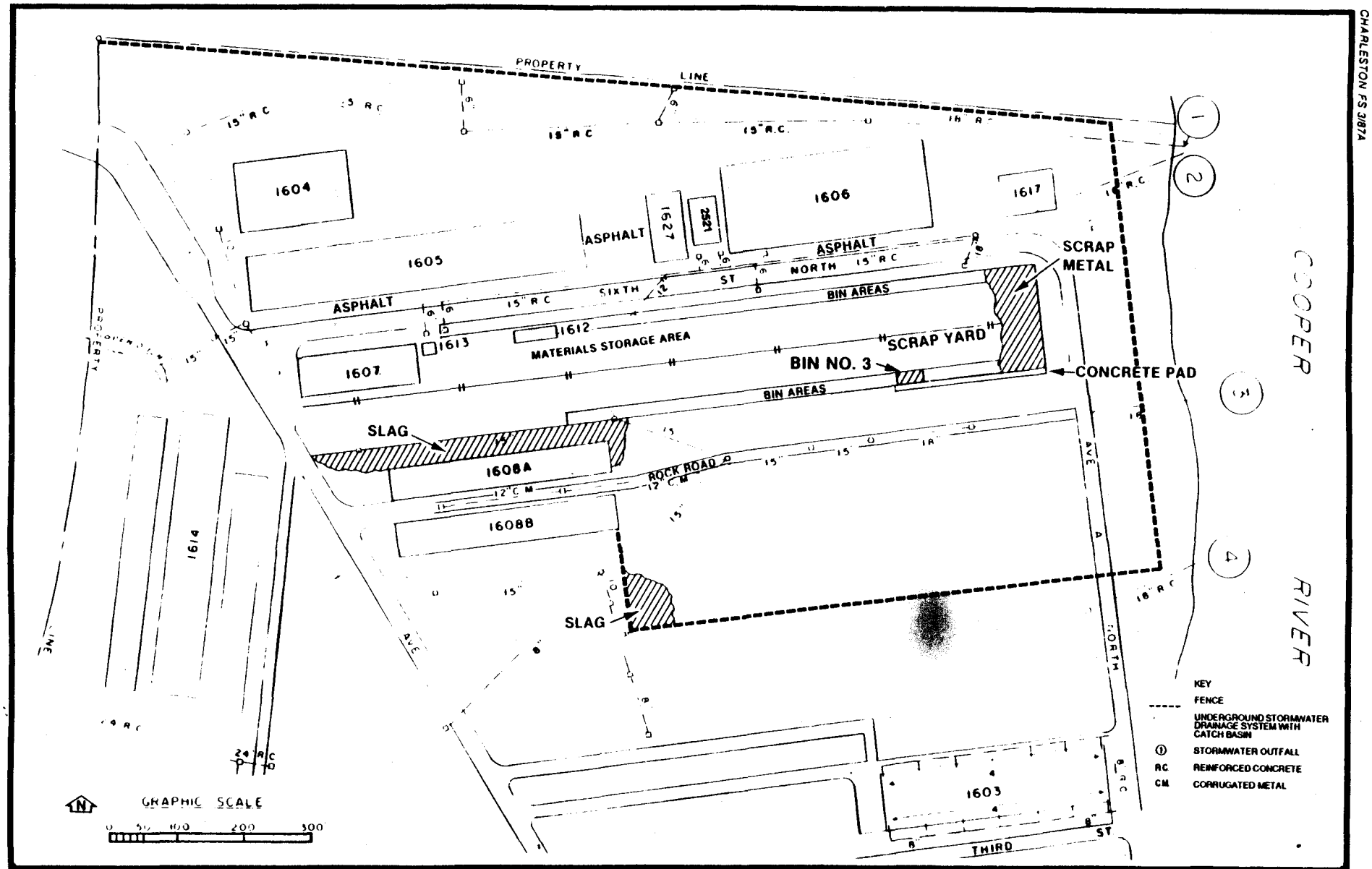

Figure 3.2-2
BUILDINGS REQUIRING DUST REMOVAL

SOURCE: ESE, 1987.

FEASIBILITY STUDY
NAVAL BASE CHARLESTON

CHARLESTON FS 3/87A

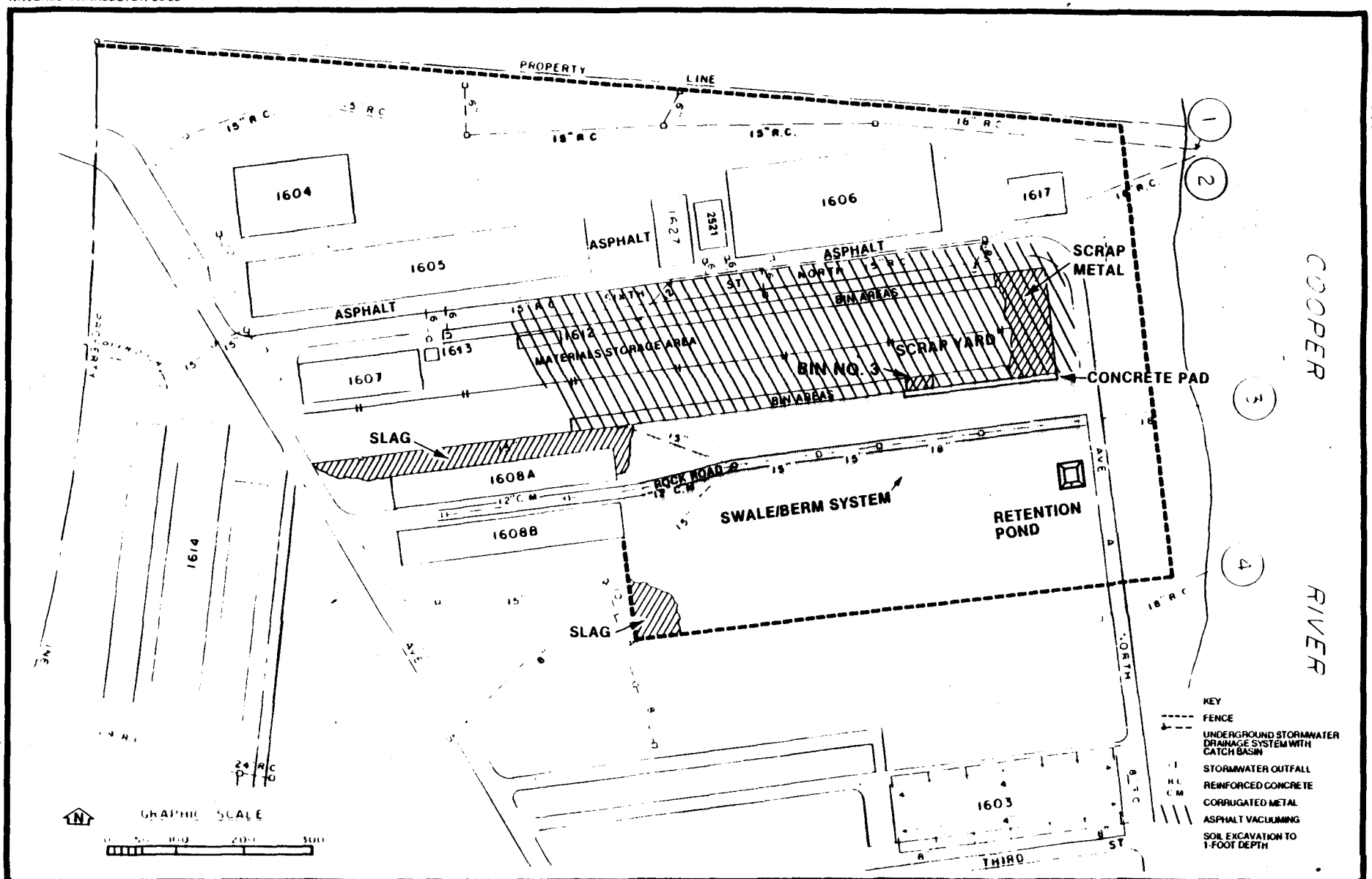

Figure 3.2-3
ALTERNATIVE 2—ASPHALT VACUUMING AND SOIL EXCAVATION (EXCAVATION TO 1-FOOT DEPTH)

SOURCE: ESE, 1987.

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lead/kg soil will be excavated and disposed of as a hazardous waste as described in Alternative 1. Materials vacuumed from the asphalt area will be included with the excavated soils for disposal.

Dust removal from the DRMO buildings will be performed in the manner described in Alternative 1.

Surface water diversion structures (swales and berms) will be constructed around the working area of the site to prevent runon/runoff during remediation. A retention pond will be constructed in the location and manner described in Alternative 1.

3.2.3 Alternative 3--Asphalt Capping

This alternative includes the asphalt capping over the area with concentrations greater than 1,000 mg lead/kg soil. As shown in Figure 3.2-4, swales, berms, and a retention pond will be constructed to control surface water onsite. Visible dust accumulated in the DRMO buildings will be removed in the manner described in Alternative 1.

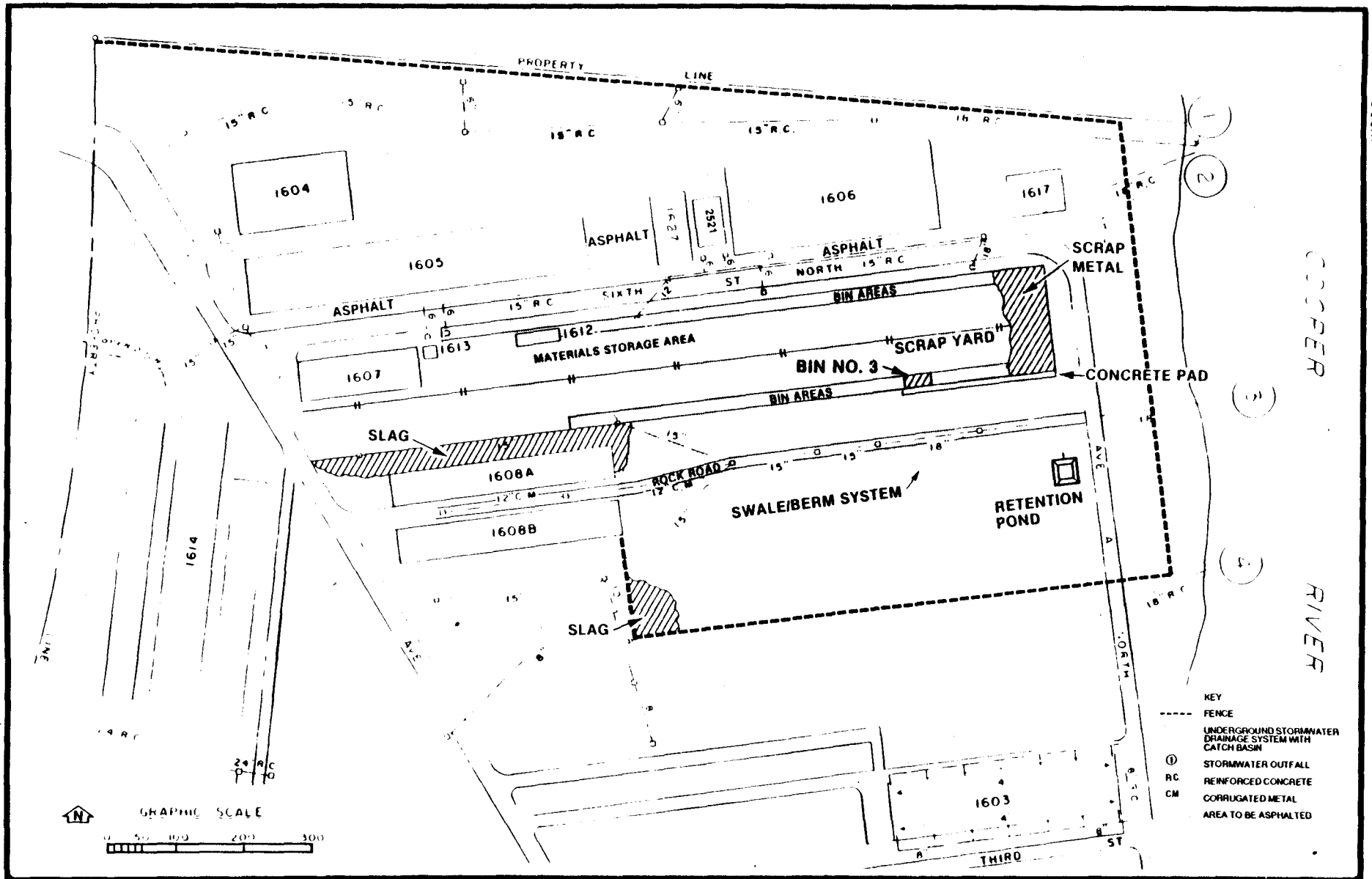

Figure 3.2-4
AREA TO BE ASPHALTED

SOURCE: ESE, 1987.

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4.0 INITIAL SCREENING OF ALTERNATIVES

The initial screening of the remedial alternatives includes identifying those alternatives which are technically viable, provide specific environmental/public health benefits, and are of reasonable cost. Those alternatives which do not meet these initial criteria are eliminated and the rationale for elimination documented. The initial screening criteria are discussed in Section 4.1.

4.1 SCREENING CRITERIA

To assess the feasibility of each alternative described in Section 3.2, the following criteria are applied.

1. Technical Evaluation--The technical evaluation includes reviewing the level of technology development; the performance (demonstrated) record; and inherent ease of construction, operation, or maintenance (implementability) for each alternative. The evaluation also includes a safety evaluation for both the installation and operation of the alternatives.
2. Environmental/Public Health Concerns--Environmental and public health screening includes identifying exposure risks and adverse impacts on the environment or public health. These impacts may be direct (i.e., ground water migration) or indirect (i.e., air pollution from remedial operations).
3. Cost Screening--The cost screening includes an order-of-magnitude estimation of capital and operating costs. The objective of the cost screening is to eliminate costly alternatives which do not provide greater benefits than less expensive alternatives. Published cost guides and ESE data on technology costs are used in the cost screening.

4.2 RESULTS OF INITIAL SCREENINGS

Using the criteria described in Section 4.1, none of the alternatives were eliminated during the initial screening. Each alternative was judged to attain applicable environmental standards or reduce the likelihood of present or future threats from DRMO, and to have no significant adverse impacts. The present-worth costs of all alternatives were within the same order of magnitude. The results of the initial screenings are presented in Table 4.2-1.

Table 4.2-1a. Alternative Screening

ALTERNATIVE 1--SOIL EXCAVATION

Screening Criteria	Comments
Technical Evaluation	
Level of Technology Developed/ Demonstrated Performance	Established, demonstrated technology exists.
Implementability	Requires excavation of the top 1 ft of soil from the unpaved contaminated area and backfill with clean fill. Also includes construction of runon/runoff control structures. Accumulated dust from the DRMO buildings will be removed.
Safety Evaluation	Normal concerns associated with standard construction activities including dust suppression during excavation and evacuation of DRMO buildings during dust removal.
Environmental/Public Health Concerns	Contaminants in existing paved area are not addressed by this alternative. Lead contamination in soils and buildings is remediated.
Order-of-Magnitude Cost ($1,000)	
Capital and O&M* Present Worth (30-year life @ 10 percent interest)	$582 (January 1987 dollars)

*Operation and maintenance.

Source: ESE, 1987.

Table 4.2-1b. Alternative Screening

ALTERNATIVE 2--ASPHALT VACUUMING AND SOIL EXCAVATION

Screening Criteria	Comments
Technical Evaluation	
Level of Technology Developed/ Demonstrated Performance	Established, demonstrated technology exists.
Implementability	Requires vacuuming of existing asphalt areas to remove contaminated dust and debris. Alternative also requires the excavation of the top 1-ft of soil from the unpaved contaminated area and backfill with clean fill. Includes construction of runon/runoff control structures. Accumulated dust from the DRMO buildings will be removed.
Safety Evaluation	Normal concerns associated with standard construction activities including dust suppression during asphalt vacuuming and soil excavation. Evacuation of DRMO buildings required during dust removal.
Environmental/Public Health Concerns	All contaminated areas are remediated. Contaminants remaining onsite are less than 1,000 mg lead/kg soil.
Order-of-Magnitude Cost ($1,000)	
Capital and O&M* Present Worth (30-year life @ 10 percent interest)	$602 (January 1987 dollars)

*Operation and maintenance.

Source: ESE, 1987.

Table 4.2-1c. Alternative Screening

ALTERNATIVE 3--ASPHALT CAPPING

Screening Criteria	Comments
Technical Evaluation	
Level of Technology Developed/ Demonstrated Performance	Established, demonstrated technology exists.
Implementability	Requires placing 4-inch asphalt cap over the entire contaminated area (concentrations >1,000 mg lead/kg soil). Also includes construction of runon/runoff control structures. Accumulated dust from the DRMO buildings will be removed.
Safety Evaluation	Normal concerns associated with standard construction activities including dust suppression during capping. Evacuation of DRMO buildings required during dust removal.
Environmental/Public Health Concerns	All contaminated areas are remediated, but contaminants remain onsite under asphalt cap.
Order-of-Magnitude Cost ($1,000)	
Capital and O&M* Present Worth (30-year life @ 10 percent interest)	$528 (January 1987 dollars)

*Operation and maintenance.

Source: ESE, 1987.

5.0 DETAILED EVALUATION OF THE ALTERNATIVES

The final detailed analysis includes defining the remaining alternatives in specific terms such as volume of soil to be excavated, transported, and disposed; extent and thickness of asphalt cap; area of building to be decontaminated; required quantities of backfill; site work; mobilization; surface water management; and closure and post-closure requirements. Each alternative was rated with regard to technical and environmental/institutional factors such as safety, engineering, public health risk and environmental effects (long-term and short-term), compliance with regulations, and institutional benefits. Alternatives were developed in sufficient detail to estimate capital and operation and maintenance (O&M) cost. The present-worth cost was calculated and used to compare the alternatives. Finally, each alternative was compared based on the technical rating, environmental/institutional rating, and present-worth cost.

5.1 RATING CRITERIA

To assess the feasibility of each alternative, the following criteria were applied in the technical and environmental/institutional ratings.

5.1.1 Criteria

Technical Feasibility--Factors considered in evaluating technical feasibility include performance, reliability, implementability, and safety. Performance is defined in terms of effectiveness and useful life. Effectiveness relates to the degree with which the alternative will prevent or minimize release of hazardous substances to current or future environmental receptors. Useful life relates to the length of time that the level of effectiveness can be maintained.

Reliability is assessed for O&M requirements and demonstrated performance. O&M requirements address labor availability, frequency, necessity, and complexity. Demonstrated performance addresses probability of failure.

Implementability is defined in terms of ease of installation and time. Ease of installation relates to constructability, applicability to site conditions, external conditions such as permits, and equipment availability. The time to implement and to achieve beneficial results was also evaluated. Safety during construction and operation was also evaluated.

Environmental/Institutional Benefits--Factors considered in evaluating environmental/institutional benefits include short-term (construction related), institutional, long-term, and public health impacts.

Short-term impacts are defined in terms of odor, noise, air, surface water, and ground water pollution; wildlife habitat and historic site alteration; disposal of construction materials; and disruption of households, businesses, and services. Institutional impacts were assessed for political jurisdictions, surface/ground water standards, air/odor/noise standards, land acquisition, land use/zoning, and local/state/federal laws or policies. Long-term benefits were evaluated for the same criteria as short-term benefits plus impacts on threatened and endangered species, use of natural resources, parks/transportation and urban facilities, and aesthetic changes.

Cost--Cost comparison required development of capital and O&M costs for each alternative. The cost estimates provide an accuracy of -30 to +50 percent and include present-worth cost in January 1987 dollars.. These estimates are not intended to represent actual construction cost but are based on conceptual design of treatment alternatives, direct quotes from vendors, and published USEPA cost curves.

5.1.2 Evaluation Methodology

Alternatives were evaluated by assessing them with regard to the aforementioned criteria. The following general scale was used with the specific criteria to provide a qualitative comparison of alternatives.

Rating	Definition
o	No change from existing conditions or negative effects.
+	A positive or moderately positive benefit.
++	An extremely positive benefit.

5.2 DETAILED EVALUATION RESULTS

The results of the technical and environmental/institutional ranking are presented in Figures 5.2-1 and 5.2-2, respectively. The present-worth costs for the 30-year life of the alternatives are ranked in Table 5.2-1. The table indicates that the costs of the remedial alternatives are not sensitive to interest rates. Components of each remedial alternative are detailed by the cost elements presented in Appendix A. If a cost element is not included in an alternative, then the cost element is zero for that alternative. The period of performance for each alternative is assumed to be 30 years.

5.2.1 Alternative 1

As described previously, this alternative involves excavation of lead contaminated soil to a 1-ft depth within the unpaved area of the 1,000 mg lead/kg soil isopleth (Figure 3.2-1). Soil disposal will be offsite at a permitted hazardous waste landfill. The site will be backfilled to the original grade with clean fill.

In each alternative, storm water runon will be diverted away from the area of excavation and the existing asphalt covered area. Storm water runoff from these areas will be collected in a storm water retention basin. The storm water management system will be left in place after removal activities have been completed. Each alternative also includes dust removal from approximately 74,000 ft^2 of DRMO buildings.

Table 5.2-1. 30-Year Alternative Present-Worth Analysis Summary
Charleston Naval Shipyard DRMO Site

Alternative	Total Present-Worth Cost in Thousands (January 1987 Dollars) i=4% $	i=7% $	i=10% $
1	584	583	582
2	604	603	602
3	544	534	528

Source: ESE, 1987.

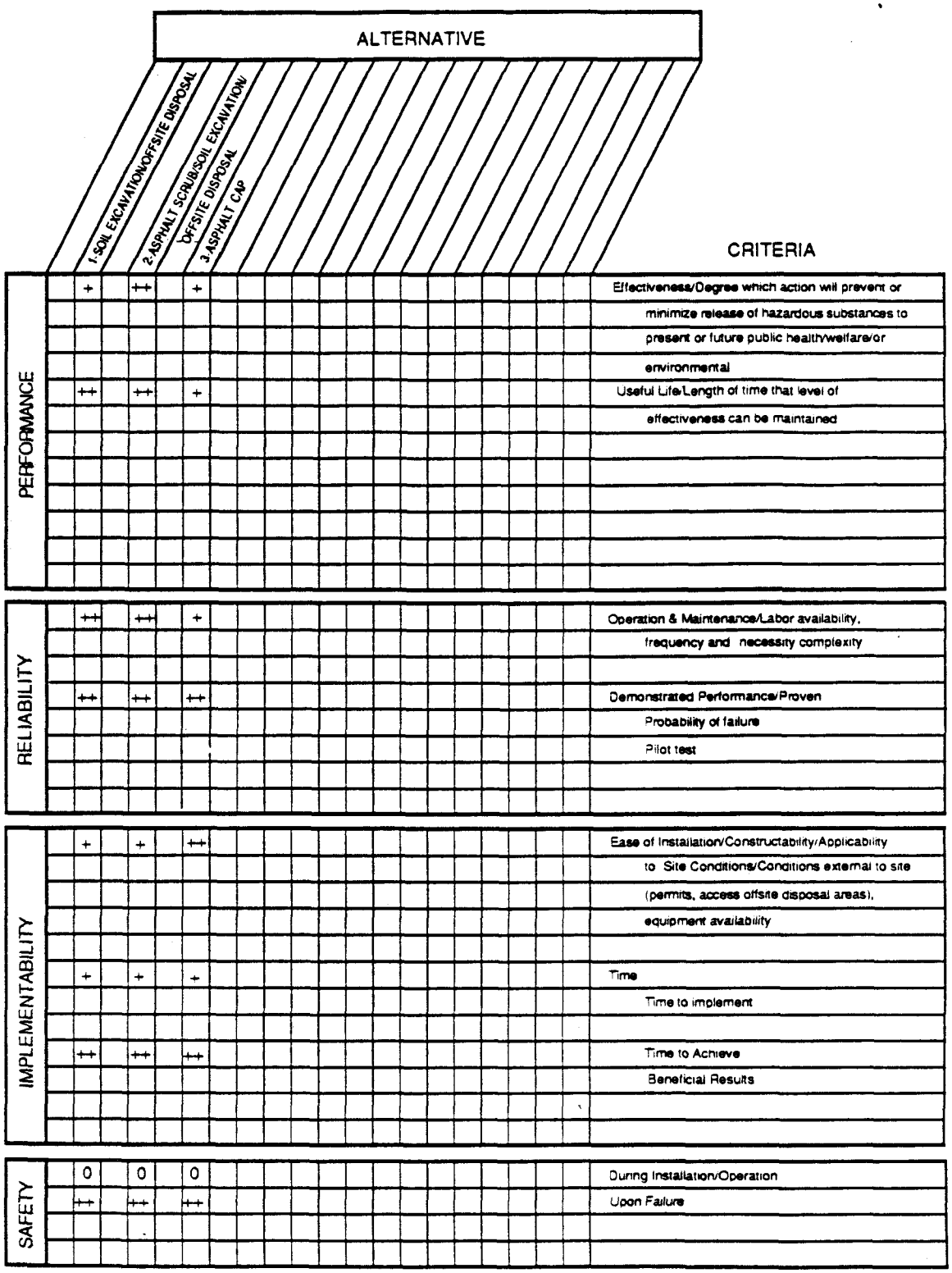

Figure 5.2-1
TECHNICAL RATING MATRIX

SOURCE: ESE, 1987.

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NAVAL BASE CHARLESTON

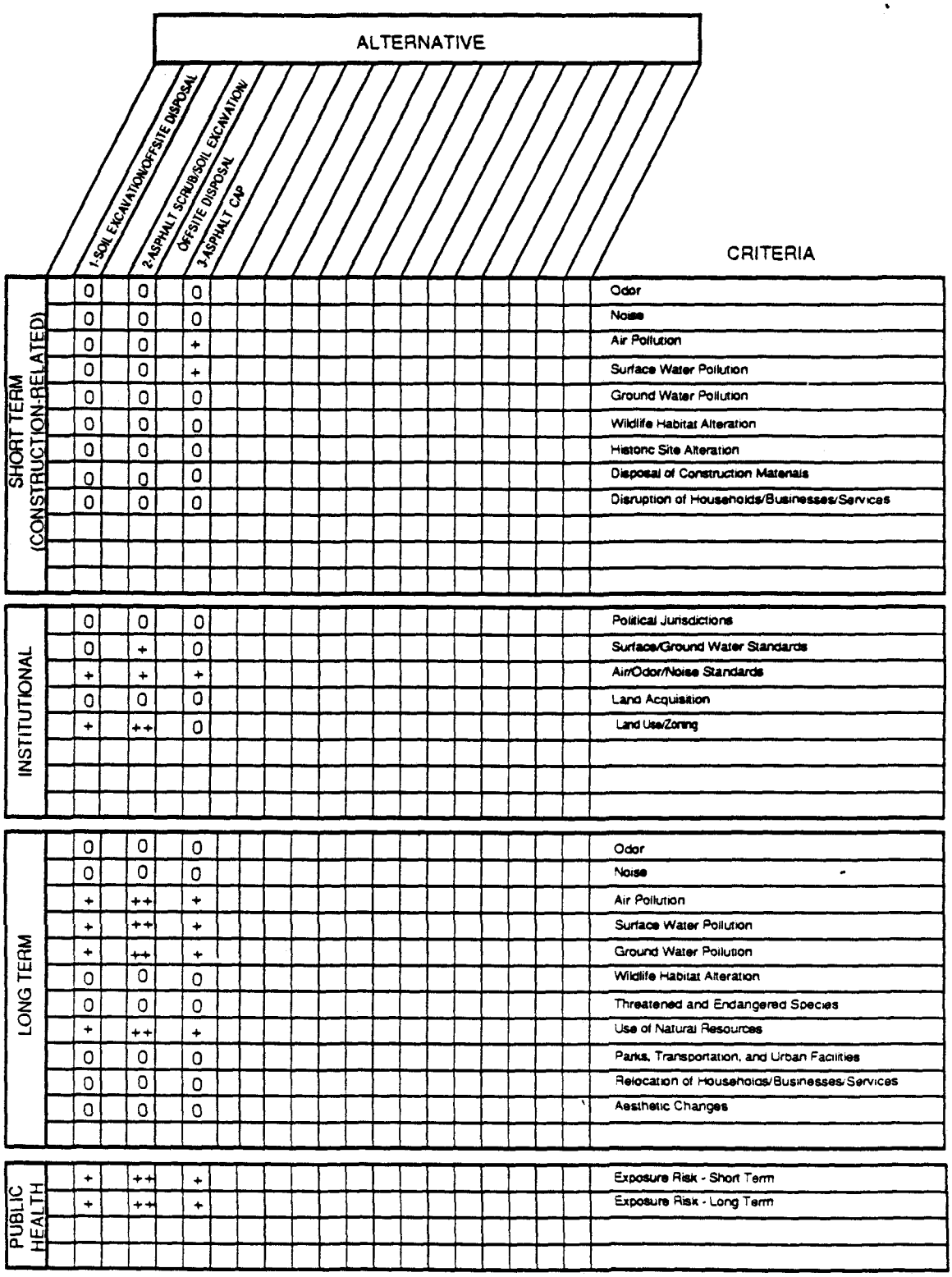

Figure 5.2-2
ENVIRONMENTAL/INSTITUTIONAL RATING MATRIX

SOURCE: ESE, 1987.

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This alternative will eliminate soils contaminated above 1,000 mg lead/kg soil, thereby reducing the generation of airborne dust from the lead-contaminated soils. The alternative will also reduce the potential for suspension of dust particles in the DRMO buildings. Some continuing generation of lead-bearing dust from the asphalt area is expected.

Additional considerations included in the analysis were:

- o The useful life of removal and offsite disposal of contaminated soils is perpetual;
- o There are no long-term O&M requirements associated with tne removal of contaminated soils;
- o Since soils contaminated above the exposure limit (1,000 mg lead/kg soil) determined in the risk assessment are removed from the site, there is no chance for future failure of the remedial technology;
- o There is potential for air and surface water pollution during the removal activities because the contaminants are being disturbed;
- o Future land-use options are increased because contaminated soils have been removed;
- o Because surficial contaminants in the asphalt area remain onsite, there is the potential for continuing release of lead to air, surface water, and ground water.

5.2.2 Alternative 2

This alternative involves excavation of lead-contaminated soil to a 1-ft depth within the unpaved area of the 1,000 mg lead/kg soil isopleth, and vacuuming of the asphalt area to remove lead-contaminated particles (Figure 3.2-3). The alternative will include storm water management and dust removal as described in the preceding section.

This alternative will eliminate soils contaminated above 1,000 mg lead/kg soil, thereby reducing the generation of airborne dust from the lead-contaminated soils. The alternative will also mitigate the generation of airborne dust from the asphalt area and reduce the potential for suspension of dust particles in the DRMO buildings.

Additional considerations included in the analysis were:

- The asphalt vacuuming will immediately reduce the release of lead-contaminated particles to the environment from that area;
- The useful life of removal and offsite disposal of contaminated soils is perpetual;
- There are no long-term O&M requirements associated with the removal of contaminated soils;
- Since soils contaminated above the exposure limit (1,000 mg lead/kg soil) determined in the risk assessment are removed from the site, there is no chance for future failure of the remedial technology;
- There is potential for air and surface water pollution during the removal activities because the contaminants are being disturbed;
- Future land-use options are increased because contaminated soils and surficial contamination in the asphalt area have been removed;
- This alternative has the least potential to cause long-term air, surface water, or ground water pollution, and allows the least restricted use of natural resources; and
- The short- and long-term exposure risks to public health are least for this alternative.

5.2.3 Alternative 3

This alternative involves installing a 4-inch asphalt cap over the area of contaminated soils (Figure 3.2-4). No removal of contaminated soils is associated with this alternative. This alternative will include storm water management and dust removal from the DRMO buildings as described in Section 5.2.1.

This alternative will mitigate the generation of airborne dust from the soils contaminated over 1,000 mg lead/kg soil, and reduce the potential for suspension of dust particles in the DRMO buildings. Some continuing generation of lead-bearing dust from the uncapped area is expected.

Additional considerations included in the analysis were:

- The useful length of time that the effectiveness of the asphalt cap can be maintained depends on its design characteristics, traffic, weather, and exposure to solvents and other chemicals;
- Regular maintenance will be required for the asphalt cap;
- Installation of the asphalt cap involves only routine construction techniques;
- Failure of the cap due to cracking, exposure to solvents, or lack of maintenance can increase the risk of exposure;
- Air and surface water pollution caused by construction activities are minimal because the lead-contaminated soils are least disturbed by implementation of this alternative; and
- Future land use may be restricted since contaminants remain on the site.

6.0 SUMMARY AND RECOMMENDATIONS

The most cost-effective alternative identified by the detailed analysis is Alternative 2, which includes excavation of lead-contaminated soil to a 1-ft depth within the unpaved area of the 1,000 mg lead/kg soil isopleth, and vacuuming of the existing asphalt area to remove lead-contaminated particles and debris. The alternative also includes diversion of storm water runon away from the area of excavation and the existing asphalt covered area. Storm water runoff from these areas will be collected in a storm water retention basin. The storm water management system will be left in place after removal activities have been completed. Also included in the alternative is dust removal from approximately 74,000 ft^2 of DRMO buildings.

Although Alternative 2 is the most costly alternative, it is favored due to consideration of long-term protection of human health, long-term protection of the environment, present and future land-use options, and effectiveness of preventing releases of hazardous constituents.

Alternative 1, which is excavation and offsite disposal of contaminated soils, storm water management, and dust removal from the DRMO buildings, is slightly less costly than Alternative 2. However, Alternative 1 provides less protection of human health than Alternative 2 since the existing asphalt area, which contains the highest lead concentrations, is not remediated.

Alternative 3, which is the installation of a 4-inch asphalt cap over the areas contaminated by more than 1,000 mg lead/kg soil or more lead, storm water management, and dust removal from the DRMO buildings, is the least costly alternative. However, Alternative 3 provides less long-term protection of human health than Alternative 2 since the asphalt cap may fail, and contaminants remaining onsite may migrate via ground water transport to areas outside the cap.

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APPENDIX A

ALTERNATIVE QUANTITIES			NUMBER OF UNITS		01-Mar-87
COST ELEMENTS	UNIT OF MEASURE	UNIT COST (JANUARY 1987 DOLLARS)	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
I.SITEWORK					
A.Clearing	acre	$2,588	0	0	0
B.Dust Control	per month	$7,505.00	1	1	1
C.Seal Storm Water Catch Basins	each	$78.14	7	7	7
II.MOBILIZATION					
A.Support/Decon Bldg.	each	$7,660	1	1	1
B.Vehicle Decon. Station					
1.Steam Cleaner Rental	per month	$388.00	1	1	1
2.Collection System	each	$1,500.00	1	1	1
C.Utilities	3% of bldg	N/A	N/A	N/A	N/A
III.CAPPING (ASPHALT CAP)					
A.Capital Cost	sqft	$1.33	0	0	226,700
IV.EXCAVATION/LOADING/HAULING					
A.Hazardous Soils	cuyd	$15.91	2410	2410	0
B.Non-Hazardous Soils	cuyd	$4.72	0	0	0
C.Hazard Constituent Monitoring	site	$11,306.00	1	1	0
V.WASTE DISPOSAL					
A.Hauling	ton	$27.50	2410	2415	2
B.Disposal	ton	$113.05	2410	2415	2
VI.ASPHALT VACUUMING					
A.Mobilization/Demobilization	day	$4,375.00	0	2	0
B.Operation	sqft	$0.07	0	159,000	0
VII.BACKFILL					
A.From Offsite	cuyd	$10.70	2410	2410	0
B.Grading	acre	$2,751	1.5	1.5	0
VIII.SURFACE WATER MANAGEMENT					
A.Run On/Run Off Control					
1.Swales/Berms	ft	$5.05	2260	2260	2260
2.Culverts	ft	$22.77	120	120	120
3.Retention Pond	cuyd	$7.43	840	840	840
IX.DUST REMOVAL					
A.Mobilization/Demobilization	day	$400.00	4	4	4
B.Operation	sqft	$2.00	74,150	74,150	74,150
X.CLOSURE					
A.Decontamination					
1.Buildings	each	$314	1	1	1
2.Equipment	site	$10,000	1	1	1
B.Reclamation/Revegetation	acre	$2,100	2	2	0
C.Post Topographic Survey	acre	$1,400.00	2	2	6
XI.POST CLOSURE					
A.Asphalt Maintenance	year	$1,738.00	0	0	1
B.Surface Water Control System Maintenance	year	$340.00	1	1	1

ALTERNATIVE 1 — SOIL EXCAVATION

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COST		ANNUAL O&M		YEAR(S) INCURRED
				LINE TOTAL	SUBTOTAL	LINE TOTAL	SUBTOTAL	START END
I SITEWORK								
A.Clearing	acre	$2,598.00	0.00	$0.00				
B.Dust Control	per month	$7,507.00	1.00	$7,507.00				
C.Seal Storm Water Catch Basins	each	$78.14	7.00	$546.98				
SUBTOTAL					$8,053.98		$0.00	
II. MOBILIZATION								
A.Support/Decon Bldg.	each	$7,660.00	1.00	$7,660.00				
B.Vehicle Decon Station								
1.Steam Cleaner Rental	per month	$388.00	1.00	$388.00				
2.Collection System	each	$1,500.00	1.00	$1,500.00				
C.Utilities	3% of bldg.	N/A	N/A	$241.44				
SUBTOTAL					$9,548.00		$0.00	
III.CAPPING (ASPHALT CAP)								
A.Capital Cost	sqft	$1.33	0.00	$0.00				
SUBTOTAL					$0.00		$0.00	
IV EXCAVATION/LOADING								
A.Hazardous Soils	cuyd	$15.91	2,140.00	$34,047.40				
B.Non-Hazardous Soils	cuyd	$4.72	0.00	$0.00				
C.Hazard Constituent Monitoring	site	$11,306.00	1.00	$11,306.00				
SUBTOTAL					$45,353.40		$0.00	
V WASTE DISPOSAL								
A.Hauling	ton	$27.50	2,140.00	$58,850.00				
B.Disposal	ton	$113.05	2,140.00	$241,927.00				
SUBTOTAL					$300,777.00		$0.00	
VI ASPHALT VACUUMING								
A.Mobilization/Demobilization	day	$4,375.00	0.00	$0.00				
B.Operation	sqft	$0.07	0.00	$0.00				
SUBTOTAL					$0.00		$0.00	
VII BACKFILL								
A.From Offsite	cuyd	$10.70	2,140.00	$22,898.00				
B.Grading	acre	$2,751.00	1.50	$4,126.50				
SUBTOTAL					$27,024.50		$0.00	
VIII SURFACE WATER MANAGEMENT								
A.Run On/Run Off Control								
1.Swales/Berms	ft	$5.05	2,260.00	$11,413.00				
2.Culverts	ft	$22.77	120.00	$2,732.40				
3.Retention Pond	cuyd	$7.43	840.00	$6,241.20				
SUBTOTAL					$20,386.60		$0.00	
IX DUST REMOVAL								
A.Mobilization/Demobilization	day	$400.00	4.00	$1,600.00				
B.Operation	sqft	$2.00	74,150.00	$148,300.00				
SUBTOTAL					$149,900.00		$0.00	
X CLOSURE								
A.Decontamination								
1.Buildings	each	$314.00	1.00	$314.00				
2.Equipment	site	$10,000.00	1.00	$10,000.00				
B.Reclamation/Revegitation	acre	$2,100.00	2.00	$4,200.00				
C.Post Topographic Survey	acre	$1,400.00	2.00	$2,800.00				
SUBTOTAL					$17,314.00		$0.00	
XI POST CLOSURE								
A.Asphalt Maintenance	year	$1,738.00	0.00			$0.00		
B.Surface Water Control System Maintenance	year	$340.00	1.00			$340.00		
SUBTOTAL					$0.00		$340.00	

TOTALS -- ALTERNATIVE 1 COST SUMMARY AND OVERHEAD	DIRECT CAPITAL COST	ANNUAL O&M
I. SITEWORK	$8,053.98	$0.00
II. MOBILIZATION	$9,548.00	$0.00
III. CAPPING (ASPHALT CAP)	$0.00	$0.00
IV. EXCAVATION/LOADING	$45,353.40	$0.00
V. WASTE DISPOSAL	$300,777.00	$0.00
VI. ASPHALT VACUUMING	$0.00	$0.00
VII. BACKFILL	$27,024.50	$0.00
VIII. SURFACE WATER MANAGEMENT	$20,386.60	$0.00
IX. DUST REMOVAL	$149,900.00	$0.00
X. CLOSURE	$17,314.00	$0.00
XI. POST CLOSURE	$0.00	$340.00
SUBTOTAL	$578,357.48	$340.00
CAPITAL COST	$578,357.48	
ANNUAL O&M	$340.00	

ALTERNATIVE 2 — VACUUMING OF ASPHALT AND SOIL EXCAVATION

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COST		ANNUAL O&M		YEAR 0 DISCOUNTED START END
				LINE TOTAL	SUBTOTAL	LINE TOTAL	SUBTOTAL	
I SITEWORK								
A Clearing	acre	$2,588.00	0.00	$0.00				
B Dust Control	per month	$7,505.00	1.00	$7,505.00				
C Seal Storm Water Catch Basins	each	$78.14	7.00	$546.98				
SUBTOTAL					$8,051.98		$0.00	
II MOBILIZATION								
A Support/Decon Bldg	each	$7,650.00	1.00	$7,650.00				
B Vehicle Decon. Station								
1 Steam Cleaner Rental	per month	$388.00	1.00	$388.00				
2 Collection System	each	$1,500.00	1.00	$1,500.00				
C Utilities	% of bldg	N/A	N/A	$241.44				
SUBTOTAL					$9,548.00		$0.00	
III CAPPING (ASPHALT CAP)								
A Capital Cost	sqft	$1.33	0.00	$0.00				
SUBTOTAL					$0.00		$0.00	
IV EXCAVATION/LOADING								
A Hazardous Soils	cuyd	$15.91	2,140.00	$34,047.40				
B Non-Hazardous Soils	cuyd	$4.72	0.00	$0.00				
C Hazard Constituent Monitoring	site	$11,306.00	1.00	$11,306.00				
SUBTOTAL					$45,353.40		$0.00	
V WASTE DISPOSAL								
A Hauling	ton	$27.50	2,145.00	$58,987.50				
B Disposal	ton	$113.05	2,145.00	$242,492.25				
SUBTOTAL					$301,479.75		$0.00	
VI ASPHALT VACUUMING								
A Mobilization/Demobilization	day	$4,375.00	2.00	$8,750.00				
B Operation	sqft	$0.07	155,000.00	$10,494.00				
SUBTOTAL					$19,244.00		$0.00	
VII BACKFILL								
A From Offsite	cuyd	$10.79	2,140.00	$22,958.60				
B Grading	acre	$2,751.00	1.50	$4,126.50				
SUBTOTAL					$27,024.50		$0.00	
VIII SURFACE WATER MANAGEMENT								
A Run On/Run Off Control								
1 Swales/Berms	ft	$5.05	2,260.00	$11,413.00				
2 Culverts	ft	$22.77	120.00	$2,732.40				
3 Retention Pond	cuyd	$7.43	840.00	$6,241.20				
SUBTOTAL					$20,386.60		$0.00	
IX DUST REMOVAL								
A Mobilization/Demobilization	day	$400.00	4.00	$1,600.00				
B Operation	sqft	$2.00	74,150.00	$148,300.00				
SUBTOTAL					$149,900.00		$0.00	
X CLOSURE								
A Decontamination								
1 Support Buildings	each	$814.00	1.00	$814.00				
2 Equipment	site	$10,000.00	1.00	$10,000.00				
B Reclamation/Revegetation	acre	$2,100.00	2.00	$4,200.00				
C Post Topographic Survey	acre	$1,400.00	2.00	$2,800.00				
SUBTOTAL					$17,814.00		$0.00	
XI POST CLOSURE								
A Repair Maintenance	year	$1,733.00	0.00			$0.00		
B Surface Water Control System Maintenance	year	$240.00	1.00			$240.00		
SUBTOTAL					$0.00		$240.00	

TOTALS — ALTERNATIVE 2 COST SUMMARY AND OVERHEAD	DIRECT CAPITAL COST	ANNUAL O&M
I. SITEWORK	$8,051.58	$0.00
II. MOBILIZATION	$3,548.00	$0.00
III. CAPPING (ASPHALT CAP)	$0.00	$0.00
IV. EXCAVATION/LOADING	$45,353.40	$0.00
V. WASTE DISPOSAL	$301,479.75	$0.00
VI. ASPHALT VACUURING	$19,244.00	$0.00
VII. BACKFILL	$27,024.50	$0.00
VIII. SURFACE WATER MANAGEMENT	$20,386.60	$0.00
IX. DUST REMOVAL	$143,900.00	$0.00
X. CLOSURE	$17,314.00	$0.00
XI. POST CLOSURE	$0.00	$340.00
SUBTOTAL	$596,302.23	$340.00
CAPITAL COST	$596,302.23	
ANNUAL O&M	$340.00	

ALTERNATIVE 3 — ASPHALT CAPPING

COST ELEMENTS	UNIT OF MEASURE	UNIT COST	NUMBER OF UNITS	DIRECT COST		ANNUAL O&M		YEARS INCURRED	
				LINE TOTAL	SUBTOTAL	LINE TOTAL	SUBTOTAL	START	END
I. SITEWORK									
A. Clearing	acre	$2,568.00	0.00	$0.00					
B. Dust Control	per month	$7,505.00	1.00	$7,505.00					
C. Seal Storm Water Catch Basins	each	$78.14	7.00	$546.98					
SUBTOTAL					$8,051.98		$0.00		
II. MOBILIZATION									
A. Support/Decon Bldg.	each	$7,660.00	1.00	$7,660.00					
B. Vehicle Decon. Station									
1. Steam Cleaner Rental	per month	$388.00	1.00	$388.00					
2. Collection System	each	$1,500.00	1.00	$1,500.00					
C. Utilities	% of bldg.	N/A	N/A	$241.44					
SUBTOTAL					$9,548.00		$0.00		
III. CAPPING (ASPHALT CAP)									
A. Capital Cost	sqft	$1.33	226,700.00	$301,511.00					
SUBTOTAL					$301,511.00		$0.00		
IV. EXCAVATION/LOADING									
A. Hazardous Soils	cuyd	$15.91	0.00	$0.00					
B. Non-hazardous Soils	cuyd	$4.72	0.00	$0.00					
C. Hazard Constituent Monitoring	site	$11,306.00	0.00	$0.00					
SUBTOTAL					$0.00		$0.00		
V. WASTE DISPOSAL									
A. Hauling	ton	$27.50	2.00	$55.00					
B. Disposal	ton	$113.05	2.00	$226.10					
SUBTOTAL					$281.10		$0.00		
VI. ASPHALT VACUUMING									
A. Mobilization/Demobilization	day	$4,375.00	0.00	$0.00					
B. Operation	sqft	$0.07	0.00	$0.00					
SUBTOTAL					$0.00		$0.00		
VII. BACKFILL									
A. From Offsite	cuyd	$10.70	0.00	$0.00					
B. Grading	acre	$2,751.00	0.00	$0.00					
SUBTOTAL					$0.00		$0.00		
VIII. SURFACE WATER MANAGEMENT									
A. Run On/Run Off Control									
1. Swales/Berms	ft	$5.05	2,260.00	$11,413.00					
2. Culverts	ft	$22.77	120.00	$2,732.40					
3. Retention Pond	cuyd	$7.43	840.00	$6,241.20					
SUBTOTAL					$20,386.60		$0.00		
IX. COST REMOVAL									
A. Mobilization/Demobilization	day	$400.00	4.00	$1,600.00					
B. Operation	sqft	$2.00	74,150.00	$148,300.00					
SUBTOTAL					$149,900.00		$0.00		
X. CLOSURE									
A. Decontamination									
1. Buildings	each	$814.00	1.00	$814.00					
2. Equipment	site	$10,000.00	1.00	$10,000.00					
B. Reclamation/Revegitation	acre	$2,100.00	0.00	$0.00					
C. Post Topographic Survey	acre	$1,400.00	6.00	$8,400.00					
SUBTOTAL					$18,714.00		$0.00		
XI. POST CLOSURE									
A. Permit Maintenance	year	$1,738.00	1.00			$1,738.00			
B. Surface Water Control System Maintenance	year	$640.00	1.00			$640.00			
SUBTOTAL					$0.00		$2,378.00		

TOTALS -- ALTERNATIVE 3 COST SUMMARY AND OVERHEAD	DIRECT CAPITAL COST	ANNUAL O&M
I. SITEWORK	$8,051.38	$0.00
II. MOBILIZATION	$9,540.00	$0.00
III. CAPPING (ASPHALT CAP)	$301,511.00	$0.00
IV. EXCAVATION/LOADING	$0.00	$0.00
V. WASTE DISPOSAL	$281.10	$0.00
VI. ASPHALT VACUUMING	$0.00	$0.00
VII. BACKFILL	$0.00	$0.00
VIII. SURFACE WATER MANAGEMENT	$20,386.60	$0.00
IX. DUST REMOVAL	$149,900.00	$0.00
X. CLOSURE	$18,714.00	$0.00
XI. POST CLOSURE	$0.00	$2,078.00
SUBTOTAL	$508,392.68	$2,078.00
CAPITAL COST	$508,392.68	
ANNUAL O&M	$2,078.00	

ALTERNATIVE 1 — SOIL EXCAVATION — CHARLESTON NAVAL SHIPYARD DRMO SITE — PRESENT WORTH ANALYSIS

PRESENT WORTH ANALYSIS (i=4 %)

COST COMPONENT	COST/YEAR COST OCCURS (THOUSANDS OF DOLLARS)																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.Capital Cost	578.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.O&M Cost	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
3.Annual Cost (Sum of Lines 1 and 2)	578.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
4.Discount Factor (percent) i	1.000	0.962	0.925	0.889	0.855	0.822	0.790	0.760	0.731	0.703	0.676	0.650	0.625	0.601	0.577	0.555	(Year 0 Cost Sub-Total)
5.Present Worth (Product of Lines 3 and 4)	578	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$582

		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1.Capital Cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.O&M Cost	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
3.Annual Cost (Sum of Lines 1 and 2)	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
4.Discount Factor (percent) i	1.000	0.534	0.513	0.494	0.475	0.456	0.439	0.422	0.406	0.390	0.375	0.361	0.347	0.333	0.321	0.308	(Year 0 Cost Sub-Total)
5.Present Worth (Product of Lines 3 and 4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$0

TOTAL PRESENT WORTH AT i= 4% $584

PRESENT WORTH ANALYSIS (i=7 %)

COST COMPONENT	COST/YEAR COST OCCURS (THOUSANDS OF DOLLARS)																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.Capital Cost	578.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.O&M Cost	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
3.Annual Cost (Sum of Lines 1 and 2)	578.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
4.Discount Factor (percent) i	1.000	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.475	0.444	0.415	0.388	0.362	(Year 0 Cost Sub-Total)
5.Present Worth (Product of Lines 3 and 4)	578.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	$581

		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1.Capital Cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.O&M Costs	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
4.Annual Cost (Sum of Lines 1, or 2 and 3)	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
5.Discount Factor (percent) i	1.000	0.339	0.317	0.296	0.277	0.258	0.242	0.226	0.211	0.197	0.184	0.172	0.161	0.150	0.141	0.131	(Year 0 Cost Sub-Total)
6.Present Worth (Product of Lines 4 and 5)	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	$1

TOTAL PRESENT WORTH AT i= 7% $583

PRESENT WORTH ANALYSIS (i=10 %)

COST COMPONENT	COST/YEAR COST OCCURS (THOUSANDS OF DOLLARS)																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.Capital Cost	578.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.O&M Cost	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
3.Annual Cost (Sum of Lines 1 and 2)	578.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
4.Discount Factor (percent) i	1.000	0.909	0.826	0.751	0.683	0.621	0.564	0.513	0.467	0.424	0.386	0.350	0.319	0.290	0.263	0.239	(Year 0 Cost Sub-Total)
5.Present Worth (Product of Lines 3 and 4)	578.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	$581

		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1.Capital Cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.O&M Cost	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
3.Annual Cost (Sum of Lines 1 and 2)	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
4.Discount Factor (percent) i	1.000	0.218	0.198	0.180	0.164	0.149	0.135	0.123	0.112	0.102	0.092	0.084	0.076	0.069	0.063	0.057	(Year 0 Cost Sub-Total)
5.Present Worth (Product of Lines 3 and 4)	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$1

TOTAL PRESENT WORTH AT i= 10% $581 $582

ALTERNATIVE 2 — VACUUMING OF ASPHALT AND SOIL EXCAVATION — CHARLESTON NAVAL SHIPYARD ORDO SITE — PRESENT WORTH ANALYSIS

PRESENT WORTH ANALYSIS (i=4 %)

COST COMPONENT	COST/YEAR COST OCCURS (THOUSANDS OF DOLLARS) 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.Capital Cost	598.3	0	0 0	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0.0	0.0	0.0	0.0	0.0	
2.O&M Cost	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0 3	
3.Annual Cost (Sum of Lines 1 and 2)	598.3	0 3	0.3	0.3	0.3	0.3	0.3	0.3	0 3	0.3	0 3	0.3	0.3	0.3	0.3	0 3	
4.Discount Factor (percent) 4	1.000	0.962	0.925	0.889	0.855	0.822	0.790	0 760	0.731	0.703	0.676	0.650	0 625	0.601	0.577	0 555	YEAR 15 SUBTOTAL
5.Present Worth (Product of Lines 3 and 4)	598	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$602
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1.Capital Cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.O&M Cost	0.0	0.3	0 3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0 3	0.3	0 3	
3.Annual Cost (Sum of Lines 1 and 2)	0.0	0.3	0.3	0 3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0 3	0.3	0 3	0.3	
4.Discount Factor (percent) 4	1.000	0.534	0.513	0.494	0.475	0.456	0 439	0.422	0.406	0.390	0 375	0 361	0 347	0 333	0 321	0 308	YEARS 16-30 SUBTOTAL
5.Present Worth (Product of Lines 3 and 4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$1
																	TOTAL PRESENT WORTH AT i= 4% $603

PRESENT WORTH ANALYSIS (i=7 %)

COST COMPONENT	COST/YEAR COST OCCURS (THOUSANDS OF DOLLARS) 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.Capital Cost	598.3	0.0	0 0	0 0	0 0	0.0	0.0	0 0	0.0	0.0	0.0	0 0	0 0	0 0	0 0	0.0	
2.O&M Cost	0.0	0.3	0 3	0.3	0.3	0.3	0.3	0 3	0.3	0.3	0.3	0.3	0 3	0 3	0 3	0 3	
3.Annual Cost (Sum of Lines 1 and 2)	598.3	0 3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0 3	0 3	
4.Discount Factor (percent) 7	1.000	0 935	0 873	0.816	0 763	0.713	0.666	0.623	0.582	0.544	0.508	0 475	0.444	0 415	0 388	0 362	YEARS 16-30 SUBTOTAL
5.Present Worth (Product of Lines 3 and 4)	598.3	0 3	0.3	0.3	0 3	0.2	0.2	0.2	0 2	0 2	0 2	0.2	0.2	0.1	0 1	0 1	$601
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1.Capital Cost	0.0	0 0	0.0	0.0	0 0	0 0	0.0	0 0	0 0	0 0	0 0	0 0	0.0	0 0	0.0	0 0	
2.O&M Costs	0 0	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	
3.Annual Cost (Sum of Lines 1 or 2 and 2)	0 0	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	
4.Discount Factor (percent) 7	1.000	0.835	0.817	0 296	0 277	0 258	0 242	0 226	0 211	0 197	0 184	0 172	0 161	0 150	0 141	0 131	YEARS 16-30 SUBTOTAL
5.Present Worth (Product of Lines 4 and 5)	0.0	0 1	0.1	0.1	0 1	0 1	0.1	0.1	0.1	0.1	0.1	0 1	0.1	0.1	0 0	0 0	$1
																	TOTAL PRESENT WORTH AT i= 7% $601

PRESENT WORTH ANALYSIS (i=10 %)

COST COMPONENT	COST/YEAR COST OCCURS (THOUSANDS OF DOLLARS) 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.Capital Cost	598.3	0 0	0 0	0 0	0.0	0 0	0.0	0 0	0 0	0 0	0 0	0 0	0 0	0.0	0.0	0.0	
2.O&M Cost	0.0	0.3	0.3	0 3	0 3	0.3	0 3	0.3	0.3	0.3	0 3	0 3	0 3	0.3	0 3	0 3	
3.Annual Cost (Sum of Lines 1 and 2)	598.3	0 3	0.3	0.3	0 3	0.3	0 3	0.3	0 3	0.3	0 3	0 3	0.3	0.3	0 3	0 3	
4.Discount Factor (percent) 10	1.000	0 909	0 826	0.751	0.683	0 621	0 564	0.513	0.467	0 424	0.386	0.350	0 319	0 290	0.263	0 239	YEARS 16-30 SUBTOTAL
5.Present Worth (Product of Lines 3 and 4)	598.3	0 3	0 3	0 3	0 2	0 2	0 2	0 2	0 2	0 1	0 1	0 1	0 1	0 1	0 1	0 1	$601
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1.Capital Cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.O&M Cost	0 0	0 3	0 3	0 3	0 3	0 3	0.3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	
3.Annual Cost (Sum of Lines 1 and 2)	0 0	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	
4.Discount Factor (percent) 10	1.000	0 218	0 198	0 180	0 164	0 149	0 135	0 123	0 112	0 102	0 092	0 084	0 076	0.069	0 063	0 057	YEARS 16-30 SUBTOTAL
5.Present Worth (Product of Lines 3 and 4)	0 0	0 1	0 1	0 1	0 1	0 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	$1
																	TOTAL PRESENT WORTH AT i= 10% $601

ALTERNATIVE 3 — ASPHALT CAPPING — CHARLESTON NAVAL SHIPYARD ORNO SITE — PRESENT WORTH ANALYSIS

PRESENT WORTH ANALYSIS (i=4 %)

COST COMPONENT	COST/YEAR COST OCCURS (THOUSANDS OF DOLLARS)																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.Capital Cost	508.4	0	0.0	0.0	0 0	0.0	0 0	0 0	0.0	0 0	0.0	0.0	0 0	0 0	0 0	0 0	
2.O&M Cost	0.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	
3.Annual Cost (Sum of Lines 1 and 2)	508.4	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	
4.Discount Factor (percent) 4	1.000	0.962	0.925	0.889	0.855	0 822	0.790	0.760	0.731	0.703	0.676	0.650	0 625	0 601	0 577	0 555	SUB TOTAL
5.Present Worth (Product of Lines 3 and 4)	508	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	$531
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1.Capital Cost	0.0	0.0	0 0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0	
2.O&M Cost	0 0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	
3.Annual Cost (Sum of Lines 1 and 2)	0.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	
4 Discount Factor (percent) 4	1.000	0.534	0.513	0 494	0.475	0 456	0 439	0 422	0.406	0 390	0 375	0 361	0 347	0 333	0 321	0 308	SUB TOTAL
5.Present Worth (Product of Lines 3 and 4)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	$11
																TOTAL PRESENT WORTH AT i= 4%	$542

PRESENT WORTH ANALYSIS (i=7 %)

COST COMPONENT	COST/YEAR COST OCCURS (THOUSANDS OF DOLLARS)																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.Capital Cost	508.4	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	
2.O&M Cost	0 0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	
3.Annual Cost (Sum of Lines 1 and 2)	508.4	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	
4 Discount Factor (percent) 7	1.000	0.935	0.873	0.816	0.763	0 713	0.666	0.623	0.582	0 544	0 508	0.475	0.444	0 415	0 388	0 362	SUB TOTAL
5.Present Worth (Product of Lines 3 and 4)	508.4	1 9	1.8	1.7	1.6	1.5	1.4	1 3	1.2	1 1	1.1	1 0	0 9	0 9	0 8	0 8	$527
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1.Capital Cost	0.0	0.0	0 0	0 0	0.0	0 0	0 0	0 0	0 0	0 0	0.0	0.0	0 0	0.0	0 0	0 0	
2.O&M Costs	0.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	
3.Annual Cost (Sum of Lines 1 or 2 and 3)	0.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	
5 Discount Factor (percent) 7	1.000	0 339	0.317	0 296	0.277	0.258	0 242	0 226	0.211	0.197	0.184	0.172	0.161	0 150	0 141	0 131	SUB TOTAL
6.Present Worth (Product of Lines 4 and 5)	0.0	0.7	0.7	0.6	0.6	0.5	0 5	0 5	0 4	0 4	0 4	0 4	0 3	0 3	0 3	0 3	$7
																TOTAL PRESENT WORTH AT i= 7%	$534

PRESENT WORTH ANALYSIS (i=10 %)

COST COMPONENT	COST/YEAR COST OCCURS (THOUSANDS OF DOLLARS)																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.Capital Cost	508.4	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	
2.O&M Cost	0 0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	
3.Annual Cost (Sum of Lines 1 and 2)	508.4	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	
4 Discount Factor (percent) 10	1.000	0.909	0 826	0 751	0.683	0.621	0.564	0 513	0.467	0 424	0 386	0 350	0 319	0.290	0 263	0 239	SUB TOTAL
5.Present Worth (Product of Lines 3 and 4)	508.4	1.9	1.7	1.6	1.4	1.3	1.2	1.1	1.0	0 9	0 8	0.7	0 7	0 6	0 5	0 5	$524
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1.Capital Cost	0.0	0 0	0.0	0.0	0 0	0 0	0 0	0.0	0 0	0.0	0 0	0.0	0.0	0 0	0 0	0 0	
2.O&M Cost	0 0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	
3.Annual Cost (Sum of Lines 1 and 2)	0 0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	
4 Discount Factor (percent) 10	1.000	0 218	0 195	0 180	0 164	0 149	0 135	0 123	0 112	0 102	0 092	0 084	0 076	0 069	0 063	0 057	SUB TOTAL
6.Present Worth (Product of Lines 3 and 4)	0 0	0 5	0 4	0 4	0 3	0 3	0 3	0 2	0 2	0 2	0 2	0 2	0 2	0 1	0 1	0 1	$4
																TOTAL PRESENT WORTH AT i= 10%	$528