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MCRD PARRIS ISLAND
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FEASIBILITY STUDY/CORRECTIVE MEASURES STUDY FOR SITE 12 SOLID WASTE MANAGEMENT UNIT 10 (SWMU10) JERICHO ISLAND DISPOSAL AREA MCRD PARRIS ISLAND SC

05/01/2004

TETRA TECH NUS, INC

Feasibility Study/ Corrective Measures Study

for

Site 12/SWMU 10 – Jericho Island Disposal Area

Marine Corps Recruit Depot

Parris Island, South Carolina

U.S. EPA ID # SC6 170 022 762

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0053

May 2004

FEASIBILITY STUDY/
CORRECTIVE MEASURES STUDY
FOR
SITE 12/SWMU 10 –
JERICHO ISLAND DISPOSAL AREA

MARINE CORPS RECRUIT DEPOT
PARRIS ISLAND, SOUTH CAROLINA
U.S. EPA ID #SC6 170 022 762

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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CONTRACT TASK ORDER 0053

MAY 2004

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ACRONYM LIST

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient Water Quality Criteria
B&R Environmental	Brown and Root Environmental
B(a)P Eq	benzo(a)pyrene Equivalents
bgs	below ground surface
CAA	Clean Air Act
CAMU	Corrective Action Management Unit
CAOs	Corrective Action Objectives
CCME	Canadian Council of Ministers of the Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
cm/sec	centimeters per second
CMS	Corrective Measures Study
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CPAHs	Carcinogenic polynuclear aromatic hydrocarbons
CTO	Contract Task Order
CWA	Clean Water Act
DDD	p,p'-dichlorodiphenyl dichloroethane
DDE	p,p'-dichlorodiphenyl dichloroethylene
DDT	p,p'-dichlorodiphenyl trichloroethane
DDTR	The sume of DDD, DDE, and DDT
DOD	Department of Defense
DOT	Department of Transportation
E.O.	Executive Order
ERA	ecological risk assessment
ER-L	Effects Range-Low
ER-M	Effects Range-Medium
ESV	Ecological Screening Values
FDEP	Florida Department of Environmental Protection
FS	Feasibility Study
GPS	Global Positioning System

GRA	general response actions
HHRA	human health risk assessment
HI	Hazard Index
HQ	Hazard Quotient
HSWA	Hazardous and Solid Waste Amendments of 1984
IAS	Initial Assessment Study
ILCR	incremental lifetime cancer risk
IR	Installation Restoration
LDRs	Land Disposal Restrictions
LLDPE	linear low-density polyethylene
LUCAP	Land Use Control Assurance Plan
LUCIP	Land Use Control Implementation Plan
LUCs	Land Use Controls
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MCRD	Marine Corps Recruit Depot
mg/kg	milligrams per kilogram
MHSPE	Ministry of Housing, Spatial Planning, and Environment
msl	mean sea level
MSWLF	Municipal Solid Waste Landfill
NAAQS	National Ambient Air Quality Standards
NACIP	Naval Assessment and Control of Installation Pollutants
NAVFACENGCOM	Naval Facilities Engineering Command
Navy	United States Navy
NCP	National Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutant
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standards
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAHs	polynuclear aromatic hydrocarbons
PCBs	polychlorinated biphenyls

PELs	Probable Effects Levels
PPE	personal protective equipment
ppm	parts per million
PRG	Preliminary Remediation Goal
PVC	polyvinyl chloride
R.	regulation
RAOs	Remedial Action Objectives
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RGO	Remedial Goal Options
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SDWA	Safe Drinking Water Act
SMCL	Secondary Maximum Contaminant Level
SOUTHDIV	Southern Division
SOUTHNAVFAC	Southern Division Naval Facilities
SSL	Soil Screening Level
SVOCs	semivolatile organic compounds
SWDA	Solid Waste Disposal Act
SWMU	Solid Waste Management Unit
TBC	to be considered
TDS	total dissolved solids
TEF	toxicity equivalent factors
TELs	Threshold Effects Levels
TSCA	Toxic Substance Control Act
TSD	treatment, storage, and disposal
TtNUS	Tetra Tech NUS, Inc.
U.S. EPA	United States Environmental Protection Agency
U.S.C.	United States Code
USFWS	United States Fish and Wildlife Service
VOCs	volatile organic compounds
yd^3	cubic yard

RESPONSE TO COMMENTS

RESPONSES TO EPA COMMENTS ON
REMEDIAL INVESTIGATION/RCRA FACILITIES INVESTIGATION REPORT FOR SITE 12/SWMU 10 – JERICHO ISLAND
MARINE CORPS RECRUIT DEPOT
PARRIS ISLAND, SOUTH CAROLINA

General Comments:

1. **Comment:** EPA concurs with the finding in this FS/CMS that excavation and off-site disposal of waste and contaminated media is the most robust and cost-effective alternative for site remediation evaluated in the FS/CMS.

   Response: Acknowledged.

Specific Comments:

1. **Comment: Page ES-1, 1st Paragraph, 3rd Sentence.** "this" or "the" should be added between "of" and "FS/CMS" in this sentence.

   Response: Agree. The change will be made.

2. **Comment: Page ES-5, Alternative 4, 5th Sub-bullet.** It is not necessary to specify off-site disposal of oversized debris as a separate component of this alternative since all waste is being disposed off-site under this remedy. This comment applies globally to descriptions of the components of Alternative 4 within the FS/CMS.

   Response: Agreed. In regards to Alternative 4, reference to off-site disposal of oversized debris will be changed throughout the document.

3. **Comment: Comment: Page ES-8, Table ES-1, 1st Criterion.** Please include the estimated time to attain RGOs for alternatives 3 and 4 (i.e., at the completion of the remedial action).

   Response: Agree. Alternatives 3 and 4 are estimated to take less than 7 months and 5 months, respectively, to achieve RGOs. This information will be added as requested.

4. **Comment: Page 2-1, Section 2.1, 3rd Paragraph, 2nd Sentence.** Based on Figure 2-1, it appears the east-central debris area should be referred to as the west-central debris area. The east-central area appears to be an area of PAH-contaminated soil. Please correct as appropriate.

Response: Agree. East-central will be changed to west-central.

5. **Comment: Page 2-3, Section 2.3.** Please include a summary of the number of samples collected by media for each investigation. A summary table and a map illustrating the sampling locations is needed.

   Response: Agree. Sample summary tables and sample location maps will be added as requested.

6. **Comment: Page 3-13, Section 3.2.3, 3rd Paragraph.** Clarify the aspects of the RCRA Subtitle D criteria that are considered relevant and appropriate, and why. Specifically, the alternatives that rely on excavation, on-site consolidation and covering or capping appear to be working within the framework of the Area of Contamination (AOC) Policy. This should be stated. The exclusion of some landfill design elements, specifically a bottom liner and leachate collection system, that are technically feasible and relevant to the onsite disposal remedies should be justified.

   Response: Waste that is present at Jericho Island is likely non-hazardous. Consequently, RCRA Subtitle D is deemed relevant and appropriate. However, the Navy did not intentionally work within the AOC Policy.

   Please note that Alternatives 2A, 2B, and 3 were costed in the FS assuming that a cap would be installed that is suitable for a RCRA Subtitle C landfill. Elements of the cost estimate include a 12-inch intermediate cover/gas-collection layer, a geosynthetic clay layer, a geomembrane liner, a geosynthetic drainage layer, an 18-inch native soil layer, and a 6-inch topsoil layer. These elements will be added to the description of the alternatives.

   As a point of departure, cost estimates were also developed (as part of these responses to comments) assuming that a RCRA Subtitle D landfill cover system was to be implemented instead of a RCRA Subtitle C cover system. The cost estimate assumes that the cover system would consist of a 6-inch biotic layer of crushed gravel, an 18-inch layer of native soil, and a 6-inch topsoil layer. A cost comparison is provided as follows.

	Capital Costs ($)	O&M Costs		Total Present Worth($)
		Min ($)	Max ($)	
Alternative 1	-	-	-	-
Alternative 2a				
RCRA C Cap	$1,286,000	$45,500	$92,900	$1,938,000
Soil Cover	$1,099,000	$45,500	$92,900	$1,752,000
Alternative 2b				
RCRA C Cap	$1,458,000	$45,500	$192,900	$2,203,000
Soil Cover	$1,272,000	$45,500	$192,900	$2,018,000
Alternative 3				
RCRA C Cap	$1,609,000	$45,500	$91,500	$2,255,000
Soil Cover	$1,342,000	$45,500	$91,500	$1,988,000
Alternative 4				
RCRA C Cap	$1,450,000	-	-	$1,450,000

It is proposed that Alternatives 2A, 2B, and 3 be revised to indicate that possible cover systems could include either one suitable for a RCRA type C or type D cover system. A description of the two possible systems will be provided as well as associated costs in the text of Section 5.0.

Also, please note that the total present worth for all of the containment options (Alternatives 2A, 2B, and 3) are higher than Alternative 4 (off-site disposal of all media).

7. **Comment: Page 3-22, Section 3.4.3, 1st Paragraph, 4th Sentence.** Both the on-site containment and off-site disposal alternatives would address surface water contamination through source removal. Please re-phrase to clarify that these remedial alternatives will address surface water contamination through source removal.

Response: Partially agree. RI data indicates that surface water does not pose unacceptable risks to human health and poses minimal risks to ecological receptors. Section 3.4.3 will be rewritten as follows.

"Based on the results of the RI, surface water is not retained as a medium of concern in this FS/CMS. The results of the HHRA indicate that surface water does not pose unacceptable risks to human health, and the ERA indicates that surface water poses minimal risks to ecological receptors. However, incidental risks posed to human and ecological receptors from exposure to surface water will be indirectly addressed through actions taken to address contaminated soil, sediment, surface debris (i.e., through source removal or containment). Actions taken to address

these contaminated media will reduce the potential for migration of COCs in these media to surface water. For example, if contaminated sediment were excavated and consolidated with the soil and debris and the entire consolidated mass was capped with an engineered landfill cap, the source of the surface water contamination would be contained. "

8. **Comment: Page 3-23, Section 3.4.4, 1st Paragraph, 4th Sentence.** Similar to specific comment 7, clarify that both on-site containment and off-site disposal alternatives will address groundwater contamination through source removal.

   Response: Agree. The following sentence will be added as the first sentence of the second paragraph of Section 3.4.4.

   "Groundwater will not be retained as a medium of concern for human health and ecological concerns; however, incidental risks posed to human and ecological receptors from exposure to groundwater will be indirectly addressed through actions taken to address contaminated soil, sediment, surface debris (i.e., through source removal or containment)."

   The last sentence of this second paragraph of Section 3.4.4 will be removed.

9. **Comment: Page 3-23, Section 3.5.1, 1st Paragraph.** The acronym ICR is defined in the text as Incremental Concern Risk, and is defined in the Acronym List as Incremental Cancer Risk. Also, the undefined acronym ILCR (incremental lifetime cancer risk) is used in the text. Please select the appropriate term and use it consistently throughout the FS/CMS.

   Response: Agree. The acronym ICR will be replaced with ILCR. This acronym will be defined in the acronym list and in the first instance of its use in the text as "incremental lifetime cancer risk."

10. **Comment: Page 3-26, Section 3.7, 2nd Paragraph, 1st Bullet, 2nd Sentence.** Please substantiate the use of background values from MCRD Parris Island Site 1 for establishing baseline concentrations at Site 12. In particular, the ubiquitous background concentrations of pesticides found on Parris Island are associated with long-term application to control pests in populated areas. However, Jericho Island is remote from Parris Island, has only been part of MCRD since 1968, is unpopulated, and is relatively inaccessible, making this comparison suspect. This comment also applies to the ecological RGOs.

    Response: The inorganic background data set is applicable to Jericho Island. Inorganic background samples were collected from two locations – Pickney Island and an undeveloped area on the

southwestern portion of Parris Island. These areas are remote from the developed areas or waste management activities at Parris Island and are therefore biased toward clean to avoid anthropogenic sources of contamination. Consequently, no change will be made in regards to the use of the inorganic background data set at Jericho Island.

As can be referenced in the RI, all pesticide detections correspond to areas where soil will be removed under Alternative 4. For simplicity, no change is proposed to the text.

11. **Comment: Page 3-26, Section 3.7, 2nd Paragraph, 1st Bullet and Tables 3-4 and 3-5.** The discussion in the text is generally organized by receptor/risk scenario and the tables are organized by media. Revising the text to better correspond to the tables, or vice versa, would clarify this presentation.

    Response: Agree. The text will be revised to correspond with the tables.

12. **Comment: Pages 3-29 through 3-22, Table 3-1.** The EPA Region 4 Land Use Control Policy is applicable, relevant and appropriate.

    Response: In accordance with the December 17, 2003 teleconference of the MCRD Parris Island Partnering Team, the EPA Region 4 Land Use Control Policy will be added as an ARAR as well as the Navy's Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions (Department of the Navy, 2003).

13. **Comment: Page 3-37, Table 3-5, 5th Column, Header.** This column title should be changed to surface soil RGO rather than sediment RGO.

    Response: Agree. The change will be made.

14. **Comment: Page 4-4, Section 4.4, 2nd Paragraph.** Provide some general guidance (rough order of magnitude) for interpreting low, moderate, and high costs.

    Response: Agree. A rough order of magnitude description of costs corresponds to the following. This general guidance will be added to the text of the report.

    - low costs - less than $500,000
    - medium costs - $500,000 to $5,000,000
    - high costs - greater than $5,000,000

15. **Comment: Page 4-5, Section 4.5.1.2.** Separate land use controls and monitoring into two distinct general response actions. These processes are distinct components of potential remedies, and are considered separate response actions by EPA. This change affects subsequent sections of the FS/CMS as well.

    Response: Agree. The change will be made.

16. **Comment: Page 4-6, Section 4.5.1.2, 2nd Paragraph, 8th Sentence.** Clarify this statement to indicate that a former residential well was located on Jericho Island, and that it has not been properly abandoned.

    Response: Partially agree. The statement will be rephrased as

    "A drinking water well is located on Jericho Island; however, this well is scheduled to be abandoned in conjunction with other field activities on the Depot."

    Abandonment of the well was discussed in a letter from the Navy to SCDHEC (Art Sanford to Don Hargrove; February 7, 2003). As discussed during the December 17, 2003 teleconference of the MCRD Parris Island Partnering Team, the Navy will be including this task in an upcoming statement of work that will be sent to Tetra Tech NUS, Inc. The time frame for completion of this task is the summer of 2004.

17. **Comment: Page 4-6, Section 4.5.1.2, 4th Paragraph.** Clarify whether or not institutional controls are already in place for Jericho Island. Since this property is located within the range control safety arc, there may be significant institutional controls in place already.

    Response: There are no formal land use controls in place at this time. However, access is effectively restricted by poor vehicle access and dense forestation. This information will be added to the text of the referenced section.

18. **Comment: Page 4-7, Section 4.5.1.2, 1st Paragraph, 2nd Sentence.** Clarify that institutional controls may be combined with other process options to form remedial alternatives.

    Response: Agreed. The change will be made.

19. **Comment: Page 4-7, Section 4.5.1.3, 1st Paragraph.** Cost estimating for both a multi-layer cap system and an earthen cover were completed as part of the evaluation of the total containment alternative. The description of the containment technology, and subsequent evaluation and alternatives development, should clarify the distinction between these approaches (i.e., cap system versus cover), where necessary.

    Response: A distinction between the relative costs of covers versus multi-layer caps will be added to the document.

20. **Comment: Page 4-15, Section 4.5.2.4, 4th Paragraph, 2nd Sentence.** It appears that the removal process option primarily describes use of excavation technology. As such, removal would be a component of on-site consolidation as well as off-site disposal. Therefore, removal, as defined, is not inconsistent with the presumptive remedy.

    Response: To resolve the inconsistency, the title of the section will be changed from "Removal" to "Excavation."

21. **Comment: Page 4-22, Section 4.5.3.4, 1st Paragraph, 1st Sentence.** "alternative" should be changed to "option" or "approach" to avoid confusion with the subsequent remedial alternatives development.

    Response: Agree. "Alternative" will be replaced with the word "option."

22. **Comment: Pages 4-25 through 4-28, Sections 4.6 and 4.7.** As previously noted, the distinction between alternatives using a single-layer cap (sic. cover) and multi-layer cap system needs to be clarified.

    Response: Agreed. The description of Alternatives 2A, 2B, and 3 will be revised to indicate that possible cover systems could include either one suitable for a RCRA-type landfill or a soil cover system. A description of the two possible systems will be provided as well as associated costs.

23. **Comment: Page 4-26, Section 4.7, 3rd Paragraph, 2nd through 4th Bullets.** Land use controls should be added to the title/list of remedy components for these alternatives.

    Response: Agree. Land-use controls will be added to the title of these alternatives.

24. **Comment: Page 5-2, Section 5.1.2, 1st Paragraph, 8th Bullet.** It should be indicated that operation and maintenance is an ongoing obligation (i.e., in perpetuity) even if the present worth of O&M beyond 30 years is negligible.

    Response: Agree. The statement will be added to Section 5.2.5.5.

25. **Comment: Page 5-5, Section 5.1.2, 4th Paragraph.** It should be noted that installation of a bottom liner and leachate collection system would likely limit, or possibly eliminate, the groundwater monitoring requirement for this remedy. Consideration should be given to including this feature in the on-site containment/disposal alternatives, although it is unlikely to decrease the cost for on-site disposal relative to off-site disposal.

    Response: As discussed during the December 17, 2003 teleconference of the MCRD Parris Island Partnering Team, the state expressed concern with reducing groundwater monitoring requirements for any on-site containment/disposal alternative. As a result, no change to the report will be made.

26. **Comment: Page 5-6, Section 5.1.2, 1st Paragraph, 2nd Sentence.** The reference to "lower strata of disposed ash" appears to be a carryover from the Site 1 FS/CMS. Please correct or clarify this statement. This text appears in parallel descriptions of other sections as well.

    Response: Agree. The statement will be removed and similar statements throughout the document will also be removed.

27. **Comment: Page 5-7, Section 5.1.2, 2nd Paragraph, 4th Sentence.** The condition for terminating monitoring should be specified. For example, after three consecutive measurements below RGO's, the Navy will notify the regulatory agencies in the Annual Monitoring Report that no additional soil monitoring will be performed. This same comment applies to monitoring requirements presented with other alternatives.

    Response: Specific details for terminating sampling would be covered in the long-term monitoring plan for the chosen remedy. No change is proposed.

28. **Comment: Page 5-8, Section 5.1.3, 3rd Paragraph, 6th Sentence.** Quarterly or semi-annual sampling of treated soils is recommended for the first year.

    Response: Agree. The alternative will be revised to include semiannual sampling of treated soils for the first year.

29. **Comment: Page 5-13, Section 5.1.4, 1st Paragraph, 1st Bullet.** If "the debris pile" were changed to "all", the description of this component of this alternative could be shorter and less cumbersome. This comment would apply to subsequent descriptions of this component of Alternative 3.

    Response: Agree. The change will be made.

30. **Comment: Page 5-16, Section 5.1.4, 4th Paragraph.** As previously discussed, the distinction between a cover and cap system should be made clearly in the technology evaluation, and applied to all on-site containment alternatives, as appropriate.

    Response: The description of Alternatives 2A, 2B, and 3 will be revised to indicate that possible cover systems could include either one suitable for a RCRA-type landfill or a soil cover system. A description of the two possible systems will be provided as well as associated costs.

31. **Comment: Page 5-19, Section 5.1.5, 1st Paragraph, 1st Sentence.** The reference to Figure 5-6 should be changed to Figure 5-5, or another Figure should be added to the FS/CMS.

    Response: Agree. The change will be made.

32. **Comment: Page 5-19, Section 5.1.5, 4th Paragraph.** Convert 69,200 ft^2 to 1.58 acres to be consistent with the unit of area used in other sections of the FS/CMS.

    Response: 69,200 ft^2 will be converted to 1.6 acres.

33. **Comment: Page 5-21, Section 5.1.5, 1st Paragraph, 1st Sentence.** Include a provision for one year of surveillance and maintenance to ensure adequate re-establishment of vegetation since routine inspection of an on-site disposal cell is not a component of this alternative.

    Response: Agree. A provision for 1 year of surveillance and maintenance will be added to the description of this alternative.

34. **Comment: Pages 5-35 through 5-39, Section 5.3.4.** The distinction between a multi-layer cap system and an earthen cover is not addressed in this section. If the earthen cover is considered a potentially viable approach for on-site disposal of wastes and contaminated media, then it should be clearly presented here and for other on-site containment alternatives, as appropriate.

Response: The description of Alternatives 2A, 2B, and 3 will be revised to indicate that possible cover systems could include either one suitable for a RCRA-type landfill or a soil cover system. A description of the two possible systems will be provided as well as associated costs.

35. **Comment: Page 5-40, Section 5.3.5.2, 1st Paragraph, 1st Sentence.** Clarify the distinction between Alternatives 4 and 3 regarding attainment of chemical-specific ARARs. Both alternatives involve excavation of all waste and contaminated soil and sediment, and isolation of these materials from the environment at Site 12 (through off-site disposal or on-site containment, respectively). Additionally, neither alternative directly addresses surface water or groundwater contamination. Therefore, recovery of surface water and groundwater under both alternatives would be essentially the same. Clarify why Alternative 4 is presented as immediately attaining chemical-specific ARARs and Alternative 3 as having exceptions for these media pending an indefinite recovery period.

Response: As described previously, RI data indicates that surface water and groundwater do not pose unacceptable risks to human health and ecological receptors. However, MCLs for cadmium and thallium were exceeded in groundwater and AWQC for several chemicals were exceeded. The text of Section 6.2.2 will be revised to indicated that the time frame for the recovery of surface water under Alternatives 3 and 4 is the same and that actions conducted under these alternatives will prevent the potential for incidental contamination of these media from occurring.

36. **Comment: Page 6-2, Section 6.2.2, 2nd Paragraph, 4th Sentence.** It appears that Alternative 4 should be included with the series of Alternatives 2a, 2b, and 3 with the notation that this is through removal and on-site/off-site containment (see specific comment 36).

Response: Partially agree. Alternative 4 will be added as an alternative that would eliminate the release of waste materials through excavation and off-site disposal.

37. **Comment: Page 6-3, Section 6.2.2, 2nd Paragraph.** As previously noted, these statements must be substantiated before they can be accepted.

Response: The referenced paragraph and the first paragraph of page 6-3 will be replaced with the following.

> "RI data indicates that surface water and groundwater do not pose unacceptable risks to human health or ecological receptors although several chemicals would remain above chemical-specific ARARs for surface water and groundwater. However, under Alternatives 3 and 4, the potential transport of waste and incidental concentrations of soil and sediment COCs to groundwater and

surface water would be eliminated through containment (Alternative 3) or excavation and off-site disposal (Alternative 4). Both alternatives would meet all soil and sediment chemical-specific ARARs immediately after completion of remediation activities, and groundwater and surface water chemical-specific ARARs would be met in the long term."

38. **Comment: Pages 6-4 and 6-5, 5th Paragraph and 1st Paragraph.** Alternative 4 should be included in these series describing the short-term effects of excavation.

    Response: Agree. Alternative 4 will be added to this discussion.

39. **Comment: Page 6-7, Table 6-1, 2nd Row.** As previously noted, the distinction in compliance with ARARs for Alternative 4 relative to Alternatives 2a, 2b and 3 must be substantiated.

    Response: The referenced entry will be modified to indicate that compliance with soil and sediment chemical-specific ARARs would be achieved when the remedial action is complete and that compliance with AWQCs and MCLs would be achieved in the future.

References

Department of the Navy, 2003. Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-Rod Actions, March, 17.

United States Environmental Protection Agency, 1998. Memorandum: Assuring Land Use Controls at Federal Facilities. Region IV, Federal Facilities Branch. April 13.

RESPONSES TO SCDHEC COMMENTS ON
DRAFT FEASIBILITY STUDY/CORRECTIVE MEASURES STUDY REPORT FOR SITE 12/SWMU 10 – JERICHO ISLAND
MARINE CORPS RECRUIT DEPOT
PARRIS ISLAND, SOUTH CAROLINA

Comments from: Donald C. Hargrove, Hydrogeologist
RCRA Hydrogeology Section I
Division of Hydrogeology
Bureau of Land and Waste Management

1. **Comment:** Executive Summary: This section states that thallium and vanadium exceeded the ecological screening values in filtered surface water samples, but later in the document (Section 2.3), only thallium is listed as exceeding the ecological screening values. Please verify which of these statements is true, and revise the text accordingly.

   Response: A surface water screening value does not exist for vanadium. The Executive Summary text will be revised to indicate that only thallium exceeded ecological screening values in filtered surface water.

2. **Comment:** Section 2.3, Nature and Extent of Contamination: This section discusses surface water sampling results and their comparison to human health criteria as well as ecological criteria. However, there does not seem to be a table that presents the data. Please revise the text to include a table that presents the numerical data, and reference the table in the text accordingly.

   Response: Disagree. This information is presented in detail in the RI/RFI report for the site and the RI/RFI is referenced in the text of 2.3. No change is proposed.

3. **Comment:** Section 3.4.4, Groundwater: This section states that there is a drinking water well located on Jericho Island. MCRD has stated in writing that this well is to be abandoned in July 2003 (letter, Sanford to Hargrove dated 13 February 2003). Reference to this well abandonment should be included in this section. Please revise accordingly.

   Response: Agree. The last sentence of the first paragraph of Section 3.4.4 will be replaced with the following.

   > "A drinking water well is located on Jericho Island; however, this well is scheduled to be abandoned in conjunction with other field activities on the Depot."

   Abandonment of the well was discussed in a letter from the Navy to SCDHEC (Art Sanford to Don Hargrove; February 7, 2003). As discussed during the December 17, 2003 teleconference of the

MCRD Parris Island Partnering Team, the Navy will be including this task in an upcoming statement of work that will be sent to Tetra Tech NUS, Inc. The time frame for completion of this task is the summer of 2004.

4. **Comment:** Table 3-3, Comparison of Groundwater Human Health COPCs to Federal and State Groundwater Criteria:
   a) This table shows a comparison between groundwater analytical results and background surface water. This type of comparison is not discussed in the text. Section 3 should be revised to discuss this comparison.
   b) This table uses the same numbers for the background surface water comparisons of both the filtered and the unfiltered analytical results. The type of surface water samples that were used (filtered vs. unfiltered) should be specified, and only used for comparison of the like sampling results for groundwater at SWMU-10. Please revise the text accordingly.

   Response:
   a) Agree. The first sentence of the second paragraph of Section 3.4.4 will be deleted and the following text will be added as the second paragraph of Section 3.4.4.

      "As determined in the HHRA, acetone, chloroform, aluminum, arsenic, cadmium, iron, manganese, and thallium were identified as human health COPCs based on a comparison of maximum site concentrations to risk-based screening levels and State and federal MCLs. However, as shown in Table 3-3, only thallium in one unfiltered groundwater sample and cadmium in filtered and unfiltered groundwater samples exceeded State and federal MCLs."

   b) Agree. Background surface water samples were collected as unfiltered samples. The background surface water results used for comparison to filtered samples will be removed from Table 3-3 and replaced with NA (not applicable).

5. **Comment:** Section 5.1.5, Alternative 4: Appendix B specifies monitoring well abandonment as part of this remedy alternative by including it in the overall cost projection. However, Section 5.1.5 does not describe well abandonment as part of the site restoration. Please revise the text to include some discussion on monitoring well abandonment as part of Alternative 4.

   Response: Agree. The following text will be added to Component 6 (Restoration of Site) of Alternative 4.

   "As part of site restoration activities, existing monitoring wells would also be abandoned in accordance with the State of South Carolina monitoring well regulations (R.61-71)."

Comments from: **Stacey French**
Corrective Action Engineering Section
Division of Hazardous and Infectious Waste Management
Bureau of Land and Waste Management

GENERAL COMMENTS

1. **Comment:** Section 5 references excavation and off-site disposal of oversized materials from the debris piles. However, the disposition is not detailed. The MCRD must ensure that the debris is properly characterized and shipped to a compatible permitted landfill (i.e. South Carolina Subtitle C landfill, etc.). The name of the disposal sites should be provided for each type of waste. Please revise appropriate sections.

   Response: While it is agreed that waste characterization would be required prior to any off-site disposal of debris; characterization is typically performed during the remedial action/corrective measures implementation phase of the remedial process. Furthermore, the final destination of the material is typically determined after characterization is performed and a suitable landfill can be identified. Both waste characterization results and waste disposal manifests would be included in a remedial action/corrective measures implementation closure report that would document all cleanup actions. In Section 5.0 of the FS/CMS, the text of the component descriptions of Alternatives 2A, 2B, and 3 will indicate that any waste disposed off site will be characterized prior to disposal. Alternative 4 already indicates this information.

SPECIFIC COMMENTS

1. **Comment: Section 1.1. Purpose of Report, pg 1-1.** The last sentence of the section states that, "the FS/CMS Report uses the results of the RI/RFI to develop and evaluate potential remedial alternatives/corrective measures." Please note that the Department has not approved the final Remedial Investigation/ Resource Conservation and Recovery Act Facility Investigation for Site 12/SWMU 10. The Department is currently reviewing the final revisions to the document, and will either issue additional comments or approve the document as written.

   Response: Acknowledged.

2. **Comment: Section 2.1 Site Description, second paragraph, pg 2-1**. The second sentence states that, "the island was acquired by the Navy in 1968 to comply with the limited distance arc required for MCRD Parris Island's rifle range." However, the location of the rifle range is not indicated in any figure presented in the FS/CMS.

Response: Agree. The location of the rifle range will be identified on Figure 1-1.

3. **Comment: Section 2.2 Site-Specific Geology and Hydrogeology, third paragraph, pg 2-2**. The second sentence states, "debris was observed on the surface, but was not encountered at depth." For clarification, please define the term "at depth".

   Response: The term "at depth" indicates "greater than 1 foot below ground surface." The paragraph will be changed accordingly.

4. **Comment: Figure 2-1, Site Layout Site 12/ SWMU 10, pg 2-13**. The text seems to indicate that SWMU 10 consists of the entire islands. However, the SWMU boundary is not indicated on the map. Please revise to specify the SWMU boundary. Additionally, there is a concrete pad shown in the southern end of the island. However, there is no indication in the text as to the use or fate of the pad. Please provide clarification in the text.

   Response: The SWMU constitutes the perimeter of the island. Figure 2-1 will be revised to include the SWMU boundary. As discussed in Appendix C of the RI/RFI Work Plan (B&R Environmental, 1998), the Marine Corps reportedly used this concrete foundation for a landing light for the base's former runway. This reported use is supported by the fact that the southeast/northwest segment of the runway is aligned with Jericho Island (as can be seen on Figure 1-1). This information will be added as the fourth paragraph of Section 2.1.

5. **Comment: Figure 2-2, Cross Section Location and Surface Debris Map, pg 2-15**. For clarification, please indicate in the text how the debris pile locations were located on the map (i.e. through GPS coordinates, etc.).

   Response: Agree. The following text will be added to the third paragraph of Section 2.1.

   > "The dimensions of the debris piles illustrated on Figures 2-1 and 2-2 were measured in the field with a tape measure and referenced to surveyed surface soil and sediment sample locations."

6. **Comment: Section 3.7 Remedial Goal Options, pg 3-26**. This section outlines the RGOs for human and ecological receptors as; PRGs and ESVs (10^{-6}) for the risk drivers identified in the RI/RFI. Please provide rationale for selecting these conservative RGOs as opposed to using the RGOs calculated in the RI/RFI.

   Response: In the RI/RFI, human health RGOs were calculated as part of the human health risk assessment; however, RGOs for protection of ecological receptors were not calculated. The RGO

methodology discussed in Section 3.7 of the FS/CMS includes protection of ecological receptors and was developed in conjunction with the MCRD Parris Island ecological subcommittee. In general, the ecological RGO values tend to be less than those developed for the protection of human health. No change is proposed.

7. **Comment: Section 3.8, Quantity of Impacted Media, pg 3-27**. This section references Section 3.6 for the identification of RGOs. This reference is incorrect, and should be changed to Section 3.7.

   Response: Agree. The reference will be changed.

8. **Comment: Table 3-5, pg 3-37**. Refer to comment #6, and revise as necessary.

   Response: Please see the response to comment #6. No change is proposed.

9. **Comment: Section 4.0 Identification, Screening, and Development of Remedial Action/ Corrective Measure Alternatives, pg 4-1.** This reference land-use controls as being a necessary component to many of the remedial alternatives presented. However, there is no clear listing of the exposure assumptions used to develop the specific land-use controls. This is of concern to the Department, as the purpose of establishing land-use controls will be used to limit human and ecological exposure to waste/contamination left in place. Please revise the appropriate subsections to include an explanation of the exposure assumptions for each recommended land-use control.

   Response: Partially agree. In Section 5.0, the general components of land-use controls are currently stated for all alternatives that leave waste and contaminated media at the site (Alternatives 2a, 2b, and 2c); however, the description of the land-use controls in Section 5.0 will be expanded as discussed in subsequent comment responses.

   If either Alternative 2a, 2b, or 3 were to be implemented, a further description of the land-use controls would be included as part of the Record of Decision for Site 12/SWMU 10.

10. **Comment: Section 4.7.2 Alternative 2a- Monitored Natural Recovery of PAH-Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Material, pg 4-27**. The last bullet of the section outlines the land-use controls associated with the remedy. Since waste will be left in place under this alternative, additional land-use controls should be included. These should include the following at a minimum: signs designating the site as a SWMU, fencing, residential use restrictions, dig restrictions, and restrictions for installation of groundwater wells. Please revise this section accordingly. Also, refer to comment #9.

Response: Partially agree. The purpose of this section is to provide a short, concise outline of the remedial components of Alternative 2a. As discussed in the beginning of Section 4.7, alternatives are briefly explained in this section and a detailed description of each alternative is provided in Section 5.0. No change to this section will be made; however, Section 5.0 will be revised to include an expanded land-use control discussion adding the elements discussed in the reviewer's comment. Specific language to be added is provided in the response to comments #15.

11. **Comment: Section 4.7.3 Alternative 2b- Enhanced Biodegradation of PAH-Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Material, pg 4-27**. Refer to comment #10.

    Response: Partially agree. The purpose of this section is to provide a short, concise outline of the remedial components of Alternative 2b. As discussed in the beginning of Section 4.7, Alternatives are briefly explained in this section and a detailed description of each alternative is provided in Section 5.0. No change to this section will be made; however, Section 5.0 will be revised to include an expanded land-use control discussion adding the elements discussed in the reviewer's comment. Specific language to be added is provided in the response to comments #17.

12. **Comment: Section 4.7.4 Alternative 3- Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials, pg 4-28**. Refer to comment # 10.

    Response: Partially agree. The purpose of this section is to provide a short, concise outline of the remedial components of Alternative 3. As discussed in the beginning of Section 4.7, Alternatives are briefly explained in this section and a detailed description of each alternative is provided in Section 5.0. No change to this section will be made; however, Section 5.0 will be revised to include an expanded land-use control discussion adding the elements discussed in the reviewer's comment. Specific language to be added is provided in the response to comments #19.

13. **Comment: Section 5.1 Remedial Action/Corrective Measures Alternatives, pg. 5-1**. This section, along with many others, summarizes the potential remedies for SWMU 10. However, the components for the alternatives are not consistent throughout the document. For instance, Section 4.7.2 lists land-use controls as a portion of alternative 2a and Section 5.1 does not. This document should provide a clear outline for the public and for the Department to use in evaluating the various remedial alternatives. Please revise this section and all others to consistently describe the remedial alternatives.

Response: It is unclear what inconsistencies the reviewer is referencing. Section 5.1 briefly lists the titles of all the alternatives and the subsequent subsections of Section 5.1 outline the components of each alternative. In Section 5.1, the title of Alternative 2a is identical to the title listed in Section 4.7.2. In the last bullet of Section 4.7.2, a brief statement is made stating that land-use controls would be implemented. The same statement is made in the introductory section of Section 5.1.2 and the land-use controls are further described as Component 8 of Section 5.1.2. Other than the expanded description that will be added in response to the reviewer's other comments on this subject, no changes are proposed.

14. **Comment: Section 5.1.2 Alternative 2a- Monitored Natural Recovery of PAH-Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Material, pg 5-2**. Refer to comment # 10.

    Response: The purpose of this section is to briefly outline the components of each alternative. As discussed in the paragraph following the referenced bullet, the details of each of the alternative's components are discussed in the text that follows. No changes are necessary for the referenced bullet.

15. **Comment: Section 5.1.2 Alternative 2a- Component 8 pg 5-2. Refer to comment # 10**. The land-use controls detailed in this section should be consistent with those listed on page 5-2.

    Response: In response to this comment and comment #10, the first paragraph of Component 8 of Section 5.1.2 will be replaced with the following:

    "Land-use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the material consolidated under the cover system (e.g., dig restrictions), to restrict access to areas with PAH-contaminated soil, to prevent residential development of the site, and to ban the use of the groundwater as a drinking water supply. A gate would be placed at the dirt road entrance to Jericho Island to prohibit unauthorized vehicles and fencing would be placed around the consolidated material. Signs would be posted to alert users of the property about the presence of the SWMU."

16. **Comment: Section 5.1.3 Alternative 2b- Enhanced Biodegradation of PAH-Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Material, pg 5-8**. Refer to comment # 10.

Response: The purpose of this section is to briefly outline the components of each alternative. As discussed in the paragraph following the referenced bullet, the details of each of the alternative's components are discussed in the text that follows. No changes are necessary for the referenced bullet.

17. **Comment: Section 5.1.3 Alternative 2b- Component 8, pg. 5-12**. Refer to comment # 15.

Response: In response to this comment and comment #11, the first paragraph of Component 8 of Section 5.1.3 will be replaced with the following:

> "Land-use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the material consolidated under the cover system (e.g., dig restrictions), to restrict access to areas with PAH-contaminated soil, to prevent residential development of the site, and to ban the use of the groundwater as a drinking water supply. A gate would be placed at the dirt road entrance to Jericho Island to prohibit unauthorized vehicles and fencing would be placed around the consolidated material. Signs would be posted to alert users of the property about the presence of the landfill."

18. **Comment: Section 5.1.4 Alternative 3- Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials, pg 5-13**. Refer to comment # 10.

Response: The purpose of this section is to briefly outline the components of each alternative. As discussed in the paragraph following the referenced bullet, the details of each of the alternative's components are discussed in the text that follows. No changes are necessary for the referenced bullet.

19. **Section 5.1.4 Alternative 3- Component 6, pg. 5-17**. Refer to comment # 15.

Response: In response to this comment and comment #12, the first paragraph of Component 6 of Section 5.1.4 will be replaced with the following:

> "Land-use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the material consolidated under the cover system (e.g., dig restrictions), to prevent residential development of the site, and to ban the use of the groundwater as a drinking water supply. A

gate would be placed at the dirt road entrance to Jericho Island to prohibit unauthorized vehicles and fencing would be placed around the consolidated material. Signs would be posted to alert users of the property about the presence of the landfill."

20. **Section 5.3.2.2 Compliance with ARARs/Media Cleanup Standards, pg. 5-27.** Refer to Comment #6.

    Response: Please refer to comment response #6.

21. **Comment: Section 5.3.2.5 Cost Analysis, pg 5-31.** In conjunction with Appendix B, this section presents a cost estimate for the remedial alternative. However, this section does not clearly outline how the long-term costs for land-use controls were estimated. Previous sections discuss the remedial costs qualitatively; therefore, it is important for the Department to understand how the costs were estimated. The cost estimates provided in Appendix B do not clearly outline the costs for implementing land-use controls (i.e. sign installation, fencing, etc.). Please revise the text and Appendix B to clarify.

    Response: Agree. The description of the land-use controls have been revised per comment response #15. The cost estimate will be revised to include costs to install a gate, fencing, and signage.

22. **Comment: Section 5.3.3.2 Compliance with ARARs/Media Cleanup Standards, pg. 5-32.** Refer to Comment #6.

    Response: Please refer to comment response #6.

23. **Comment: Section 5.3.3.5 Cost Analysis, pg 5-35.** Refer to Comment # 21.

    Response: Agree. The description of the land-use controls has been revised per comment response #17. The cost estimate will be revised to include costs to install a gate, fencing, and signage.

24. **Comment: Section 5.3.4.2 Compliance with ARARs/Media Cleanup Standards, pg. 5-36.** Refer to Comment #6.

    Response: Please refer to comment response #6.

25. **Comment: Section 5.3.3.5 Cost Analysis, pg 5-39.** Refer to Comment # 21.

    Response: Agree. The description of the land-use controls have been revised per comment response #19. The cost estimate will be revised to include costs to install a gate, fencing, and signage.

26. **Comment: Section 5.3.5.2 Compliance with ARARs/Media Cleanup Standards, pg. 5-40.** Refer to Comment #6.

    Response: Please refer to comment response #6.

27. **Comment: Figure 5-1 Alternative 2a- Monitored Natural Recovery of PAH-Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Material, pg 5-43.** This figure shows a 175 ft. by 175 ft. consolidation area. However, the text does not explain how the location of the consolidation area was selected. The Department is concerned that the consolidation area may be located in a currently unimpacted area of the SWMU. Additionally, there is no discussion of the measures to be taken to ensure that RCRA Land Disposal Restrictions are not triggered during the implementation of the remedial alternative (i.e. CAMU, etc.). Please revise the text accordingly.

    Response: The consolidation area was chosen on an upgradient portion of the island so that flooding concerns would be minimized. This statement will be added to the text.

    As previously stated in comment response #4, the SWMU boundary consists of the perimeter of the entire island. Under Alternatives 2a, 2b, and 3, waste would be kept within the boundary of the SWMU; consequently, RCRA Land Disposal Restrictions would not be triggered.

28. **Comment: Figure 5-3 Enhanced Biodegradation of PAH-Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Material, pg 5-47.** Refer to Comment #27.

    Response: Please refer to comment response #27.

29. **Comment: Figure 5-4 Alternative 3- Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials, pg 5-49.** Refer to Comment #27.

Response: Please refer to comment response #27.

30. **Comment: Section 6.2.9 Cost, pg 6-5.** Refer to Comment #21.

    Response: Please refer to comment response #21.

31. **Comment: Table 6-1 Comparative Analysis of Alternatives, pg. 6-8.** This table should be revised accordingly based on previous comments.

    Response: Acknowledged. The table will be revised to reflect the new costs calculated based on previous comments (comments #21, 23, and 25).

REFERENCES

B&R Environmental, 1998. RI/RFI Work Plan for Site 12/SWMU 10 – Jericho Island Disposal Area, July.

RESPONSES TO NOAA COMMENTS ON
FEASIBILITY STUDY/CORRECTIVE MEASURES STUDY FOR SITE 12/SWMU 10 – JERICHO ISLAND
MARINE CORPS RECRUIT DEPOT
PARRIS ISLAND, SOUTH CAROLINA

Specific Comments:

1. **Comment:** Based on information in the subject report, Alternative 4 (source removal and off-site disposal) appears to be the Preferred Alternative. Notable reasons for selecting Alternative 4 are briefly described below.
   a) Source removal will eliminate unacceptable risks that exist now on-site.
   b) Off-site disposal will eliminate the need for a cap, long-term monitoring and land use restrictions.
   c) Other than the No Action alternative, Alternative 4 is the least costly ($1.45M).

   Response: The Navy concurs with NOAA's choice for the preferred alternative. Upon consensus of the MCRD Parris Island Partnering Team, a proposed plan will be developed with Alternative 4 as the preferred alternative and these reasons will be incorporated into the proposed plan for the site.

2. **Comments on the Executive Summary** (Note that changes made to the executive summary will be made to applicable portions of the FS)

   a) Comment: Define RGOs when first used (as was done for other acronyms).

   Response: In the executive summary, the first occurrence of the acronym RGO will be defined as remedial goal option.

   Comment: Numerical RGOs should be reported in the Executive Summary. At the very least, the text should refer the reader to tables containing numerical RGOs.

   Response: The last sentence of the first paragraph of the "Remedial Action Objectives/Corrective Action Objective" section of the executive summary currently references the reader to applicable RGO summary tables in Section 3.0 of the FS. No change is proposed.

   b) Comment: Clarify the last sentence in third full paragraph on page ES-2. The first part of the sentence indicates thallium and vanadium exceeded ecological screening values while the latter indicates surface water doesn't pose risk to ecological receptors. Provide the reader with a

clearer transition between "risky" thallium and vanadium and a conclusion of no unacceptable risk.

Response: As discussed in the response to SCDHEC comments (D. Hargrove, specific comment 1), a surface water screening value does not exist for vanadium. In accordance with the NOAA and SCDHEC reviewers' comments, the referenced sentence will be revised as follows:

> "The results of the ERA screening indicated that of the 16 chemicals detected in the 13 surface water samples collected during the RI, only one detection of thallium exceeded an ecological screening value. Furthermore, thallium was eliminated from consideration as a chemical of concern (COC) in the ERA Step 3A discussion. Consequently, chemicals detected in surface water do not pose risks to ecological receptors."

c) Comment: Delete the fourth bullet on page ES-3 or provide the technical basis for assuming sediment RGOs based on benthic toxicity are protective of higher trophic level receptors. If this were true, food web modelling to assess chemical risks to higher trophic level receptors would never be necessary. Also, clarify the last sentence in this bullet. It makes no sense to this reviewer.

Response: The bullet will be removed.

d) Comment: The description of remedial action alternatives (pages ES-4 & ES-5) repeatedly refers to PAH as a presumptive COC. However, PAH are never mentioned earlier in the Executive Summary when "Media of Concern" are described. Resolve this apparent contradiction.

Response: The second sentence of the first full paragraph of page ES-2 will be replaced with the following:

> "A remedial action/corrective measure [e.g., excavation of sediment with polynuclear aromatic hydrocarbon (PAH), semivolatile organic compound (SVOC), pesticide, and inorganic concentrations in excess of remedial goal options (RGOs) and consolidation of the material under an engineered landfill cap] is necessary to address this medium."

e) **Comment:** In each alternative (pages ES-4 & ES-5), please add the following text to the description of the restoration component, "… according to the restoration plan developed during remedial design."

Response: Agreed. The sentence will be added as requested.

f) **Comment:** The above changes in the Executive Summary should also be reflected in the appropriate corresponding sections of the main body of the report.

Response: The changes as discussed in the responses to the reviewer's comments will be incorporated as necessary.

EXECUTIVE SUMMARY

Tetra Tech NUS, Inc. (TtNUS) has prepared this Feasibility Study (FS)/Corrective Measures Study (CMS) Report for the Jericho Island Disposal Area [Site 12/Solid Waste Management Unit (SWMU 10] located at the Marine Corps Recruit Depot (MCRD) Parris Island, South Carolina. This report was prepared for the United States Navy (Navy) Southern Division (SOUTHDIV) Naval Facilities Engineering Command (NAVFACENGCOM) under Contract Task Order (CTO) 0053, for the Comprehensive Long-Term Environmental Action Navy (CLEAN) III Contract Number N62467-94-D-0888. The objective of this FS/CMS report is to develop and evaluate potential remedial alternatives/corrective measures for addressing risks to human health and the environment found within Site 12/SWMU 10.

SITE DESCRIPTION

Jericho Island (Site 12) is approximately 25 acres in size and is located northwest of Horse Island. The island was acquired by the Navy in 1968 to comply with the limited distance arc required for MCRD Parris Island's rifle range. Site 12 was reportedly used from 1955 to 1968 as a waste disposal area for local residents. However, no organized landfill operations were reported to have occurred at the site. Disposed waste consisted of routine domestic refuse including small metal cans, beer and soda bottles, hubcaps, tires, buckets, cinderblocks, rusted metal 5-gallon cans, sheet metal, paper, plastic, and wood. The site has an irregular, undulating surface due to the random scattering of waste piles, ranging up to approximately 30 feet in diameter and 5 feet in height (Kearney, 1990). After MCRD Parris Island acquired Site 12, the area was no longer used for waste disposal purposes.

Three areas containing surface debris are currently present on Jericho Island. Two of these areas are located in the upland portion of the island (one in the west-central and one in the southern portion of the island). The other area containing surface debris is located at the southern edge of the island and extends into the adjacent sediment.

MEDIA OF CONCERN

During the remedial investigation, it was determined that soil and debris contain the source of contaminants within the Site 12 disposal area and are the primary media of concern in this FS/CMS. The results of the Human Health Risk Assessment (HHRA) showed that, under some exposure scenarios, arsenic and iron were leading risk drivers in a localized area of PAI-10-SS-14. In addition, lead was identified at a concentration of 1,100 milligrams per kilogram (mg/kg), which exceeds the Office of Solid Waste and Emergency Response (OSWER) soil screening level of 400 mg/kg for residential land use. The results of the Ecological Risk Assessment (ERA) indicated that copper, iron, lead, and mercury pose

potential risks to terrestrial invertebrates and/or terrestrial plants in the vicinity of surface soil sample PAI-SS-14-01. Iron, lead, and mercury concentrations in soil sample PAI-SS-14-01 also pose potential risks to some upper-level terrestrial receptors.

Based on the nature and extent of contamination and the results of the HHRA and ERA presented in the Site 12 Remedial Investigation/RCRA Facilities Investigation (RI/RFI), sediment in the area of Site 12 is retained as a medium of concern for this FS/CMS. A remedial action/corrective measure [e.g., excavation of sediment with polynuclear aromatic hydrocarbon (PAH), semivolatile organic compound (SVOC), pesticide, and inorganic concentrations in excess of remedial goal options (RGOs) and consolidation of the material under an engineered landfill cap] is necessary to address this medium. The results of the HHRA showed that risks associated with chemicals detected in sediment samples are within acceptable risk ranges. The maximum concentrations of chemicals detected in sediment were compared to Region IV ecological screening levels (ESVs). Chemicals exceeding ESVs were retained as ecological chemicals of potential concern (COPCs) and hazard quotient (HQ) values were calculated. HQs are the ratio of the exposure point contaminant concentration to the ESV. The results of the ERA indicated that 4,4'-DDT, aluminum, antimony, arsenic, barium, chromium, cobalt, copper, iron, lead, mercury, nickel, selenium, thallium, vanadium, and zinc had at least one HQ greater than 1.0 for the aquatic food chain modeling, using samples collected in 1998 and 1999.

Two sediment waste samples were collected at Site 12; Aroclor-1254, antimony, arsenic, cadmium, copper, iron, lead, and manganese were identified as human health COPCs. The results of the ERA indicated that di-n-octyl phthalate, bis(2-ethylhexyl)phthalate, 4,4'-DDE, 4,4'-DDT, dieldrin, endrin, Aroclor-1254, antimony, arsenic, cadmium, chromium, copper, iron, lead, nickel, silver, and zinc exceed ecological screening criteria. Based on these potential risks and the presence of surficial waste material, sediment waste will be retained as a medium of concern in this FS/CMS.

Based on the results of the HHRA, surface water is not retained as a medium of concern in this FS/CMS. The results of the HHRA showed that bis(2-ethylhexyl)phthalate and arsenic, iron, and manganese in unfiltered samples were the only surface water COCs. However, because of the transient nature of surface water, this medium will be addressed through the management of debris, surface soil, and groundwater. It is anticipated that the containment remedial action/corrective measure for soil and debris, coupled with a remedial action/corrective measure for sediment, would reduce the potential for migration of these COCs to surface water. The results of the ERA screening indicated that of the 16 chemicals detected in the 13 surface water samples collected during the RI/RFI, only one detection of thallium exceeded an ecological screening value. Furthermore, thallium was eliminated from consideration as a chemical of concern (COC) in the ERA Step 3A discussion. Consequently, chemicals detected in surface water do not pose risks to ecological receptors.

Groundwater will not be retained as a primary medium of concern in this FS/CMS but will be addressed through the containment of surface soil, debris, and sediment and the implementation of restrictions. As determined the HHRA, acetone, chloroform, aluminum, arsenic, cadmium, iron, manganese, and thallium were identified as human health COPCs based on a comparison of maximum site concentrations to risk-based screening levels and State and federal MCLs. However, only thallium in one unfiltered groundwater sample and cadmium in filtered and unfiltered groundwater samples exceeded State and federal MCLs. The results of the ERA did not indicate that groundwater poses a concern to ecological receptors. As a result, groundwater was not retained as a medium of concern for ecological concerns. Also, groundwater is not currently used as a potable water supply at the site and is not expected to be used in the future as a potable water supply. This scenario is based on the high salinity and total dissolved solids content of the groundwater.

REMEDIAL ACTION OBJECTIVES/CORRECTIVE ACTION OBJECTIVES

Site-specific remedial action objectives/corrective action objectives (RAOs/CAOs) consist of medium-specific goals for protecting human health and the environment. RAOs/CAOs are developed to permit consideration of a range of alternatives. RGOs for the selected COCs are summarized in Tables 3-4 and 3-5 of this report.

The following RAOs/CAOs have been developed for Site 12/SWMU 10.

- Eliminate contact with debris and impacted surface soils by human and ecological receptors.

- Eliminate the migration of COCs from the source material (impacted soil and debris) to downgradient media (i.e., sediment, surface water, and groundwater).

- Eliminate human exposure (i.e., direct exposure to construction worker, adolescent trespassers, adolescent recreational users, adult recreational users, child resident, adult resident, and lifelong resident) to COCs in sediment and sediment waste at concentrations in excess of RGOs. RGOs take into consideration an incremental lifetime cancer risk (ILCR) of 1.0E-06 for individual COCs. Additionally, RGOs take into consideration an HQ of 1.0 where noncarcinogenic effects would be expected. Elimination of COCs in sediment will also address human health concerns identified from chemicals detected in surface water.

- Comply with chemical-specific, location-specific, and action-specific federal and state ARARs.

REMEDIAL ACTION/CORRECTIVE MEASURES ALTERNATIVE DEVELOPMENT

Remedial action/corrective measure alternatives were developed that address the COCs and exposure pathways in order to achieve the RAOs/CAOs. The following alternatives have been developed for Site 12:

- Alternative 1 – No Action: This alternative is developed in accordance with the NCP to provide a baseline for comparison to other alternatives.

- Alternative 2a – Monitored Natural Recovery for PAH-contaminated Soil and Excavation/ Consolidation/Capping of Contaminated Sediment and Waste Material/Land-use Controls and Monitoring. Alternative 2a consists of the following components:

  - Monitored natural recovery of soil with concentrations of PAHs above the RGOs for the protection of ecological and human receptors.

  - Excavation of waste materials in the debris pile areas and impacted soil and sediment with concentrations above the RGOs for protection of human and ecological receptors and consolidation within a designated area of Site 12.

  - Installation of a low-permeability cover system over the consolidated and regraded waste materials and sediment.

  - Removal and off-site disposal of oversized debris from within the debris piles.

  - Restoration of the site where excavation was performed according to the restoration plan developed during the remedial design.

  - Implementation of land use controls for the limits of the proposed cover and the areas of soil contaminated with PAHs, long-term monitoring of the groundwater and the PAH-contaminated soil, 5-year reviews of the site, and operation and maintenance of the cover system.

- Alternative 2b – Enhanced Biodegradation of PAH-contaminated Soil and Excavation/ Consolidation/Capping of Contaminated Sediment and Waste Materials/Land use Controls and Monitoring. Alternative 2b consists of all the same elements as Alternative 2a, except that enhanced biodegradation would be used on the soil with concentrations of PAHs above the RGOs for the protection of ecological and human receptors.

- Alternative 3 – Excavation/Consolidation/Capping of all Contaminated Sediment, Soil, and Waste Materials/Land use Controls and Monitoring. Alternative 3 consists of the following components:

  - Excavation of waste materials in the debris pile areas and impacted soil and sediment with concentrations above the RGOs for protection of human and ecological receptors and excavation of soil contaminated with PAHs above RGOs for protection of human and ecological receptors and consolidation within a designated area of Site 12.

  - Installation of a low-permeability cover system over the consolidated and regraded soil, waste materials, and sediment.

  - Removal and offsite disposal of oversized debris from within the debris piles.

  - Restoration of site where excavation was performed according to the restoration plan developed during the remedial design.

  - Implementation of land use controls for the limits of the proposed cover, long-term monitoring of the groundwater, 5-year reviews of the site, and operation and maintenance of the cover system.

- Alternative 4 – Excavation and Off-Site Disposal of Waste Materials, Soil, and Sediment (follows unrestricted land use evaluation per Navy guidance). Alternative 4 consists of the following components:

  - Excavation of sediment with concentrations of inorganic chemicals and PAHs above the RGOs for protection of human and ecological receptors.

  - Excavation of soil with concentrations of PAHs above the RGOs for protection of human and ecological receptors.

  - Excavation of waste materials and impacted soil and sediment in the debris pile areas.

  - Transportation and disposal of soil, sediment, and waste materials to approved off-site disposal facilities.

  - Restoration of the site according to the restoration plan developed during the remedial design.

EVALUATION OF ALTERNATIVES

Each alternative was evaluated using criteria specified in the U.S. Environmental Protection Agency (U.S. EPA) Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (U.S. EPA, 1988) and RCRA Corrective Action Plan (Final) (U.S. EPA, 1994). These criteria include protection of human health and the environment; media clean-up standards; source control; waste management standards; long-term reliability and effectiveness; reduction in toxicity, mobility, and/or volume; short-term effectiveness; implementability; and cost. Sections 5.0 and 6.0 of this report presents the results of this evaluation process. The analysis is presented in Table ES-1.

TABLE ES-1

COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

Criterion	Alternative 1	Alternative 2a	Alternative 2b	Alternative 3	Alternative 4
Overall Protection of Human Health and the Environment	Not protective.	Protective.	More protective than Alternative 2a.	More protective than Alternative 2a and 2b.	Most protective of any alternative.
Compliance with ARARs/Media Cleanup Standards	Does not comply.	Compliance with AWQCs and MCLs in the future. Complies with Federal and state solid waste and hazardous waste landfill closure requirements.	Compliance with AWQCs and MCLs in the future. Complies with Federal and state solid waste and hazardous waste landfill closure requirements.	Compliance with AWQCs and MCLs in the future. Complies with Federal and state solid waste and hazardous waste landfill closure requirements.	Compliance with soil and sediment chemical-specific ARARs when remedial action is complete. Compliance with AWQCs and MCLs in the future.
Source Control	No source control.	Source control through presumptive remedy of containment. Sediment excavation and consolidation under the cap system.	Source control through presumptive remedy of containment. Sediment excavation and consolidation under the cap system.	Source control through presumptive remedy of containment. Total sediment and soil excavation and consolidation under the cap system	Source control through excavation and off-site disposal.
Waste Management Standards	Not applicable.	Complies with Federal and state solid waste and hazardous waste landfill closure requirements.	Complies with Federal and state solid waste and hazardous waste landfill closure requirements.	Complies with Federal and state solid waste and hazardous waste landfill closure requirements.	Complies with Federal and state solid waste and hazardous waste handling, transportation and disposal requirements.
Long-term Reliability and Effectiveness	Not effective or permanent.	Effective and permanent with proper O&M and land use controls. Long-term monitoring and 5-year reviews are required.	Effective and permanent with proper O&M and land use controls. Long-term monitoring and 5-year reviews are required.	Effective and permanent with proper O&M and land use controls. Long-term monitoring and 5-year reviews are required.	More effective and permanent than 2a, 2b, and 3. No O&M, land use controls, long-term monitoring, or 5-year reviews are required. Long-term management of waste is handled by others.

TABLE ES-1

COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

Criterion	Alternative 1	Alternative 2a	Alternative 2b	Alternative 3	Alternative 4
Reduction in toxicity, mobility, or volume through treatment	None.	Reduction in contaminant mobility through excavation, consolidation, and capping. Destruction of PAHs through biodegradation. May take 10 to more than 30 years to attain RGOs.	Reduction in contaminant mobility through excavation, consolidation, and capping. Destruction of PAHs through biodegradation. May take in excess of 1 to 5 years to attain RGOs.	Reduction in contaminant mobility through excavation, consolidation, and capping. No treatment. Estimated to take 7 months to attain RGOs.	Source removed and disposed off-site. No treatment expected. Estimated to take 5 months to attain RGOs.
Short-term Effectiveness	Not applicable.	Short-term impacts to ecological habitat. Impacts to local community from transportation of cap material on site. Remedial actions completed in 6 months.	Short-term impacts to ecological habitat. Impacts to local community from transportation of cap material on site. Remedial actions completed in 6 months.	Short-term impacts to ecological habitat. Impacts to local community from transportation of cap material on site. Remedial actions completed in 7 months	Short-term impacts to ecological habitat. Impacts to local community from transportation of waste material off site. Remedial actions completed in 5 months.
Implementability	Not applicable.	Readily implementable	Readily implementable.	Readily implementable.	Readily implementable.
Cost	$0	<u>RCRA C Cap</u> Capital $1,286,000 O&M $45,500 to 92,900 Present Worth $1,938,000 <u>RCRA D Cap</u> Capital $1,099,000 O&M $45,500 to 92,900 Present Worth $1,752,000	<u>RCRA C Cap</u> Capital $1,458,000 O&M $45,500 to 192,900 Present Worth $2,203,000 <u>RCRA D Cap</u> Capital $1,272,000 O&M $45,500 to 192,900 Present Worth $2,018,000	<u>RCRA C Cap</u> Capital $1,609,000 O&M $45,500 to 91,500 Present Worth $2,255,000 <u>RCRA D Cap</u> Capital $1,342,000 O&M $45,500 to 91,500 Present Worth $1,988,000	Capital $ 1,450,000 O&M $ 0 Present Worth $ 1,450,000
State and U.S. EPA Acceptance	To be determined.	To be determined.	To be determined.	To be determined.	To be determined.
Community Acceptance	To be determined.	To be determined.	To be determined.	To be determine.	To be determined.

1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

Tetra Tech NUS, Inc. (TtNUS) has prepared this Feasibility Study (FS)/Corrective Measures Study (CMS) Report for the Jericho Island Disposal Area [Site 12/Solid Waste Management Unit (SWMU) 10] located at the Marine Corps Recruit Depot (MCRD) Parris Island, South Carolina (as shown in Figure 1-1). This report was prepared for the United States Navy (Navy) Southern Division (SOUTHDIV) Naval Facilities Engineering Command (NAVFACENGCOM) under Contract Task Order (CTO) 0053, for the Comprehensive Long-Term Environmental Action Navy (CLEAN) III Contract Number N62467-94-D-0888.

The objective of the Remedial Investigation/Resource Conservation and Recovery Act (RCRA) Facility Investigation (RI/RFI) and FS/CMS process is to gather and evaluate information sufficient to select an appropriate remedy for a given site based on an informed risk management decision-making process. An RI/RFI (TtNUS, 2001) was performed at Site12/SWMU 10 between July 1998 and September 1998 that included soil, groundwater, surface water, sediment, and sediment waste pile sampling. Two additional sediment sampling events occurred in December 1988 and December 1999. The purpose of these activities was to characterize the nature and extent of contamination in areas where the potential for off-site migration of contamination exists from past waste disposal at Site12/SWMU 10. Both human health and ecological risk assessments were included in the report to support site decisions.

This FS/CMS Report uses the results of the RI/RFI Report to develop and evaluate potential remedial alternatives/corrective measures for addressing risks to human health and the environment found within these areas.

1.2 REGULATORY SETTING

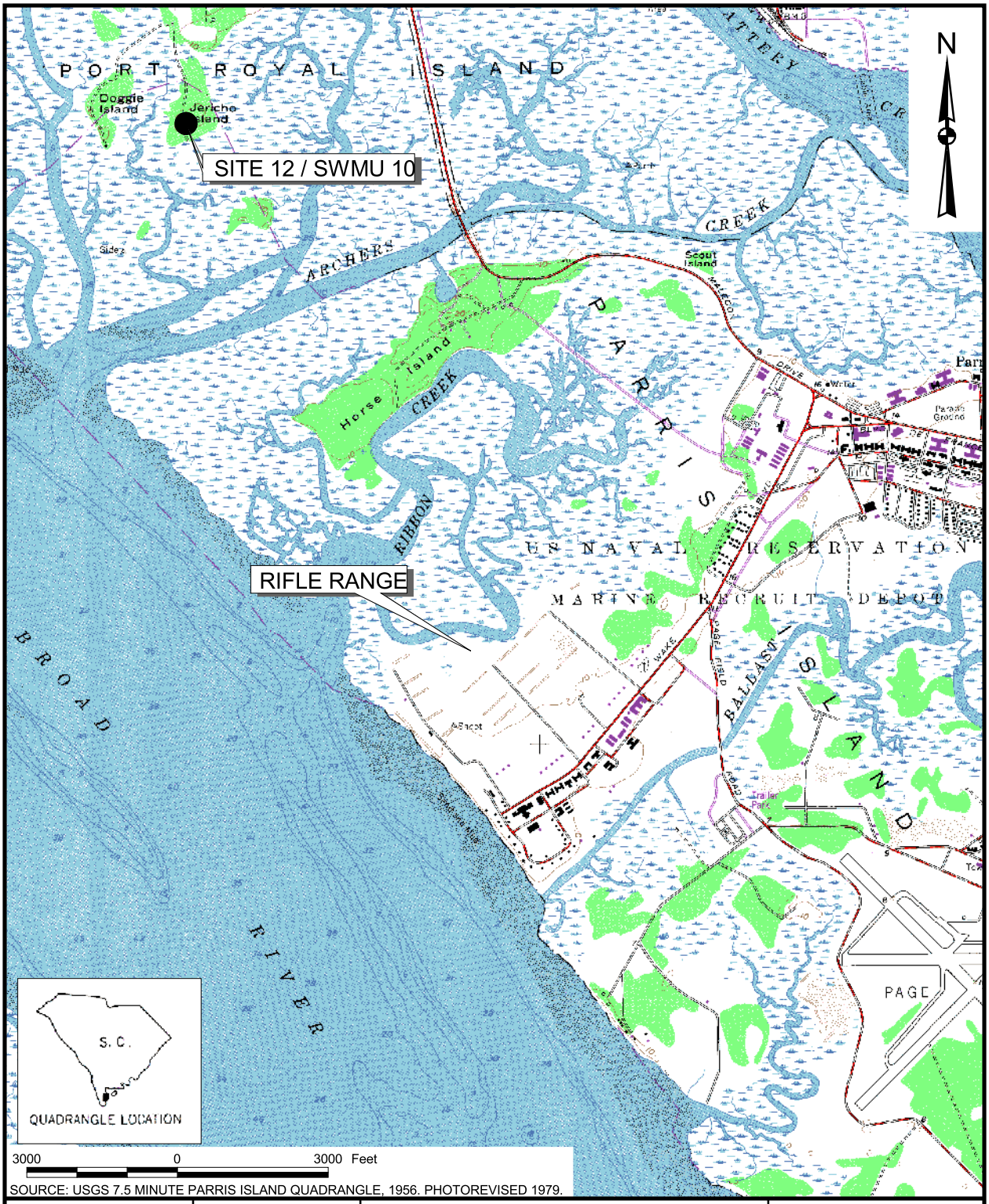
The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act of 1986 (SARA) established a program for the cleanup of hazardous waste disposal and spill sites nationwide. This program contains provisions for the cleanup of contamination from past hazardous waste operations and past hazardous material spills and is the framework for Installation Restoration (IR) programs at Navy and Marine Corps installations. RCRA, as amended, also establishes a cleanup program that provides for current and future hazardous waste management practices, as well as cleanup of past disposal sites at permitted or interim status Navy/Marine Corps installations. SOUTHDIVNAVFACENGCOM has the responsibility for implementing the Navy's IR Program at MCRD Parris Island.

Because of the past hazardous waste activities conducted at MCRD Parris Island, South Carolina, this facility meets criteria for conducting IR activities under the CERCLA regulatory framework. To date, the MCRD Parris Island has completed steps equivalent to the Preliminary Assessment/Site Investigation (PA/SI) and RI phases of the CERCLA remedial action process at Site 12/SWMU 10. The MCRD Parris Island also meets the criteria for conducting IR activities under the authority of RCRA because, in the late 1980s, this facility submitted a RCRA Part A application. In accordance with RCRA, this action required MCRD Parris Island to conduct corrective action for the release of hazardous waste or hazardous constituents from SWMUs. As part of this requirement, an interim RCRA Facility Assessment (RFA) was conducted in 1990. Since this time, MCRD Parris Island has withdrawn its Part A application.

Because of the circumstances surrounding MCRD Parris Island's IR Program history, discussions have been held among representatives from the U.S. Marine Corps, the Navy, South Carolina Department of Health and Environmental Control (SCDHEC), and the United States Environmental Protection Agency (U.S. EPA) Region 4 to determine the appropriate regulatory framework for conducting IR activities at MCRD Parris Island. From these discussions, it has been decided that this report will encompass both CERCLA and RCRA requirements and the title, FS/CMS, reflects this decision. For ease of reading and clarity, the Jericho Island Disposal Area (Site 12/SWMU 10) will be referred to as Site 12 for the remainder of this document.

1.3 REPORT ORGANIZATION

This report is divided into six sections. Section 1.0 presents the purpose of the report and the regulatory setting at MCRD Parris Island. Section 2.0 provides background information regarding Site 12. Section 3.0 presents the development of remedial action objectives/corrective measures objectives. Section 4.0 describes the identification, screening, and development of remedial action/corrective measures alternatives. Section 5.0 presents a detailed evaluation of the remedial action/corrective measure alternatives. Section 6.0 provides a comparative analysis of the alternatives. Appendices A through D provide support documentation for this report.



SOURCE: USGS 7.5 MINUTE PARRIS ISLAND QUADRANGLE, 1956. PHOTOREVISED 1979.

DRAWN BY MJJ	DATE 09Oct99	DEPOT LOCATION MAP MCRD, PARRIS ISLAND, SOUTH CAROLINA	CONTRACT NUMBER 7803
CHECKED BY	DATE		OWNER NO.
COST/SCHEDULE-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1-1 REV 1

P:\GIS\PARRIS\JERICHO.APR DEPOT LOCATION MAP 4/28/04 KMP

2.0 DESCRIPTION OF CURRENT CONDITIONS

2.1 SITE DESCRIPTION

MCRD Parris Island is located along the southern coast of South Carolina within Beaufort County, approximately 1 mile south of the city of Port Royal and 3 miles south of the city of Beaufort. MCRD Parris Island covers approximately 8,047 acres that consist of dry land, salt marshes, saltwater creeks, and ponds, as shown in Figure 1-1. MCRD Parris Island is the reception and recruit training facility of the Marine Corps for enlisted men from states east of the Mississippi River and for enlisted women nationwide.

Jericho Island (Site 12) is approximately 25 acres in size and is located northwest of Horse Island, as shown on Figure 1-1. The island was acquired by the Navy in 1968 to comply with the limited distance arc required for MCRD Parris Island's rifle range. Site 12 was reportedly used from 1955 to 1968 as a waste disposal area for local residents. However, no organized landfill operations were reported to have occurred at the site. Disposed waste consisted of routine domestic refuse including small metal cans, beer and soda bottles, hubcaps, tires, buckets, cinderblocks, rusted metal 5-gallon cans, sheet metal, paper, plastic, and wood. The site has an irregular, undulating surface due to the random scattering of waste piles, ranging up to approximately 30 feet in diameter and 5 feet in height (Kearney, 1990). After MCRD Parris Island acquired Site 12, the area was no longer used for waste disposal purposes.

As shown on Figure 2-1, three areas containing surface debris are currently present on Jericho Island. Two of these areas are located in the upland portion of the island (one in the west-central and one in the southern portion of the island). The other area containing surface debris is located at the southern edge of the island and extends into the adjacent sediment. The dimensions of the debris piles illustrated on Figure 2-1 and 2-2 were measured in the field with a tape measure and referenced to surveyed surface soil and sediment sample locations.

A concrete pad is located on the southern end of the island. The Marine Corps reportedly used this concrete foundation for a landing light for the base's former runway. This reported use is supported by the fact that the southeast/northwest segment of the runway is aligned with Jericho Island as can be seen in Figure 1-1.

2.2 SITE-SPECIFIC GEOLOGY AND HYDROGEOLOGY

The geology at Site 12 was interpreted by classifying subsurface soil samples collected during the drilling of soil borings installed during the RI/RFI. Information from the Soil Survey of Beaufort and Jasper

Counties, South Carolina, 1980 (U.S. Department of Agriculture, Soil Conservation Service) was used for the correlation of soil types.

Soil boring logs are provided in Appendix A.2 of the RI/RFI Report (TtNUS, 2001). Based on the data obtained from the soil borings, cross sections approximating existing conditions (e.g., ground surface and groundwater elevations, lithologic description, and surface features) have been generated. Figure 2-2 identifies the locations of cross-sections A-A' and B-B' in a plan view. Figures 2-3 and 2-4 present the cross-sectional transects of A-A' and B-B', respectively.

A detailed discussion of the site-specific geology and hydrogeology of Site 12 is presented in Sections 3.3 and 3.4 of the RI/RFI Report (TtNUS, 2000). The following paragraphs summarize geologic and hydrogeologic information for Site 12.

Surface soil collected from Site 12 during the RI/RFI field event consisted of fine to medium sands with a varying silt content. Sediment samples collected from the tidal flat area consisted of fine to coarse sand with varying silt and clay content and clay with varying sand and silt content. Surface debris was observed primarily on the west-central and southern portions of the islands; most of the debris was located on the southern end. Debris, consisting of glass and rusted metal, was observed over a distance of approximately 200 feet along the tidal flat on the southern end of the island.

Based on the test borings drilled during the RI/RFI, the subsurface geology at the site did not appear to have been affected by human activities. Landfilled debris was observed on the surface but was not encountered at depths greater than 1 foot below ground surface (bgs), with the exception of borings PAI-10-SB-06 and PAI-10SB-07. At these borings, surface debris was encountered at depths of 4 feet and 2 feet, respectively. These borings were located on the southern end of the island within a large area of surface debris. The soil encountered in the soil borings typically consisted of fine to medium sand with a varying silt and clay content. The borings were terminated when auger refusal was encountered at depths ranging from 26 to 39.5 feet bgs, which was interpreted to be the top of the Hawthorne Formation.

In general, a shallow groundwater table exists at Site 12. The depths to groundwater measured at the beginning of the tidal study ranged from 0.78 to 7.82 feet bgs. Groundwater was encountered during installation of the monitoring wells at depths ranging from less than 1 foot to approximately 4 feet bgs. Based on the results of the tidal study, all wells are tidally influenced, with fluctuations varying from 0.28 to 1.9 feet (TtNUS, 2000).

Groundwater primarily moves through the coarser, sand-size sediments of the surficial aquifer. Due to the limited extent of the sandy clays, they are not likely to act as confining units. The upper surficial

aquifer is approximately 21 to 30 feet thick across the site, based on the depth of the top of rock encountered in the soil borings. Recharge of the shallow aquifer beneath the site is likely to occur primarily through infiltration of precipitation across the island. In general, the water-level data suggest an overall groundwater flow pattern from the interior and southern end of the island to the marshes and open water located east and west of the island. The geometric mean hydraulic conductivity for the seven shallow surficial aquifer wells was calculated to be 3.39 feet per day [1.20×10^{-3} centimeters per second (cm/sec)]. The geometric mean hydraulic conductivity for the seven deep surficial aquifer wells was calculated to be 3.30 feet per day (1.17×10^{-3} cm/sec). The values for the shallow and deep wells are within the typical range of hydraulic conductivity for silty sands, well-sorted sands, and fine sands (Fetter, 1980).

The tidal study results indicated that both shallow and deeper groundwater within the surficial aquifer are tidally influenced. Overall, tidal effects were most prominent in the deep wells located along the eastern and northern island margins, with tidal fluctuations of over 1 foot observed. Site 12 is also located within the 100-year flood plain.

2.3 NATURE AND EXTENT OF CONTAMINATION

Several investigations, in addition to the RI/RFI, have been conducted at Site 12:

- In 1986, the Naval Energy and Environmental Support Activity (NEESA) conducted an IAS (NEESA, 1986) under the Naval Assessment and Control of Installation Pollutants (NACIP) Program. The IAS is equivalent to the preliminary assessment phase of the CERCLA process. NEESA concluded that there was no potential threat for contaminant migration from Site 12 and the site did not pose a threat to human health and the environment. Therefore, a verification step (Phase II of the NACIP Program) was not recommended for Site 12.

- In accordance with the requirements of MCRD Parris Island's application for a RCRA permit, an Interim RCRA Facility Assessment (RFA) was performed from January 1990 to March 1990 (Kearney, 1990).

- In December 1995, Brown and Root (B&R) Environmental conducted sampling and analysis of surface soil and sediment at MCRD Parris Island to generate a contaminant hazard score and relative site ranking.

- In May 1998, B&R Environmental (B&R Environmental, 1998) conducted a high-resolution vertical magnetic gradient survey and global positioning system (GPS) survey. The purpose was to delineate

the lateral extent of waste disposal activities and provide station position information for the vertical magnetic gradient data.

The results of these investigations are summarized in Section 1.4.3 of the RI/RFI Report for Site 12 (TtNUS, 2001). Additionally, the nature and extent of contamination, as determined during the RI/RFI, are presented in Section 4.0 of the RI/RFI report (TtNUS, 2001) and summarized in the following paragraphs. Tables 2-1 to 2-3 present summaries of the samples collected for chemical analysis during the investigation. Figures 2-2, 2-5, and 2-6 present the locations of these samples.

In surface soil samples, one semivolatile organic compound (SVOC) [benzo(a)pyrene] and three inorganic compounds (arsenic, iron, and lead) exceeded human health screening criteria [U.S. EPA Region 3 residential Risk-based Concentrations (RBCs)]. In addition, one volatile organic compound (VOC) (chloroform), 13 SVOCs, [pentachlorophenol and 12 polycyclic aromatic hydrocarbons (PAHs)], one pesticide (4,4'-DDE), and 10 inorganics exceeded ecological screening criteria (U.S. EPA Region 4 soil screening values).

In groundwater samples, two VOCs (acetone and chloroform) exceeded human health screening criteria (U.S. EPA Region 3 Tapwater RBCs). No other organic compounds detected in groundwater exceeded a human health screening criterion and no organic compounds exceeded an ecological screening criterion. In a comparison of groundwater concentrations of unfiltered inorganic compounds to human health criteria, detections of four compounds (arsenic, iron, manganese, and thallium) exceeded such criteria. In a comparison of groundwater concentrations of filtered inorganic compounds to U.S. EPA Region 4 surface water ecological screening values (assuming groundwater discharges to surface water), only detections of nickel exceeded such criteria.

In surface water samples, one SVOC [bis(2-ethylhexyl)phthalate] exceeded a human health screening criterion. No other organic compounds detected in surface water exceeded a human health screening criterion and no organic compounds exceeded an ecological screening criterion. In a comparison of unfiltered inorganic surface water results to human health criteria, detections of three inorganics (arsenic, iron, and manganese) exceeded such criteria. In a comparison of filtered surface water results to U.S. EPA Region 4 ecological screening values, only detections of thallium exceeded such criteria.

In sediment samples collected in 1998 and 1999, three inorganics (arsenic, iron, and lead) exceeded a human health screening criteria (U.S. EPA Region 3 Residential RBCs). Three SVOCs [acenaphthene, benzo(b)fluoranthene, and bis(2-ethyhexyl)phthalate] and three pesticides (4,4'-DDT, alpha chlordane, and gamma chlordane) exceeded ecological screening criteria (U.S. EPA Region 4 screening values).

Nine inorganics (antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc) exceeded their ecological screening criteria; criteria were not available for the remaining nine inorganics.

In sediment waste samples collected in 1995, one polychlorinated biphenyl (PCB) (Aroclor-1254) and three inorganics (arsenic, iron, and lead) exceeded human health screening criteria (U.S. EPA Region 3 residential RBCs). Two SVOCs [di-n-octyl phthalate and bis(2-ethylhexyl)phthalate], four pesticides (4,4'-DDE, 4,4'-DDT, dieldrin, and endrin), one PCB (Aroclor-1254), and 10 inorganics (antimony, arsenic, cadmium, chromium, copper, iron, lead, nickel, silver, and zinc) exceeded ecological screening criteria (U.S. EPA Region 4 screening values).

2.4 HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

2.4.1 Human Health Risk Assessment

A baseline human health risk assessment (HHRA) was conducted to characterize and quantify potential health risks at Site 12, in the absence of remedial action. The results of the HHRA are presented in Section 6.0 of the RI/RFI Report (TtNUS, 2001) and are summarized below.

The human health risk assessment considered site media exposure to construction workers, adolescent trespassers, adolescent recreational users, adult recreational users, potential future child residents, potential future adult residents, and hypothetical lifelong residents. The estimated cancer risks and Hazard Indices (HIs) are summarized as follows. HI results less than 1.0 are desirable while estimated cancer risks less than 10^{-4} are desirable.

- All estimated incremental lifetime cancer risks (ILCRs) for construction workers, adolescent trespasser, adolescent recreational user, and adult recreational user were within U.S. EPA's target risk range of 10^{-4} to 10^{-6}. The total cancer risks across all media for each receptor are as follows: construction workers (4.5×10^{-6}), adolescent trespasser (1.3×10^{-5}), adolescent recreational user (1.3×10^{-5}), and adult recreational user (5.9×10^{-6}).

- The estimated HI for a construction worker exposed to surface soil was 1.4, which exceeds the acceptable level of 1.0. However, the HIs for the individual target organs were less than the acceptable level of 1.0. Arsenic (HI = 0.52) and iron (HI = 0.8) were the main contributors to the HI. Similarly, the estimated HI for exposure to sediment waste was 1.1, but the HIs for the individual target organs were all less than the acceptable level of 1.0, indicating that no adverse health effects are anticipated for construction workers exposed to sediment waste under the defined conditions. The estimated HIs for exposure to groundwater, surface water, and sediment were each less than 1.0. The cumulative HI across all media was 2.7.

- All estimated HIs for the adolescent trespasser and adolescent recreational user were less than the acceptable level of 1.0. These values indicate that no adverse health effects are anticipated for adolescent trespassers exposed to surface soil, sediment, surface water, and sediment waste under the defined conditions. For both receptors, the cumulative HI across all media was 1.0.

- All estimated HIs for the adult recreational user were less than the acceptable level of 1.0. The cumulative HI across all media was 0.70.

- Estimated ILCRs for the on-site child resident were within U.S. EPA's target risk range of 10^{-4} to 10^{-6} with the exception of exposure to groundwater. Arsenic (ILCR = 2.9×10^{-4}) was the major contributor to the cancer risk for exposure to groundwater. The total ILCR across all media was 4.1×10^{-4}.

- Estimated ILCRs for the on-site adult resident were within U.S. EPA's target risk range of 10^{-4} to 10^{-6} with the exception of exposure to groundwater. Arsenic (ILCR = 4.9×10^{-4}) was the major contributor to the cancer risk for exposures to groundwater. The total ILCR across all media was 5.5×10^{-4}.

- Estimated ILCRs for the on-site lifelong resident were within U.S. EPA's target risk range of 10^{-4} to 10^{-6} with the exception of exposure to surface soil and groundwater. Arsenic was the major contributor to the ILCR for exposures to surface soil (ILCR = 1.4×10^{-4}) and groundwater (ILCR = 7.8×10^{-4}). The total ILCR across all media was 9.6×10^{-4}.

- The estimated HI for a child resident exposed to surface soil was 7.3, which exceeds the acceptable level of 1.0. Arsenic (HI = 2.5) and iron (HI = 4.3) were the main contributors to the HI for exposure to surface soil. The estimated HI for a child resident exposed to groundwater was 43, which exceeds the acceptable level of 1.0. Arsenic (HI = 6.5), cadmium (HI = 1.0), iron (HI = 23), manganese (HI = 4.4), and thallium (HI = 7.9) were the main contributors to the HI. The estimated HI for a child resident exposed to sediment waste was 4.2, which exceeds the acceptable level of 1.0. Aroclor 1254 (HI = 2.0) and iron (HI = 1.7) were the main contributors to the HI for exposure to sediment waste. The estimated HIs for exposure to sediment and surface water were each less than the acceptable level of 1.0, indicating that no adverse health effects are anticipated for child residents exposed to sediment and surface water under the defined conditions. The cumulative HI across all media was 55.0.

- Estimated HIs for the adult resident were less than the acceptable level of 1.0 with the exception of exposure to groundwater. The estimated HI for an adult resident exposed to groundwater was 73, which exceeds the acceptable level of 1.0. Acetone (HI = 1.2), arsenic (HI = 11), cadmium (HI = 1.8),

iron (HI = 38), manganese (HI = 7.4), and thallium (HI = 13) were the main contributors to the HI. The estimated HIs for exposure to soil, sediment, surface water, and sediment waste were each less than the acceptable level of 1.0. The cumulative HI across all media was 74.

- In summary, arsenic and iron are the leading risk drivers in surface soil. However, only one detection of arsenic and iron was observed above human health screening criteria. These detections are localized to surface soil sample location PAI-10-SS-14. Risks associated with surface soil in areas outside PAI-10-SS-14 are within acceptable risk ranges. Similarly, Aroclor-1254 and iron are the leading risk drivers in the sediment waste samples [PI-012-01 (35) and PI-012-01 (36)]. Risks associated with chemicals detected in other sediment samples are within acceptable risk ranges.

- Risk drivers in groundwater consist of acetone, arsenic, cadmium, iron, manganese, and thallium. However, risks to human receptors may be overestimated due to the following circumstances:

  - Iron and manganese are likely attributable to natural sources.

  - Cadmium was detected at concentrations slightly greater than U.S. EPA's maximum concentration levels (MCLs); but, at concentrations less than RBCs.

  - Thallium was detected in only one groundwater sample and infrequently throughout other media.

  - Arsenic was detected in groundwater samples at concentrations less than MCLs.

  - Detected concentrations of acetone are relatively infrequent, with minor exceedances of risk-based concentrations. Detections of acetone could be attributable to introduction during laboratory procedures or analysis.

2.4.2 Ecological Risk Assessment

An ecological risk assessment (ERA) was performed to characterize the potential risks from site-related contaminants to ecological receptors. The results of the ERA are presented in Section 7.0 of the RI/RFI Report (TtNUS, 2001). A summary of the results of the ERA, as determined during the RI/RFI, is provided below.

The initial ecological risk screening determined that one VOC (chloroform), several SVOCs [pentachlorophenol, di-n-octyl phthalate, bis(2-ethylhexyl)phthalate, and 13 PAHs], six pesticides (4,4'-DDE, 4,4'-DDT, alpha-chlordane, dieldrin, endrin, gamma-chlordane), one PCB (Aroclor-1254), and several inorganics exceeded U.S. EPA Region 4 screening values, indicating a potential risk to ecological

receptors. As a result, these constituents were retained as ecological Chemicals of Potential Concern (COPCs). In addition, several other chemicals were retained as ecological COPCs because they lacked ecological screening criteria.

The food chain modeling evaluated five aquatic receptors (the mink, heron, mummichog, red drum, and osprey) and six terrestrial receptors (the shrew, mouse, robin, hawk, fox, and woodcock). The modeling indicated that many of the initial ecological COPCs do not represent a threat to site receptors even under a worst-case scenario (organisms constantly exposed to maximum concentrations). Chemicals that pose potential risks are identified below.

- 4,4'-DDE, aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, mercury, vanadium, and zinc had at least one hazard quotient (HQ) greater than 1.0 for the terrestrial food chain modeling using maximum concentrations of surface soil.

- 4,4'-DDT, aluminum, antimony, arsenic, barium, chromium, cobalt, copper, iron, lead, mercury, nickel, selenium, thallium, vanadium, and zinc had at least one HQ greater than 1.0 for the aquatic food chain modeling using samples collected in 1998 and 1999.

- Bis(2-ethylhexyl)phthalate, 4,4'-DDE, 4,4'-DDT, Aroclor-1254, endrin, aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, vanadium, and zinc had at least one HQ greater than 1.0 for the aquatic food chain modeling using maximum concentrations of 1995 sediment ecological COPCs.

Only four metals were detected in filtered surface water samples. Results of the food chain modeling using maximum and mean concentrations of filtered surface water indicated that thallium and vanadium had HQs greater than 1.0.

2.5 APRIL 2001 SEDIMENT SAMPLING

Analytical results from 1998 samples collected at surface soil sample locations PAI-10-SS-08 and PAI-10-SS-12 indicated that elevated levels of PAHs were present at both sampling locations and an estimated detection of pentachlorophenol was present at PAI-10-SS-12. Consequently, the MCRD Parris Island Partnering Team decided to resample these locations in April 2001 for these parameters to confirm the 1998 results. The 1998 and 2001 samples are compared in Table 2-1.

At surface soil location PAI-10-SS-08, the 2001 analytical results denote higher PAH concentrations than those detected in 1998. In most cases, the 2001 PAH concentrations were one order of magnitude higher than 1998 results and most detected PAHs exceeded ecological screening criteria. Additionally,

benzo(a)anthracene, benzo(a)pyrene [B(a)P], benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and B(a)P equivalent concentrations exceeded human health screening criterion in the 2001 sample. Consequently, the 2001 analytical results at PAI-10-SS-08 confirm the results of the 1998 sampling and indicate that potential risks to human health and the environment may be present at this location.

At surface soil location PAI-10-SS-12, 10 PAHs were detected in the 2001 sample; however, none of the detected concentrations exceeded a human health or ecological screening criterion. In addition, pentachlorophenol was not detected in the 2001 sample. Accordingly, the 2001 analytical results at PAI-10-SS-12 indicate that risks to human health and the environment are not present at this location and do not confirm the 1998 results.

TABLE 2-1

SUMMARY OF SURFACE SOIL SAMPLES COLLECTED
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

Sample ID	Date Collected	Depth Collected (feet bgs)	Analysis
PAI-10-SS-01-01	1998	0 - 1	(1), (2), (3)
PAI-10-SS-02-01	1998	0 - 1	(1), (2), (3)
PAI-10-SS-03-01	1998	0 - 1	(1), (2), (3)
PAI-10-SS-04-01	1998	0 - 1	(1), (2), (3)
PAI-10-SS-05-01	1998	0 - 1	(1), (2), (3), (4)
PAI-10-SS-06-01	1998	0 - 1	(1), (2), (3)
PAI-10-SS-07-01	1998	0 - 1	(1), (2), (3), (6)
PAI-10-SS-08-01	1998	0 - 1	(1), (2), (3)
PAI-10-SS-08-02	2001	0 - 1	(7)
PAI-10-SS-09-01	1998	0 - 1	(1), (2), (3)
PAI-10-SS-10-01	1998	0 - 1	(1), (2), (3), (5), (6)
PAI-10-SS-11-01	1998	0 - 1	(1), (2)
PAI-10-SS-12-01 PAI-10-SS-12-01D	1998 1998	0 - 1 0 - 1	(1), (2) (1), (2)
PAI-10-SS-12-02	2001	0 - 1	(7) (8)
PAI-10-SS-13-01	1998	0 - 1	(1), (2), (4)
PAI-10-SS-14-01	1998	0 - 1	(1), (2), (4)
PAI-10-SS-15-01A	1998	0 - 1	(1), (2)
PAI-10-SS-15-01	1998	0 - 1	(1), (2)
PAI-10-SS-16-01	1998	0 - 1	(1), (2)
PAI-10-SS-17-01	1998	0 - 1	(1), (2)

PAI-10-SS-15-01A - Surface soil sample collected at Site 12. Sample ID changed from PAI-10-SS-15-01. PAI-10-SS-15-01 was used for a background location sample ID.
PAI-10-SS-012-01D - duplicate sample.

1 TCL VOCs, SVOCs, Pesticides, PCBs, TAL Metals (total), and Cyanide.
2 Acid volatile sulfide/simultaneous extracted metals (AVS/SEM).
3 TOC and pH.
4 Hexavalent chromium.
5 Natural moisture content, grain size analysis, and Atterberg Limits.
6 Porosity, grain size analysis, bulk density, and specific gravity.
7 PAHs.
8 Pentachlorophenol.

TABLE 2-2

SUMMARY OF GROUNDWATER SAMPLES COLLECTED
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

Sample ID	Date Collected	Depth Collected (Feet)	Analysis
PAI-10-GW-01-01	1998	Shallow surficial	(1), (2), (3), (5), (6)
PAI-10-GW-02-01	1998	Deep surficial	(1), (2), (3), (5), (6)
PAI-10-GW-03-01	1998	Shallow surficial	(1), (3), (5), (6)
PAI-10-GW-04-01	1998	Deep surficial	(1), (3), (5), (6)
PAI-10-GW-05-01	1998	Shallow surficial	(1), (3), (5), (6)
PAI-10-GW-06-01	1998	Deep surficial	(1), (3), (5), (6)
PAI-10-GW-07-01 PAI-10-GW-07-01D	1998 1998	Shallow surficial Shallow surficial	(1), (3), (5), (6) (1), (3), (5), (6)
PAI-10-GW-08-01	1998	Deep surficial	(1), (3), (5), (6)
PAI-10-GW-09-01	1998	Shallow surficial	(1), (3), (4), (5), (6)
PAI-10-GW-10-01	1998	Deep surficial	(1), (3), (5), (6)
PAI-10-GW-11-01	1998	Shallow surficial	(1), (2), (4), (5), (6)
PAI-10-GW-12-01	1998	Deep surficial	(1), (3), (5), (6)
PAI-10-GW-13-01	1998	Shallow surficial	(1), (3), (5), (6)
PAI-10-GW-14-01	1998	Deep surficial	(1), (3), (5), (6)

PAI-10-GW-07-01D - Duplicate sample

1 TOC and hardness ($CaCO_3$).
2 Hexavalent chromium.
3 TCL VOCs, SVOCs, pesticides, PCBs, TAL metals (totals), TAL metals, (dissolved), and cyanide.
4 RCRA Appendix IX organics (including volatile organics, semivolatile organics, pesticides/PCBs, pesticides, and chlorinated herbicides), RCRA Appendix IX inorganics, and cyanide.
5 TDS, TSS, chloride, fluoride, nitrate/nitrite, and sulfate.
6 Dissolved oxygen, salinity, temperature, pH, and turbidity.

TABLE 2-3

SUMMARY OF SURFACE WATER SAMPLES COLLECTED
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

Sample ID	Date Collected	Depth Collected (Feet)	Analysis
PAI-10-SW-01-00	1998	Surface	(1), (3), (4), (5)
PAI-10-SW-02-00	1998	Surface	(1), (3), (4), (5)
PAI-10-SW-02-00	1998	Surface	(1), (3), (4)
PAI-10-SW-03-00	1998	Surface	(1), (3), (4)
PAI-10-SW-04-00	1998	Surface	(1), (3), (4)
PAI-10-SW-05-00	1998	Surface	(1), (3), (4)
PAI-10-SW-06-00	1998	Surface	(1), (3), (4)
PAI-10-SW-07-00	1998	Surface	(1), (3), (4)
PAI-10-SW-08-00 PAI-10-SW-08-00-D	1998 1998	Surface Surface	(1), (3), (4), (5) (1), (3), (4), (5)
PAI-10-SW-09-00	1998	Surface	(1), (2), (3), (4), (5)
PAI-10-SW-10-00	1998	Surface	(1), (2), (3), (4), (5)
PAI-10-SW-11-00	1998	Surface	(1), (3), (4)
PAI-10-SW-12-00	1998	Surface	(1), (3), (4), (5)
PAI-10-SW-13-00	1998	Surface	(1), (2), (3), (4), (5)
PAI-10-SW-14-00	(6)	(6)	(6)
PAI-10-SW-15-00	(6)	(6)	(6)
PAI-10-SW-16-00	1998	Surface	(1), (3), (4), (5)
PAI-10-SW-17-00	1998	Surface	(1), (3), (4), (5)
PAI-10-SW-18-00	1998	Surface	(1), (3), (4), (5)

PAI-01-SW-001-00D - Duplicate sample
1 TOC and hardness ($CaCO_3$).
2 Hexavalent chromium.
3 TCL VOCs, SVOCs, pesticides, PCBs, TAL metals (totals), TAL metals (dissolved), and cyanide.
4 Dissolved oxygen, salinity, temperature, pH, and turbidity.
5 Secchi disk.
6 Surface water samples are not associated with sample locations PAI-10-SW-14 and PAI-10-SW-15.

TABLE 2-4

SUMMARY OF SEDIMENT SAMPLES COLLECTED
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

Sample ID	Date Collected	Depth Collected (feet bgs)	Analysis
PAI-10-SD-01-01 PAI-10-SD-01-01A	1998 1998	0-0.5 0-0.5	(1), (2), (5), (6) (4)
PAI-10-SD-02-01 PAI-10-SD-02-01D PAI-10-SD-02-01A PAI-10-SD-02-01DA	1998 1998 1998 1998	0-0.5 0-0.5 0-0.5 0-0.5	(1), (2), (5), (6) (1), (2) (4) (4)
PAI-10-SD-03-01 PAI-10-SD-03-01A	1998 1998	0-0.5 0-0.5	(1), (2), (5), (6) (4)
PAI-10-SD-04-01 PAI-10-SD-04-01A	1998 1998	0-0.5 0-0.5	(1), (2), (5), (6) (4)
PAI-10-SD-05-01 PAI-10-SD-05-01A	1998 1998	0-0.5 0-0.5	(1), (2), (5), (6) (4)
PAI-10-SD-06-01 PAI-10-SD-06-01A	1998 1998	0-0.5 0-0.5	(1), (2), (5), (6) (4)
PAI-10-SD-07-01 PAI-10-SD-07-01A	1998 1998	0-0.5 0-0.5	(1), (2), (5), (6) (4)
PAI-10-SD-08-01 PAI-10-SD-08-01A	1998 1998	0-0.5 0-0.5	(1), (2), (5), (6) (4)
PAI-10-SD-09-01 PAI-10-SD-09-01A	1998 1998	0-0.5 0-0.5	(1), (2), (3), (5), (6) (4)
PAI-10-SD-10-01 PAI-10-SD-10-01A	1998 1998	0-0.5 0-0.5	(1), (2), (3), (5), (6) (4)
PAI-10-SD-11-01 PAI-10-SD-11-01A	1998 1998	0-0.5 0-0.5	(1), (2), (5), (6) (4)
PAI-10-SD-12-01 PAI-10-SD-12-01A	1998 1998	0-0.5 0-0.5	(1), (2), (5), (6) (4)
PAI-10-SD-13-01 PAI-10-SD-13-01A	1998 1998	0-0.5 0-0.5	(1), (2), (3), (5), (6) (4)
PAI-10-SD-14-01 PAI-10-SD-14-02 PAI-10-SD-14-01A PAI-10-SD-14-02A	1998 1998 1998 1998	0-0.5 0-0.5 0.5-1.0 0.5-1.0	(1), (2), (5), (6) (1), (2), (5), (6) (4) (4)
PAI-10-SD-15-01 PAI-10-SD-15-01A	1998 1998	0-0.5 0-0.5	(1), (2), (5), (6) (4)
PAI-10-SD-16-01 PAI-10-SD-16-01A	1998 1998	0-0.5 0-0.5	(1), (2), (5), (6) (4)
PAI-10-SD-17-01 PAI-10-SD-17-01A	1998 1998	0-0.5 0-0.5	(1), (2), (5), (6) (4)
PAI-10-SD-18-01 PAI-10-SD-18-01A	1998 1998	0-0.5 0-0.5	(1), (2), (5), (6) (4)

TABLE 2-4

SUMMARY OF SEDIMENT SAMPLES COLLECTED
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

Sample ID	Date Collected	Depth Collected (feet bgs)	Analysis
PAI-10-SD-19-01	1999	0-0.5	(1) excluding VOCs
PAI-10-SD-20-01	1999	0-0.5	(1) excluding VOCs

PAI-10-SD-02-01D - Duplicate sample.
PAI-10-SD-01-01A - Addendum sample collected in December 1998. All other samples collected July to September 1998.
1 TCL VOCs, SVOCs, pesticides, PCBs, TAL metals (total), and cyanide.
2 TOC and pH.
3 Hexavalent chromium.
4 PAHs.
5 Acid volatile sulfide/simultaneous extracted metals (AVS/SEM).
6 Grain size analysis and bulk density.

TABLE 2-5

COMPARISON OF PAI-10-SS-08 AND PAI-10-SS-12 1998 AND 2001 RESULTS
SITE 12/SWMU 10 - JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

Parameter	PAI-10-SS-08-01 1998	PAI-10-SS-08-02 2001	Human Health Screening Criteria [1]	Ecological Screening Criteria [2]
2-METHYLNAPHTHALENE	ND	9 J	1,600,000	100[a]
ACENAPHTHENE	ND	30	4,700,000	20,000
ACENAPHTHYLENE	ND	32	2,300,000[b]	100[c]
ANTHRACENE	24 J	350 J	23,000,000	100
BENZO(A)ANTHRACENE	140 J	3,100	870	100[a]
BENZO(A)PYRENE	120 J	1,700	87	100
BENZO(B)FLUORANTHENE	120 J	2,900	870	100[a]
BENZO(G,H,I)PERYLENE	50 J	1,200	2,300,000[b]	100[a]
BENZO(K)FLUORANTHENE	110 J	1,400	8,700	100[a]
CHRYSENE	160 J	1,800	87,000	100[a]
DIBENZO(A,H)ANTHRACENE	ND	840 J	87	100[a]
FLUORANTHENE	280 J	4,000	3,100,000	100
FLUORENE	ND	17 J	3,100,000	100[c]
INDENO(1,2,3-CD)PYRENE	69 J	1,300	870	100[a]
NAPHTHALENE	ND	10 J	1,600,000	100
PHENANTHRENE	140 J	1,600	2,300,000[b]	100
PYRENE	230 J	3,400	2,300,000	100
B(a)P EQUIVALENTS [d]	214	3,286	434[e]	NA
TOTAL PAH CONC. [d]	1,464	16,888	NA	1,000

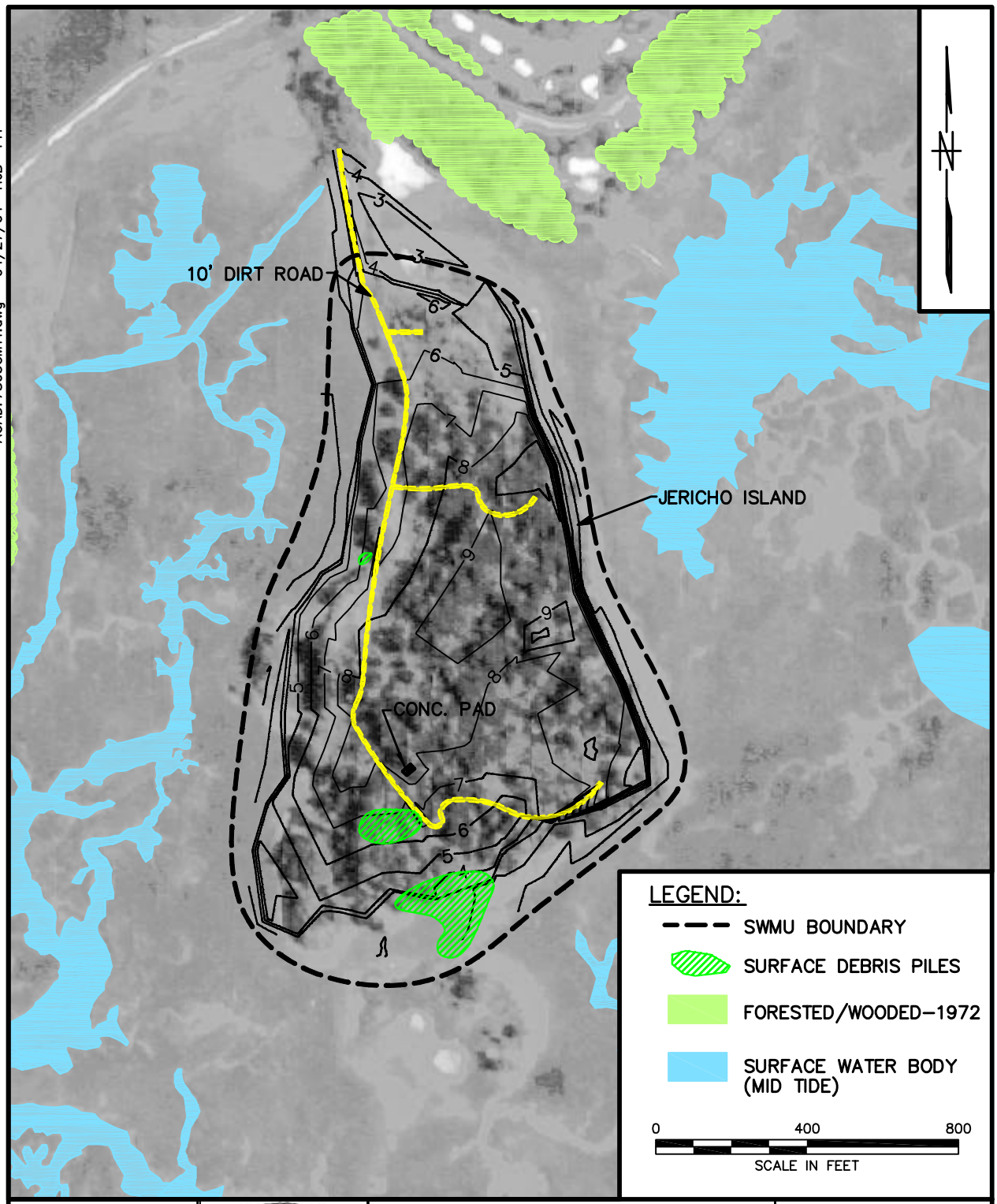
Parameter	PAI-10-SS-12-01 1998	PAI-10-SS-12-01-D 1998	PAI-10-SS-12-02 2001	Human Health Screening Criteria [1]	Ecological Screening Criteria [2]
2-METHYLNAPHTHALENE	ND	600	ND	1,600,000	100[a]
ACENAPHTHENE	ND	440	ND	4,700,000	20,000
ACENAPHTHYLENE	ND	580	ND	2,300,000[b]	100[c]
BENZO(A)ANTHRACENE	ND	ND	33	870	100[a]
BENZO(A)PYRENE	ND	ND	33	87	100
BENZO(B)FLUORANTHENE	ND	ND	53	870	100[a]
BENZO(G,H,I)PERYLENE	ND	ND	16 J	2,300,000[b]	100[a]
BENZO(K)FLUORANTHENE	ND	ND	15 J	8,700	100[a]
CHRYSENE	ND	ND	27	87,000	100[a]
FLUORANTHENE	ND	ND	39	3,100,000	100
FLUORENE	ND	220 J	ND	3,100,000	100[c]
INDENO(1,2,3-CD)PYRENE	NA	NA	22	870	100[a]
NAPHTHALENE	ND	2,700	ND	1,600,000	100
PENTACHLOROPHENOL	ND	240 J	ND	5,300	2
PHENANTHRENE	ND	ND	16 J	2,300,000[b]	100
PYRENE	ND	ND	40	2,300,000	100
B(a)P EQUIVALENTS [d]	154	154	47	434[e]	NA
TOTAL PAH CONC. [d]	794	5,029	203	NA	1,000

1. U.S. EPA Region 3 Soil Residential RBCs (April 13, 2000).
2. U.S. EPA Region 4 Ecological Screening Levels.

a Benzo(a)pyrene was used as a surrogate for high molecular weight PAH compounds when an ESV was not available.
b Naphthalene was used as a surrogate for low molecular weight PAH compounds when an ESV was not available.
c Value for pyrene.
d Value derived via methodology provided in RI Appendix G (TtNUS, October 2001).
e Seven times the Region IX PRG for benzo(a)pyrene.

Shaded cells indicate that a human health or ecological screening criterion has been exceeded.

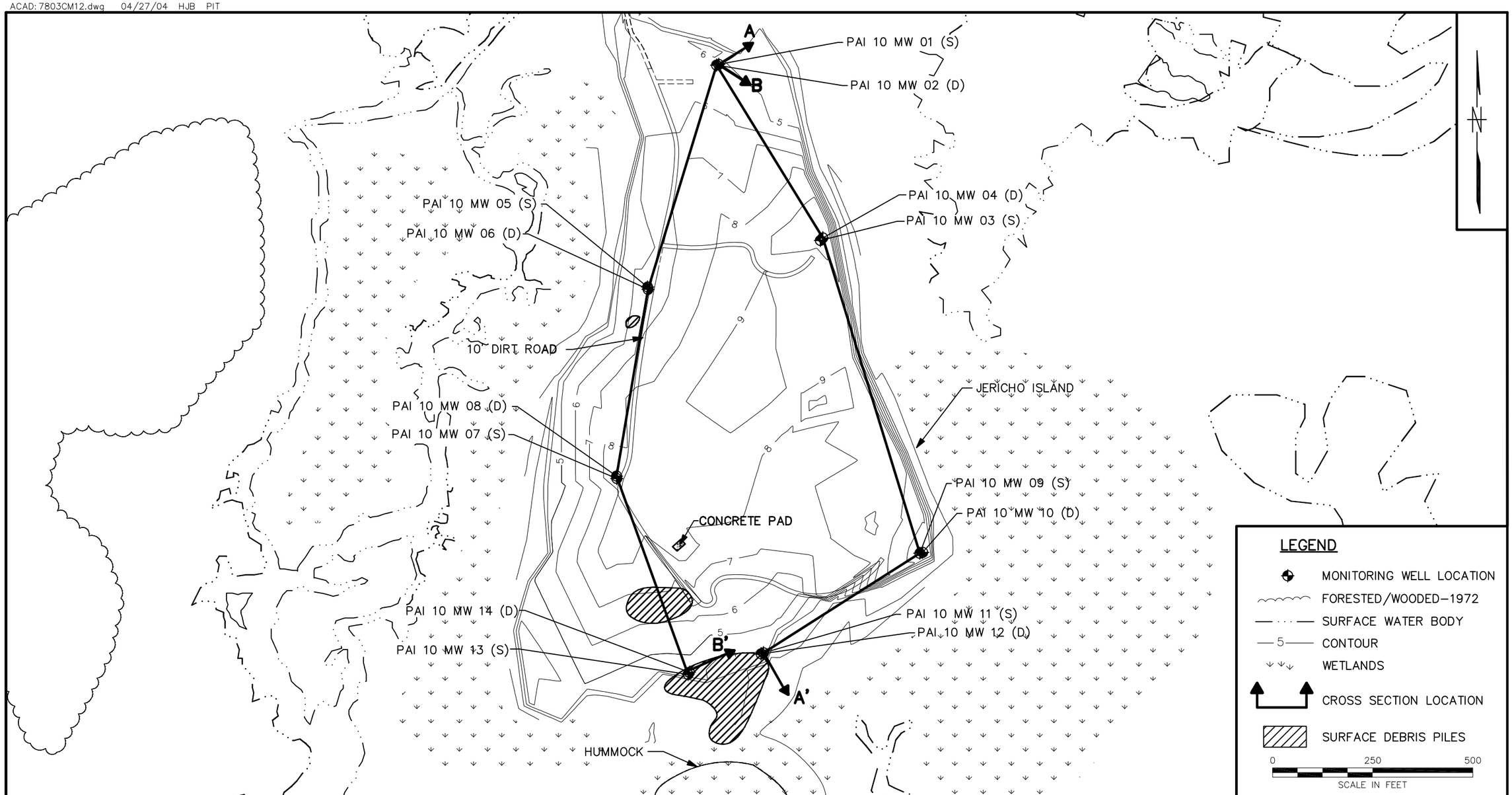
ACAD: 7803CM11.dwg 04/27/04 HJB PIT



DRAWN BY HJP DATE 8/2/01		SITE LAYOUT SITE 12/SWMU 10 JERICHO ISLAND DISPOSAL AREA MCRD PARRIS ISLAND, SOUTH CAROLINA	CONTRACT NO. 7803
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-1 / REV. 1

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98

ACAD: 7803CM12.dwg 04/27/04 HJB PIT



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

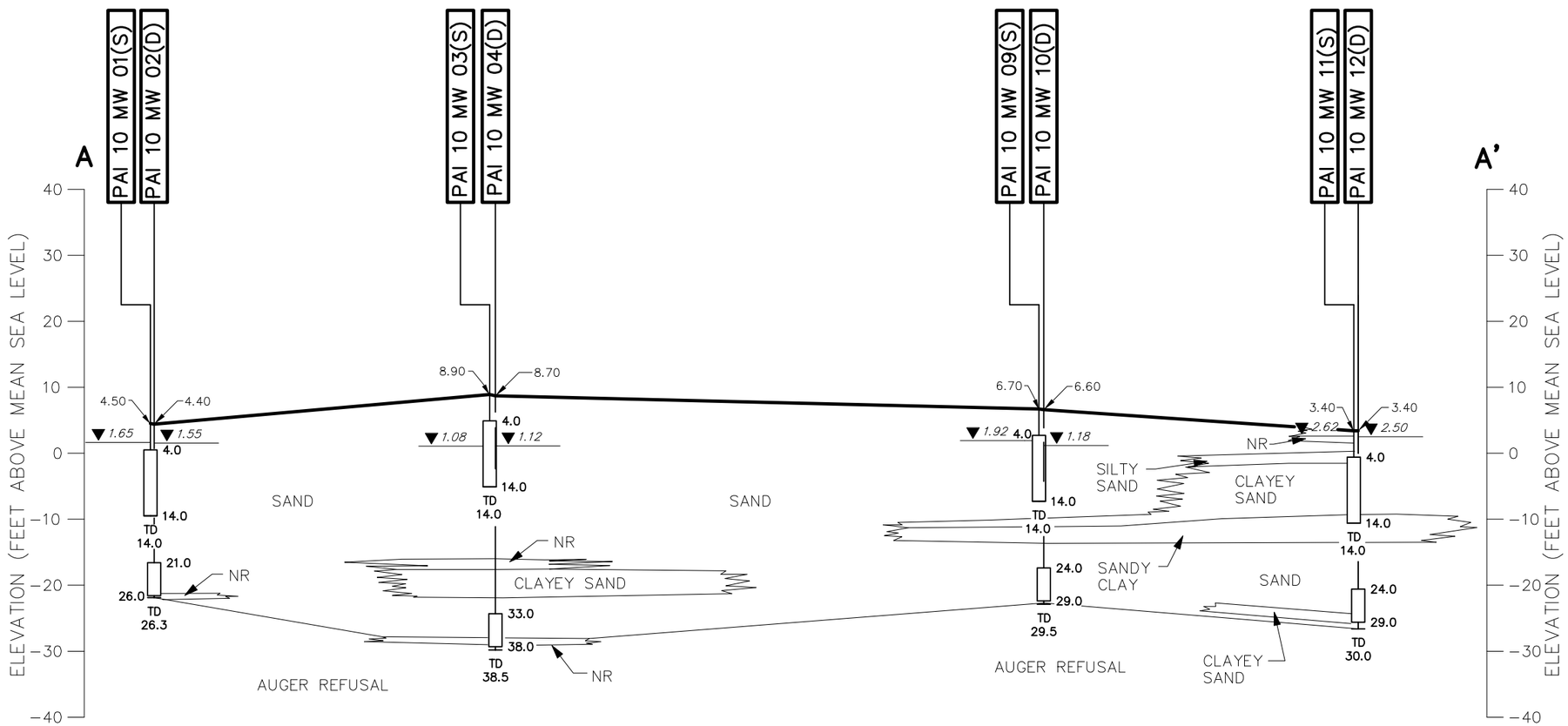
DRAWN BY HJP DATE 8/2/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

CROSS SECTION LOCATION AND
SURFACE DEBRIS MAP
SITE 12/SWMU 10
JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7803
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-2
REV. 1

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: 7803CX05.dwg 04/27/04 HJB PIT



LEGEND:

MONITORING WELL OR BORING NUMBER — PAI 10 MW 01(S)

GROUND SURFACE ELEVATION — 4.50

GROUND SURFACE

GROUNDWATER ELEVATION

TOP OF MONITORED INTERVAL (FT BGS) — 4.0

LITHOLOGIC CONTACT (INFERRED BETWEEN BORINGS)

BOTTOM OF MONITORED INTERVAL (FT BGS) — 14.0

TOTAL DEPTH OF WELL OR BORING (FT BGS) — TD 14.0

NR = NO RECOVERY

0 200 400
HORIZONTAL SCALE IN FEET

0 20 40
VERTICAL SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

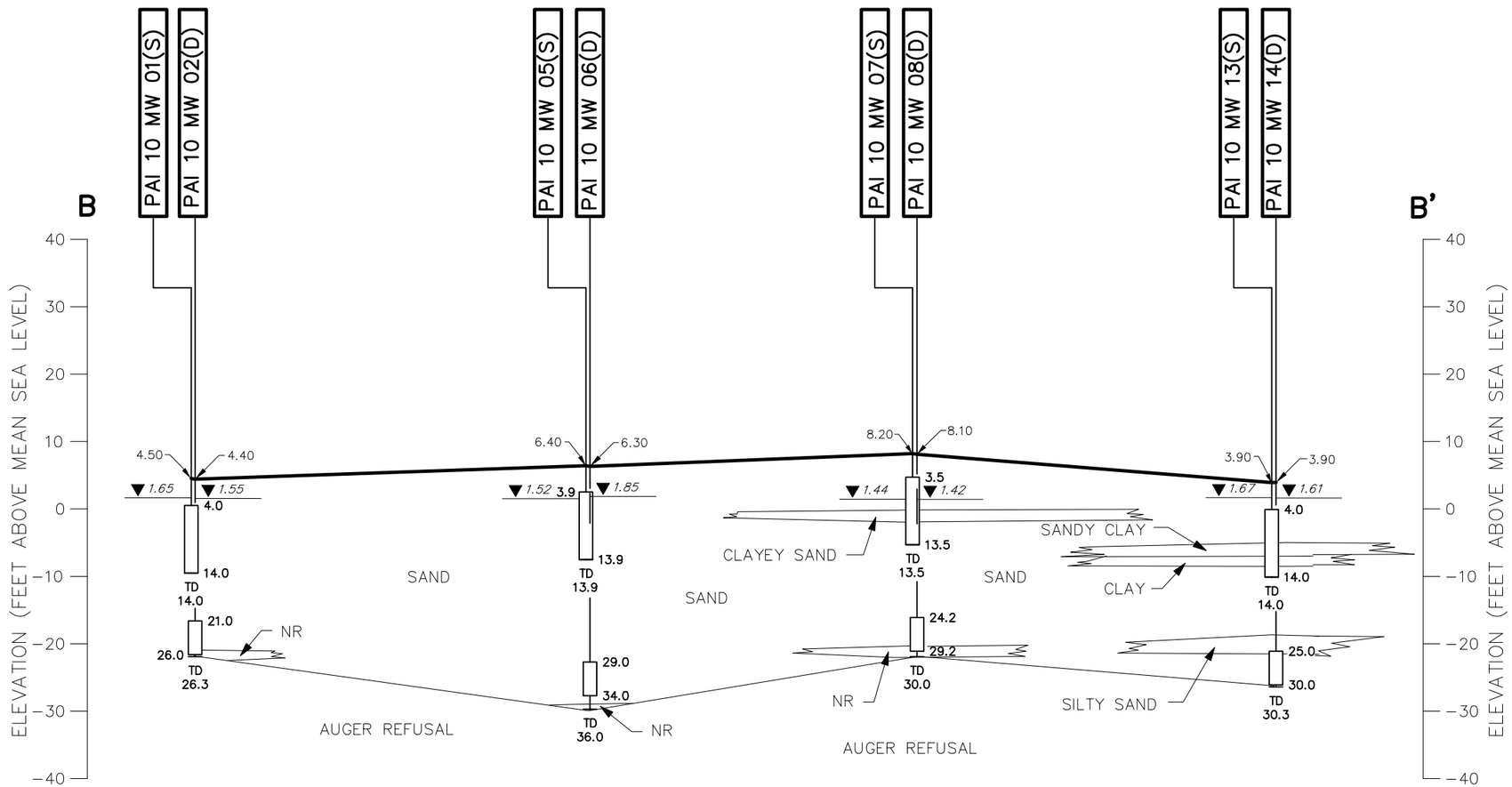
DRAWN BY HJP DATE 8/2/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

CROSS SECTION A–A'
SITE 12/SWMU 10
JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7803
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2–3
REV. 1

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: 7803CX06.dwg 04/27/04 HJB PIT



LEGEND:

MONITORING WELL OR BORING NUMBER — PAI 10 MW 01(S)

GROUND SURFACE ELEVATION — 4.50

GROUND SURFACE

GROUNDWATER ELEVATION

TOP OF MONITORED INTERVAL (FT BGS) — 4.00

LITHOLOGIC CONTACT (INFERRED BETWEEN BORINGS)

BOTTOM OF MONITORED INTERVAL (FT BGS) — 14.0

TOTAL DEPTH OF WELL OR BORING (FT BGS) — TD 14.0

0 200 400
HORIZONTAL SCALE IN FEET

0 20 40
VERTICAL SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

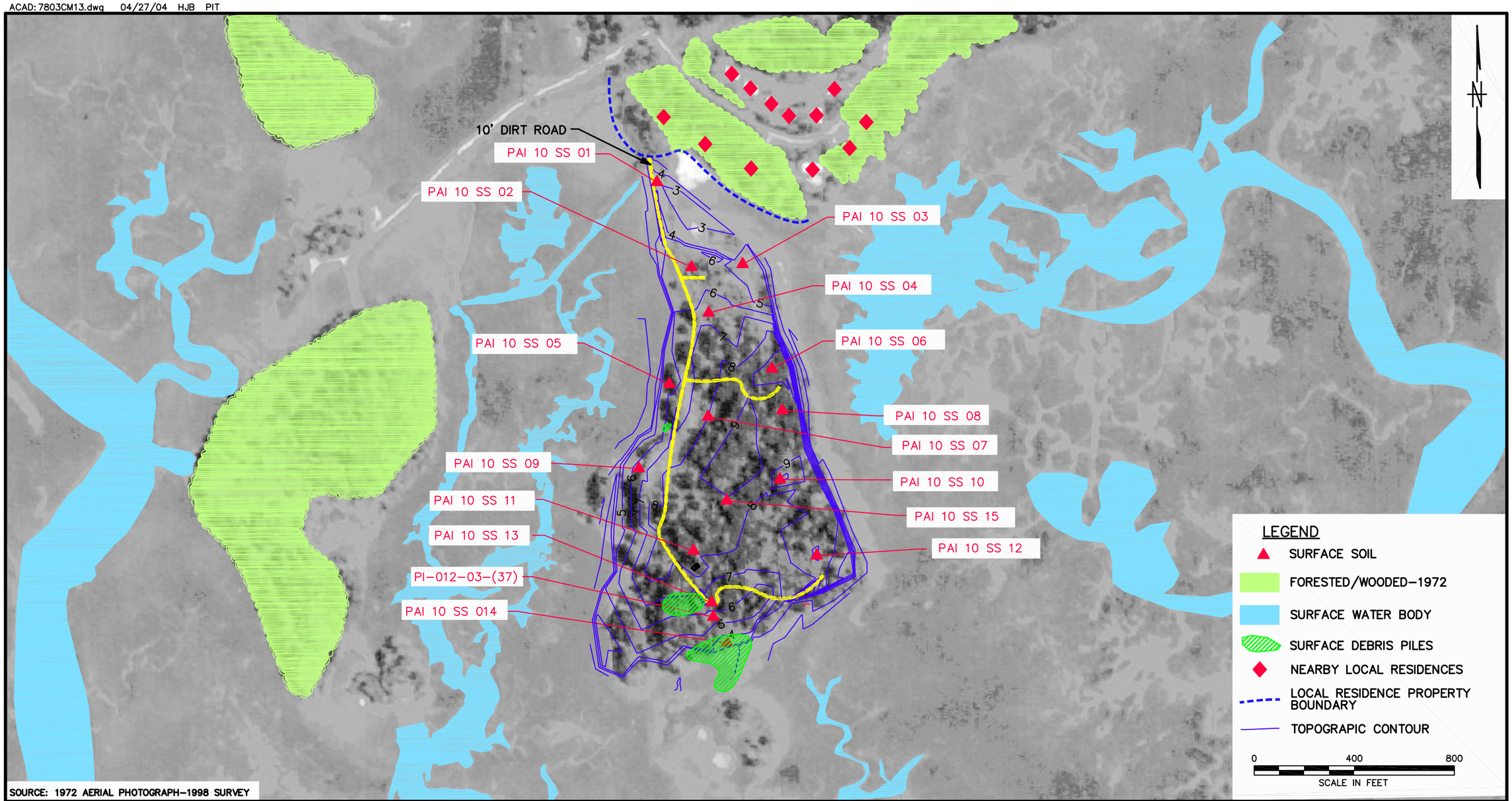
DRAWN BY HJP DATE 8/2/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

CROSS SECTION B–B'
SITE 12/SWMU 10
JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7803
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2–4
REV. 1

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: 7803CM13.dwg 04/27/04 HJB PIT



SOURCE: 1972 AERIAL PHOTOGRAPH-1998 SURVEY

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

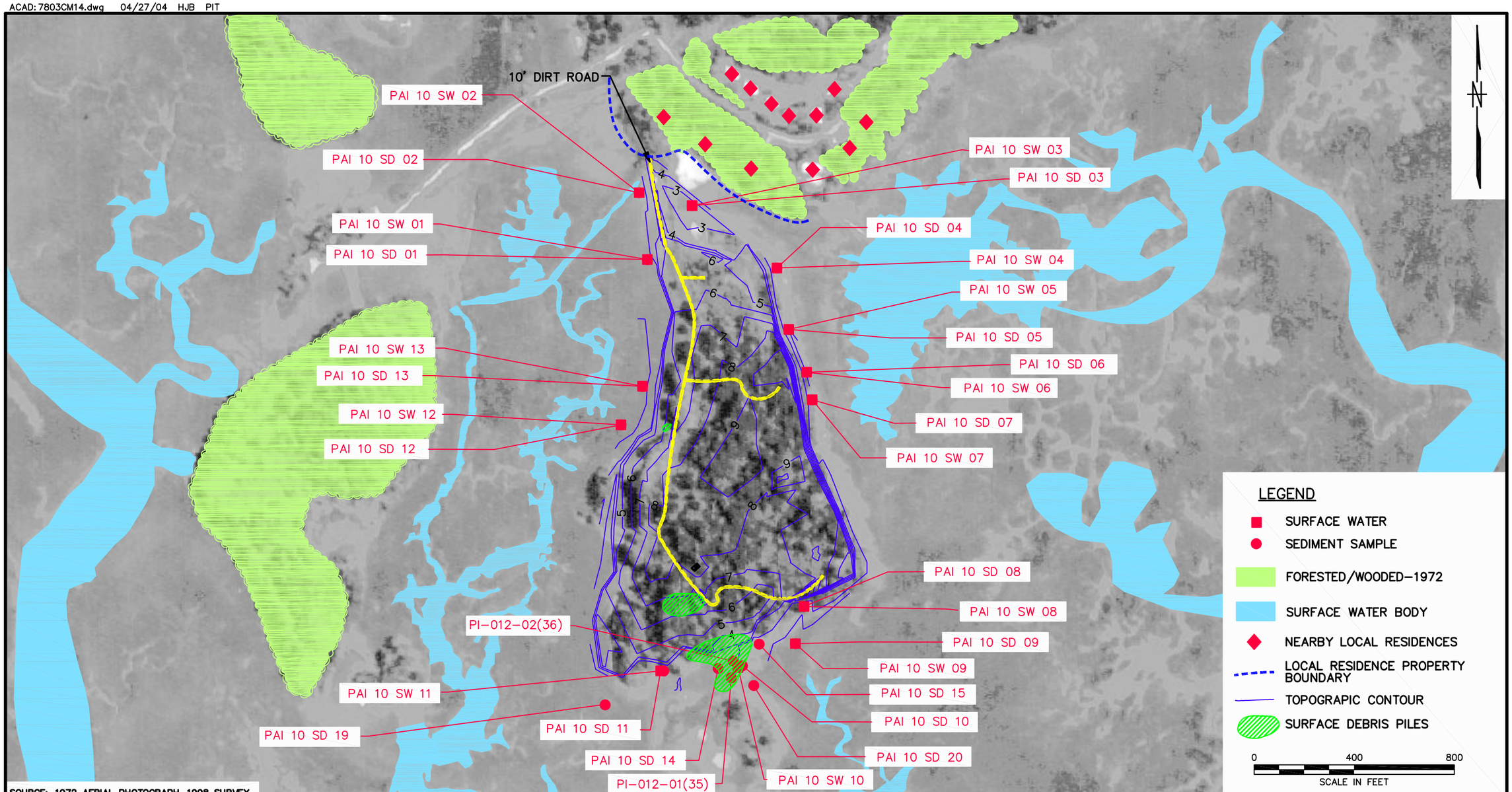
DRAWN BY MF DATE 7/25/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SURFACE SOIL
SAMPLE LOCATION MAP
SITE 12/SWMU 10
JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7803
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-5
REV. 1

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: 7803CM14.dwg 04/27/04 HJB PIT



SOURCE: 1972 AERIAL PHOTOGRAPH-1998 SURVEY

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MF DATE 7/24/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SURFACE WATER AND SEDIMENT SAMPLE LOCATION MAP
JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7803
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-6
REV. 1

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

3.0 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES/CORRECTIVE MEASURES OBJECTIVES

3.1 INTRODUCTION

Remedial action objectives/corrective action objectives (RAOs/CAOs) are developed as medium- and chemical-specific objectives that will result in the protection of human health and the environment. Typically, RAOs/CAOs are developed based on promulgated standards [e.g., Ambient Water Quality Criteria (AWQCs)], background concentrations determined from a site-specific investigation, and human health and ecological risk-based concentrations developed in accordance with the U.S. EPA risk assessment guidance.

Section 3.0 presents the development of RAOs/CAOs for Site 12 at MCRD Parris Island. Section 3.2 presents Applicable or Relevant and Appropriate Requirements (ARARs), which include requirements, criteria, or limitations promulgated under the Federal and state laws that address a chemical, action, or location at a site. Section 3.3 presents a discussion on presumptive remedies for landfills and the applicability of a presumptive remedy approach for Site 12. Sections 3.4 and 3.5 discuss the media and chemicals of concern (COCs) that will be addressed in this FS/CMS. Based on ARARs and the identified media of concern and COCs, Section 3.6 presents the site-specific RAOs/CAOs. A range of chemical-specific values or remedial goal options (RGOs) that would attain these objectives is presented in Section 3.7. Lastly, Section 3.8 presents areas of waste and impacted sediment at Site 12 based on the selected RGOs.

3.2 ARARS/MEDIA CLEANUP STANDARDS

ARARs/media cleanup standards, which include the requirements, criteria, or limitations promulgated under Federal and state law that address a chemical, location, or action at a site, are presented in this section.

The definition of ARARs is as follows:

- Any standard, requirement, criterion, or limitation under Federal environmental law.
- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-citing law that is more stringent than the associated Federal standard, requirement, criterion, or limitation.

One of the primary concerns during the development of RAOs/CAOs is the degree of human health and environmental protection afforded by a given remedy. Consideration should be given to remedies that attain or exceed ARARs.

Definitions of the two types of ARARs, as well as other to be considered (TBC) criteria, are given below:

- 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 directly and fully address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site.

- 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 sufficiently similar (relevant) to those encountered at a site that their use is well suited (appropriate) to the particular site.

- TBC Criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing remedial actions or necessary for determining what is protective of human health and/or the environment. Examples of TBC criteria include U.S. EPA Drinking Water Advisories and RBCs.

These requirements are presented to provide decision makers with a complete evaluation of potential ARARs in developing, identifying, and selecting a corrective measure alternative.

ARARs fall into three categories, based on the manner in which they are applied:

- Chemical Specific: Health-/risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples of chemical-specific ARARs include Maximum Contaminant Levels (MCLs) and Clean Water Act (CWA) water quality criteria. Chemical-specific ARARs are considered in evaluating the extent of site cleanup.

- Location Specific: Restrictions based on the concentration of hazardous substances or the conduct of activities in specific locations. These may restrict or preclude certain remedial action/corrective measures or may apply only to certain portions of site. Examples of location-specific ARARs include floodplain and coastal zone management requirements. Location-specific ARARs pertain to special site features.

- Action Specific: Technology- or activity-based controls or restrictions on activities related to management of hazardous waste. Action-specific ARARs pertain to implementing a given remedy.

Tables 3-1 and 3-2 present a summary of Federal and state ARARs and TBCs for potential remedial action/corrective measures undertaken for Site 12 at MCRD Parris Island. The following sections present a brief description of each chemical-, location-, or action-specific ARAR and TBC contained in Tables 3-1 and 3-2.

3.2.1 Chemical-Specific ARARs and TBCs

This section presents a summary of Federal and state chemical-specific ARARs and TBCs. These criteria provide medium-specific guidance on "acceptable" or "permissible" concentrations of chemicals.

The Safe Drinking Water Act (SDWA) [40 Code of Federal Regulations (CFR) 140-143] promulgated National Primary Drinking Water Standard MCLs (40 CFR 141). MCLs are enforceable standards for chemicals in public drinking water supply systems. They consider not only health factors but also the economic and technical feasibility of removing a chemical from a water supply system. Secondary MCLs (SMCLs) (40 CFR 143) are not enforceable but are intended as guidelines for chemicals that may adversely affect the aesthetic quality of drinking water, such as taste, odor, color, and appearance, and may deter public acceptance of drinking water provided by public water systems.

The SDWA also established MCL Goals (MCLGs) for several organic and inorganic compounds in drinking water. MCLGs are set at levels of no known or anticipated adverse health effects, with an adequate margin of safety. The National Contingency Plan (NCP) [40 CFR 300.430(e)(2)(i)] states that MCLGs that are set at levels above zero shall be attained by remedial actions for groundwater or surface waters that are current or potential sources of drinking water [where the MCLGs are relevant and appropriate under the circumstances of the release based on the factors in Section 300.400(g)(2) of the NCP]. If an MCLG is found not to be relevant and appropriate, the corresponding MCL will be achieved where relevant and appropriate to the circumstances of the release. For MCLGs that are set at zero, the MCL promulgated for that chemical under the SDWA will be attained by the remedial action. In cases involving multiple contaminants or pathways where attainment of chemical-specific ARARs will result in a cumulative cancer risk in excess of 1E-04, criteria in paragraph (e)(2)(i)(A) of Section 300.430 (i.e., risk-based criteria) may be considered when determining the cleanup level to be attained. The NCP explains that cleanup levels set at zero (generally the case for carcinogens) are not appropriate because complete elimination of risk is not possible and because "true zero" cannot be detected.

The CWA sets U.S. EPA AWQCs that are non-enforceable guidelines developed for pollutants in surface waters, pursuant to Section 304(a)(1) of the CWA. Although AWQCs are not legally enforceable, they

should be considered as relevant and appropriate requirements. AWQCs are available for the protection of human health from exposure to chemicals in surface water as well as from ingestion of aquatic biota and for the protection of freshwater and saltwater aquatic life. AWQCs may be considered for existing discharges to the marsh and actions that involve groundwater treatment and/or discharge to nearby surface waters.

RCRA Subtitle C regulates the treatment, storage, and disposal of hazardous waste from its generation until its ultimate disposal. In general, RCRA Subtitle C requirements for the treatment, storage, or disposal of hazardous waste will be applicable if

- The waste is a listed or characteristic waste under RCRA.
- The waste was treated, stored, or disposed (as defined in 40 CFR 260.10) after the effective date of the RCRA requirements under consideration.
- The activity at the CERCLA site constitutes current treatment, storage, or disposal as defined by RCRA.

The following chemical-specific requirements included in the RCRA Subtitle C regulations are potentially applicable to MCRD Parris Island:

- Identification and listing of hazardous waste (40 CFR 261)
- Groundwater protection and groundwater monitoring (40 CFR 264.90-264.101)
- Land disposal restrictions (40 CFR 268.1-268.50)

U.S. EPA Health Advisories (U.S. EPA, 1996a) are nonenforceable guidelines (TBCs) developed by the U.S. EPA Office of Drinking Water for chemicals that may be intermittently encountered in public water supply systems. Health advisories are available for short-term, longer-term, and lifetime exposure for a 10-kilogram child and/or a 70-kilogram adult. Health advisories may be pertinent for remedial action/corrective measures involving groundwater, especially for chemicals that are not regulated under the SDWA.

U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) (U.S. EPA, 2000) are concentrations in soil, groundwater, and air that, if exceeded, may be of potential concern to human receptors. These concentrations are calculated for a target HQ of 1.0 for noncarcinogenic effects and a target ILCR of 1.0E-6 for carcinogenic effects. Region 9 PRGs are TBC.

Generic Soil Screening Levels (SSLs) (U.S. EPA, 1996b) are soil levels that, if exceeded through three possible exposure pathways, may be of potential concern to human receptors. SSLs consider the following exposure pathways: direct ingestion of soil, inhalation of volatile compounds and fugitive dust, and migration to groundwater. SSLs are TBC.

Dutch Soil Clean-up Act Ecological Screening Values (ESVs) (Beyer, 1990) and Dutch Ministry of Housing Intervention Values and Target Values - Soil Quality Standards [Ministry of Health, Spatial Planning, and the Environment (MHSPE), 1994] are published ESVs for soil. Soil screening levels from the Netherlands were taken from the interim Dutch Soil Clean-up Act (Beyer, 1990). Three categories were identified by the Dutch: Category A refers to background concentrations in soil or detection limits; Category B refers to moderate soil contamination that requires additional study; and Category C refers to threshold values that require immediate cleanup. The newer Dutch values (MHSPE, 1994) include target values and intervention values. Target values represent the "soil quality required for the full restoration of the soil's functionality for human, animal and plant life," or "soil quality ultimately aimed for." The intervention values replace the 1990 C values and represent "the concentration levels of the contaminants in the soil . . . above which the functionality of the soil for human, plant, and animal life is seriously impaired or threatened." The 1994 intervention values also take into account ecotoxicological considerations. These values are TBC.

Oak Ridge National Laboratory Toxicity Benchmarks for Soil (Efroymson, 1997a and 1997b) are surface soil guidelines indicative of toxicity to soil invertebrates and terrestrial plants. The values were derived using data from field and laboratory studies, bibliographic databases, and published literature. These values are TBC.

Canadian Council of Ministers of the Environment Soil Quality Guidelines (CCME, 1997) is a listing of ESVs for surface soil. The derivation process for the guidelines considers adverse effects from direct soil contact and from the ingestion of soil and food. Four approaches were used to evaluate contact with soil: weight of evidence, lowest-observed-effect concentration method, median effects method, and comparison with nutrient and energy cycling. These values are TBC.

The memorandum entitled Ecological Risk Assessment at Military Bases (U.S. EPA Region 4, 1998a) contains a listing of ESVs for surface soils, sediments, and surface water. The ESVs consist largely of the TBC sources cited in this section (Section 3.2.1). Many of the surface water screening values are Federal AWQCs and, thus, are relevant and appropriate.

Effect Range-Low (ER-L) and Effects Range-Median (ER-M) Level (Long et al., 1995). ER-L and ER-M values are based on data from many studies where sediment concentrations were coupled with apparent

biological effects (Long et al., 1995). With all data combined, the ER-L is the 10th percentile of sediment concentrations associated with effects to benthic organisms. The 50th percentile of the effects data is the ER-M. Concentrations below the ER-L represent a minimal effects range within which biological effects would rarely be observed. Concentrations between the ER-L and ER-M represent a possible effects range within which effects would occasionally occur. Concentrations above the ER-M represent a probable-effects range within which effects would frequently occur. These values are TBC.

Probable Effects Levels (PELs) and Threshold Effects Levels (TELs) [Florida Department of Environmental Protection (FDEP), 1994] are similar to ER-L and ER-M values; however, the TELs and PELs also incorporate chemical concentrations observed or predicted to be associated with no adverse biological effects (no-effects data). The TEL is the geometric mean of the 15th percentile in the effects data set and the 50th percentile in the no-effects data set. Sediment contaminant concentrations below the TEL (i.e., the minimal effects range) are not considered to represent significant hazards to aquatic organisms (FDEP, 1994). The PEL is the geometric mean of the 50th percentile in the effects data set and 85th percentile in the no-effects data set. The PEL represents the lower limit of the range of chemical concentrations that are usually or always associated with adverse biological effects. Contaminant concentrations between the TEL and the PEL constitute the possible effects range (i.e., adverse biological effects are possible). These values are TBC.

South Carolina State Primary Drinking Water Regulations (R.61-58) are promulgated pursuant to S.C. Code Sections 44-55-10 et seq. and are collectively known as the State Primary Drinking Water Regulations. Standards within these regulations are for maintaining the purity of the drinking water of the state. Regulation 61-58.5 establishes MCLs in groundwater for inorganic, organic, and volatile synthetic organic chemicals. Additionally, Regulation 61-58.5 establishes SMCLs and lead and copper action levels. These criteria are applicable to public water systems, defined as any public or privately owned waterworks system that provides drinking water, whether bottled or piped, for human consumption, including the source of supply, whether the source of supply is of surface or subsurface origin; all structures and appurtenances used for the collection, treatment, storage, or distribution of drinking water delivered to consumers; and any part or portion of the system and including any water treatment facility that in any way alters the physical, chemical, radiological, or bacteriological characteristics of drinking water, provided that public water system shall not include a drinking water system serving a single private residence or dwelling.

Since all groundwater in the State of South Carolina is considered a potential drinking water source regardless of salinity, these regulations are applicable. Cadmium and thallium concentrations in the groundwater exceeded state MCLs of 5 and 2 µg/L.

Hazardous Waste Management Regulations (R.61-79) promulgated pursuant to authority in the South Carolina Hazardous Waste Management Act (§44-56-30) regulate the management of hazardous waste. Similar to RCRA, the following chemical-specific requirements included in the Hazardous Waste Management Regulations are potentially applicable to MCRD Parris Island:

- Identification and listing of hazardous waste (R.61-79.261)
- Groundwater protection and groundwater monitoring (R.61-79.264)
- Land disposal restrictions (R.61-79.268)

3.2.2 Location-Specific ARARs and TBCs

This section presents a summary of Federal and state location-specific ARARs and TBCs. These potential ARARs and TBCs are as follows.

U.S. EPA's Groundwater Protection Strategy (U.S. EPA, 1984) policy is to protect groundwater for its highest present or potential beneficial use. The strategy designates three categories of groundwater:

- Class I - Special Groundwater: Waters that are highly vulnerable to contamination and are either irreplaceable or ecologically vital sources of drinking water.

- Class II - Current and Potential Sources of Drinking Water and Waters Having Other Beneficial Uses: Waters that are currently used or that are potentially available.

- Class III - Groundwater Not a Potential Source of Drinking Water and of Limited Beneficial Use. Class III groundwater units are further subdivided into two subclasses.

  - Subclass IIIA includes groundwater units that are highly to intermediately interconnected to adjacent groundwater units of a higher class and/or surface waters. They may, as a result, be contributing to the degradation of the adjacent waters. They may be managed at a similar level as Class II groundwater, depending upon the potential for producing adverse effects on the quality of adjacent waters.

  - Subclass IIIB is restricted to groundwater characterized by a low degree of interconnection to adjacent surface waters or other groundwater units of a higher class within the Classification Review Area. These groundwaters are naturally isolated from sources of drinking waters in such a way that there is little potential for producing adverse effects on quality. They have low resource values outside of mining or waste disposal.

Groundwater at Site 12 is likely considered Class II. Monitoring wells are highly saline; however, a drinking water well exists on Jericho Island.

CWA Section 404 River and Harbors Act, Section 10 (40 CFR 230, 33 CFR 320-330) prohibits the unauthorized obstruction or alteration of any navigable waters of the United States. Examples of activities requiring an Army Corps of Engineers permit (33 CFR 322) include construction of a structure in or over any waters of the United States, excavation or deposit of material in such waters, and various types of work performed in such waters, including fill and stream channelization. The waters in the vicinity of Site 12, most notably Archers Creek, are classified as navigable waters and, therefore, the Act is applicable.

Federal Floodplain Management Executive Order [Executive Order (E.O.) 11988] requires Federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with occupancy and modification of flood plains. Site 12 is located within the 100-year floodplain and is therefore a potentially applicable ARAR.

Federal Protection of Wetlands Executive Order (E.O. 11990) is an applicable ARAR that requires Federal agencies, in carrying out their responsibilities, to take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. Site 12 is surrounded by saltwater marshlands.

The Endangered Species Act of 1973 [16 United States Code (U.S.C.) 1531 et seq.] provides for consideration of the impacts on endangered and threatened species and their critical habitats. Remedial action/corrective measures, if required, would need to be conducted in a manner such that the continued existence of any endangered or threatened species is not jeopardized or its critical habitat is not adversely affected. Consultation with the United States Fish and Wildlife Service (USFWS) is also required. The Endangered Species Act could potentially apply because wood storks and least terns may live in the general area. Also, an active bald eagles nest is located 2.3 miles southeast of the site.

The Fish and Wildlife Coordination Act (16 U.S.C. 661, et seq.) (40 CFR 122.49) provides for consideration of the impacts on wetlands and protected habitats. The act requires that Federal agencies, before issuing a permit or undertaking Federal action for the modification of any body of water, consult with the appropriate state agency exercising jurisdiction over wildlife resources to conserve those resources. Consultation with the USFWS is also required.

The Coastal Zone Management Act of 1972 (16 U.S.C. 1451, et seq.) provides for the preservation and protection of coastal zone areas, management of coastal zones to be the state's responsibility, and the management of coastal zone development to be in such a way as to minimize the effects on coastal zone resources. Section 304(1) excludes Federal lands from the coastal area if those lands are subject solely to the discretion of or are held in trust by the Federal government. However, under Section 307 (c), paragraphs (1) and (2), Federal activities and development projects in or directly affecting the coastal zone must be consistent to the maximum extent practicable with a federally approved state management program.

Historic Sites, Buildings, and Antiquities Act of 1935 (16 U.S.C. 461 et seq.) states that it is Federal policy to preserve historic and prehistoric properties of national significance. Site 12 is not classified as such a property nor is it known to possess aspects of historic or prehistoric significance; however, this Act would be applicable if information were found to classify it as such a property. As such, this Act is potentially applicable.

Archaeological and Historic Preservation Act of 1974 (16 U.S.C. 469 et seq.) contains provisions for the protection of historic and archaeological data affected by any Federal construction project or federally licensed project, activity, or program. Although no such data are known to exist within the boundaries of Site 12, this Act would be applicable if such data were to be found.

Archeological Resources Protection Act of 1979 [16 U.S.C. 479(aa) et seq.] requires Federal land managers to issue permits for the excavation or removal of archeological artifacts from lands under their jurisdiction. The Act requires that relevant Native American tribes be notified of permit issuance if significant religious or cultural sites will be affected. Artifacts have not previously been discovered within the boundaries of Site 12; however, if such artifacts were to be found during remedial activities, this Act would be applicable.

Native American Grave Protection and Repatriation Act of 1990 (25 U.S.C. 3001 et seq.) is an applicable requirement and requires, upon discovery of human remains during a Federal undertaking, cessation of activity for a minimum of 30 days and consultation with Native American groups.

Bald Eagle Protection Act of 1940, as amended (16 U.S.C. 688 et seq.), is not an applicable requirement. This act contains provisions for prohibiting the disturbance of bald eagles. A bald eagle is known to nest in the vicinity of Site 3; however, this site is approximately 2.3 miles southeast of Site 12 and therefore this Act is not applicable for Site 12.

Conservation Programs on Military Reservations (Sikes Act) of 1960, as amended (16 U.S.C. 670(a) et seq.), is an applicable requirement and requires that military installations manage natural resources for multipurpose uses and public access appropriate for those uses consistent with the military department's mission.

Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361 et seq.), mandates a moratorium on the killing, capturing, harming, importing, and disturbing of marine mammals and marine mammal products. Marine mammals are not known to inhabit Archers Creek adjacent to Site 12 and, therefore, this Act is not applicable.

Water Classifications and Standards (R.61-68) promulgated pursuant to authority in the South Carolina Pollution Control Act (Section 48-1-10 et seq.) establish a system and rules for managing and protecting the quality of South Carolina's surface water and groundwater. The regulations establish the state's official classified water uses for all state waters, establish general rules and specific numeric water-quality standards for protecting classified and existing water uses, and establish procedures for classifying waters of the state. Classified Water (R.61-69) contains classifications of water bodies in South Carolina.

Site 12 is approximately 0.5 miles north of Archers Creek, which is classified under R.61-69 as SA. According to R.61-69, waters classified as SA are tidal saltwaters suitable for primary and secondary contact recreation, crabbing, and fishing, except harvesting of clams, mussels, or oysters for market purposes or human consumption. They are also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora.

Because Site 12 groundwater is not freshwater (i.e., salinity readings greater than 0.048 percent as identified by SCDHEC, 1998), it is not considered an underground source of drinking water. Further support of this is provided under R.61-68, which defines an underground source of drinking water as a water with fewer than 10,000 milligrams per liter (mg/L) total dissolved solids (TDS). During the RI/RFI, Site 12 groundwater had an average TDS of 13,875 mg/L, which indicates that Site 12 groundwater is not an underground source of drinking water.

South Carolina Coastal Zone Management Act (§44-39-10) was promulgated to encourage development of coastal resources within the framework of a coastal planning program. The program is designed to protect the sensitive and fragile areas from inappropriate development and provide adequate environmental safeguards with respect to the construction of facilities in the critical areas of the coastal zone. This statute is applicable in that remedial action/corrective measures would need to be implemented to protect nearby coastal areas.

Groundwater Mixing Zone Application Guidance (SCDHEC, 1997b) provides guidance on preparing groundwater mixing zone applications and to furnish technical recommendations on meeting the conditions for a groundwater mixing zone established under R.61-68. A mixing zone is a hydrogeologically controlled three-dimensional flow path in the subsurface, which constitutes the pathway for waste constituents to migrate from a source. Non-attainment of MCLs within the mixing zone is permitted upon acceptance of the mixing zone application to SCDHEC.

3.2.3 Action-Specific ARARs and TBCs

This section presents a summary of Federal and state action-specific ARARs and TBCs. These potential ARARs and TBCs are as follows.

RCRA Subtitle C regulates the treatment, storage, and disposal of hazardous waste from its generation until its ultimate disposal. In general, RCRA Subtitle C requirements for the treatment, storage, or disposal of hazardous waste will be applicable if

- The waste is a listed or characteristic waste under RCRA.
- The waste was treated, stored, or disposed (as defined in 40 CFR 260.10) after the effective date of the RCRA requirements under consideration.
- The activity at the CERCLA site constitutes current treatment, storage, or disposal as defined by RCRA.

RCRA Subtitle C requirements may be applicable when the waste is sufficiently similar to a hazardous waste and/or the on-site remedial action constitutes treatment, storage, or disposal and the particular RCRA requirement is well suited to the circumstances of the contaminant release and site. RCRA Subtitle C requirements may also be applicable when the remedial action constitutes generation of a hazardous waste. On-site activities, mandated by a federally ordered Superfund cleanup, must comply with the substantive requirements of RCRA Subtitle C but not with the administrative requirements (i.e., permits) of RCRA. All RCRA Subtitle C requirements must be met if the cleanup is not under Federal order and/or when the hazardous waste moves off site.

The following requirements included in the RCRA Subtitle C regulations may pertain to Site 12 at MCRD Parris Island.

- Hazardous waste generator requirements (40 CFR 262) – Regulations with which a generator that treats, stores, or disposes of hazardous waste on site must comply. This is applicable if hazardous waste is generated during a remedial action.

- Transportation requirements (40 CFR 263) – Regulations for the manifest and recordkeeping systems and for the immediate action and cleanup of hazardous waste discharges (spills) during transportation. These are applicable if hazardous waste is shipped off site.

- Standards for owners and operators of hazardous waste treatment, storage, and disposal (TSD) facilities (40 CFR 264). Regulations that govern the treatment, storage, and disposal of hazardous waste. These are applicable if hazardous waste is sent to a TSD.

- Interim status standards for owners and operators of hazardous waste TSD facilities (40 CFR 265) – Includes regulations for final cover requirements for final closure of interim status landfills. Under these regulations, the owner or operator must cover the landfill with a final cover designed and constructed to provide long-term minimization of migration of liquids through the closed landfill, function with minimum maintenance, promote drainage and minimize erosion or abrasion of the cover, accommodate settling and subsidence so that the cover's integrity is maintained, and have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present. Because the type of waste disposed at Site 12 was primarily nonhazardous in nature, these requirements are not applicable; however, certain aspects are relevant and appropriate.

- Land Disposal Restrictions (LDRs) (40 CFR 268) - Applicable only if hazardous waste is shipped off site.

Based on data obtained during the RI/RFI and other investigations, surface soil, sediment, surface water, and groundwater at Site 12 are not expected to be a characteristic or listed RCRA hazardous waste. However, waste materials were not tested and, if excavated for off-site disposal, would have to be properly classified.

The Hazardous and Solid Waste Amendments (HWSA) are the 1984 amendments to RCRA that require phasing out land disposal of hazardous waste. Additionally, the HSWA establishes a corrective actions program requiring four basic elements (assessment, investigation, CMS, implementation) and establishes a regulatory program for underground storage tanks (USTs).

RCRA Subtitle D establishes design and operating criteria for solid waste (nonhazardous) landfills. In general, RCRA Subtitle D establishes minimum design and operating criteria for all solid waste landfills that

- Receive municipal solid waste as defined in 40 CFR 258
- Codispose sewage sludge with municipal solid waste
- Receive nonhazardous municipal solid waste combustion ash
- Are not regulated under Subtitle C of RCRA

The closure and post-closure care requirements under RCRA Subtitle D are intended to minimize the infiltration of water into the landfill and maintain the integrity of the cover during the post-closure period by minimizing cover erosion. They include closure and post-closure plans (post-closure plans must include a description of monitoring and maintenance activities, as well as a description of any uses of the property during the post-closure period) and minimum requirements for a final landfill cover. The landfill cover is designed to minimize infiltration and erosion and

- Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present or a permeability no greater than 1×10^{-5} cm/sec, whichever is less.

- Minimize infiltration through the closed municipal solid waste landfill (MSWLF) by the use of an infiltration layer that contains a minimum 18 inches of earthen material.

- Minimize erosion of the final cover by the use of an erosion layer that contains a minimum 6 inches of earthen material that is capable of sustaining native plant growth.

These criteria do not apply to municipal solid waste landfill units that did not receive waste after October 9, 1991 and therefore are not applicable because disposal activities at Site 12 ceased prior to 1968; however, certain aspects are relevant and appropriate.

<u>The CWA,</u> as amended, governs point-source discharges through the National Pollutant Discharge Elimination System (NPDES), discharge or dredge or fill material, and oil and hazardous waste spills to United States waters. NPDES requirements (40 CFR 122) will be applicable if the direct discharge of pollutants into surface waters is part of the remedial action.

<u>Toxic Substances Control Act (TSCA)</u> (40 CFR 761.60-761.79 Subpart D Storage and Disposal) specifies treatment, storage, and disposal requirements for PCBs based on the PCB concentration of the original material. Specifically, remediation for non-liquids (soil, rags, debris) exceeding 50 ppm is addressed in 40 CFR 761.6. TSCA is not considered an ARAR because PCBs were not detected in site media at a concentration greater than 50 ppm.

National Ambient Air Quality Standards (NAAQS) (40 CFR 50) promulgated under the Clean Air Act (CAA) (42 U.S.C. 7401) require the attainment and maintenance of primary and secondary NAAQS to protect public health and public welfare, respectively. These standards are not source specific but rather are national limitations on ambient air quality. States are responsible for assuring compliance with the NAAQS. The implementation, maintenance, and enforcement of NAAQS are potentially applicable ARARs.

Also promulgated under the CAA are New Source Performance Standards (NSPS) (40 CFR 60) and National Emissions Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR 61). NSPS are established for new sources of air emissions to ensure that the new stationary sources minimize emissions. These standards are for categories of stationary sources that cause or contribute to air pollution that may endanger public health or welfare. NSPS regulations are not considered an ARAR at MCRD Parris Island. NESHAPs, which are emission standards for source types (i.e., industrial categories) that emit hazardous air pollutants, are considered potentially applicable for MCRD Parris Island.

Department of Transportation (DOT) Rules for Hazardous Materials Transport (49 CFR Parts 107 and 171-179) regulate the transport of hazardous materials, including packaging, shipping equipment, and placarding. These rules are considered potentially applicable to wastes shipped off site for laboratory analysis, treatment, or disposal.

The Occupational Safety and Health Act (OSHA) Standards (29 CFR 1910) regulate occupational safety and health requirements applicable to workers engaged in on-site field activities.

National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.) requires Federal agencies to evaluate the environmental impacts associated with major actions that they fund, support, permit, or implement. Specifically, NEPA requires Federal agencies to consider five issues during the planning of major action: the environmental impact of the proposed action; any adverse impacts that cannot be avoided with the proposed implementation; alternatives to the proposed action; the relationship between short-term and long-term effects; and any irreversible and irretrievable commitments of resources that would be involved in a proposed action. Remedial action/corrective measures could constitute significant activities, thereby making NEPA requirements ARARs; however, activities conducted in accordance with the NCP are considered to meet the substantive NEPA requirements.

Soil Conservation Act (U.S.C. 5901 et seq.) provides for the application of soil conservation practices on Federal lands. During remedial activities, implementation of such practices would be required.

Presumptive Remedy for CERCLA Municipal Landfill Sites (U.S. EPA, 1993) establishes containment as the presumptive remedy for CERCLA municipal landfills because the volume and heterogeneity of the waste in municipal landfills generally make treatment impracticable. Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills (U.S. EPA, 1996c) provides guidance on applying the containment presumptive remedy to military landfills. Site 12 was investigated assuming that the landfill presumptive remedy would be implemented.

Policy on Land Use Controls (LUCs) Associated with Environmental Restoration Activities (DOD, 2001) requires that feasibility studies that consider a remedy requiring a land use restriction shall include the costs of implementing and maintaining the LUC, as well as an evaluation of an "unrestricted use" alternative. This policy is applicable to the Site 12 FS/CMS because LUCs are a typical part of the presumptive remedy for landfills.

Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions [Department of the Navy (DON), 2003]. A policy document that outlines a framework agreed upon by the U.S. EPA and DON for implementing land use controls at NPL sites at Navy installations.

Memorandum: Assuring Land Use Controls at Federal Facilities (U.S. EPA, 1998b). This memorandum establishes U.S. EPA Region 4 Federal Facilities Branch policy on measures to be taken to assure the long-term effectiveness of land use controls being relied upon to protect human health and the environment at contaminated federal facilities undergoing remediation pursuant to CERCLA and/or RCRA.

Well Standards (R. 61-71) set forth requirements for protecting underground sources of drinking water from contamination and include provisions for the classification and regulation of wells and establishment of standards for location, construction, materials, reporting, operation, maintenance, and abandonment. These regulations are applicable for any remedial action/corrective measure that involves the installation or abandonment of monitoring wells at Site 12.

Hazardous Waste Management Regulations (R.61-79) promulgated pursuant to authority in the S.C. Hazardous Waste Management Act (§44-56-30) regulate the management of hazardous waste. Similar to RCRA requirements, Hazardous Waste Management Regulations may be applicable when the waste is sufficiently similar to a hazardous waste and/or the on-site remedial action constitutes treatment, storage, or disposal and the particular requirement is well suited to the circumstances of the contaminant release and site. Hazardous Waste Management Regulations may also be applicable when the remedial action constitutes generation of a hazardous waste.

The following requirements included in the Hazardous Waste Management Regulations are potentially applicable at Site 12.

- Hazardous waste generator requirements (R.61-79.262).
- Transportation requirements (R.61-79.263).
- Standards for owners and operators of hazardous waste treatment, storage, and disposal (TSD) facilities (R.61-79.264).
- Interim status standards for owners and operators of hazardous waste TSD facilities (R.61-79.265).
- Land Disposal Restrictions (R.61-79.268) - Applicable if hazardous waste is shipped off site, because re-grading of waste at Site 12 will be handled under an area of contamination (AOC) concept that would not trigger LDRs. AOCs function solely to manage wastes that are generated at a RCRA facility for the purpose of implementing remedial actions required at the facility.

Based on data obtained during the RI/RFI and other investigations, surface soil, sediment, surface water, and groundwater at Site 12 are not expected to be a characteristic or listed RCRA hazardous waste. However, waste materials were not tested during the RI. If excavated for off-site disposal, waste would have to be properly classified.

The interim status standards for owners and operators of hazardous waste TSD facilities (R.61-79.265) also include regulations for final cover requirements for final closure of interim status landfills. Under these regulations, the owner or operator must cover the landfill with a final cover designed and constructed to provide long-term minimization of migration of liquids through the closed landfill, function with minimum maintenance, promote drainage and minimize erosion or abrasion of the cover, accommodate settling and subsidence so that the cover's integrity is maintained, and have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present. Because the type of waste disposed at Site 12 was primarily nonhazardous in nature, these requirements are not applicable; however, certain aspects are relevant and appropriate.

Air Pollution Control Regulations and Standards (R.61-62) are promulgated pursuant to the Pollution Control Act S.C. Code Sections 48-1-10 et seq. Standards within these regulations are for maintaining the purity of the air resources of the state. Regulation 62-5 establishes Air Pollution Control Standards and include Ambient Air Quality Standards and Standards for VOCs and Toxic Air Pollutants. These

regulations would be applicable for remedial action/correctives measures that would result in emissions to the atmosphere.

Solid Waste Management: Collection, Temporary Storage, and Transportation of Municipal Solid Waste (R.61-107.5) establishes minimum standards for the collection, temporary storage, and transportation of solid waste prior to processing, disposal, etc. of that waste. This regulation applies to any person who collects, temporarily stores, and/or transports municipal solid waste. This regulation is applicable to the management of any solid waste generated during remedial action/corrective measures at Site 12.

Solid Waste Management: Construction, Demolition, and Land-Clearing Debris Landfills (R.61-107.11) establishes minimum standards for the site selection, design, operation, and closure of construction, demolition, and land-clearing debris landfills. Some construction, demolition, and land-clearing debris may have been disposed at Site 12; however, other types of waste are co-mingled with this debris and, therefore, other South Carolina landfill regulations would supercede. This regulation is not applicable, although certain aspects are relevant and appropriate.

Solid Waste Management: MSWLF (R.61-107.258) establishes minimum criteria under the South Carolina Solid Waste Policy and Management Act of 1991, as amended, and all applicable Federal regulations, for all MSWLF units, as well as for MSWLFs that are used to dispose of sewage sludge. These regulations apply to owners and operators of new MSWLF units, existing MSWLF units, and lateral expansions. The effective date of this regulation is October 9, 1993.

These regulations include a description of a final cover system for the landfill that is designed to minimize infiltration and erosion. The final cover system is to be designed and constructed to

- Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present or a permeability no greater than 1×10^{-5} cm/sec, whichever is less.

- Minimize infiltration through the closed MSWLF by the use of an infiltration layer that contains a minimum 18 inches of earthen material.

- Minimize erosion of the final cover by the use of an erosion layer that contains a minimum 1 foot of earthen material that is capable of sustaining native plant growth.

Because disposal activities ceased in 1965, this regulation is not applicable; however, certain aspects are relevant and appropriate.

Sanitary Landfill Design, Construction, and Operation (R.61-70) sets forth regulations for the disposal of refuse (solid waste) on land without creating pollution, nuisances, environmental threats, or hazards to public health and safety. The regulation states that, beginning on July 1, 1972, no system for land disposal of refuse (solid waste) shall be operated in South Carolina without a written permit issued by the State Board of Health. Per this regulation, "a final cover shall be applied to any surface that represents the final grade of the sanitary landfill. A minimum of two feet of a well-graded soil cover, compacted and graded, will usually fulfill the requirements of final cover." Because disposal activities ceased in 1968, this regulation is not applicable; however, certain aspects are relevant and appropriate.

Standards for Stormwater Management and Sediment Reduction (R.72-300 and R.72-405) require that all land-disturbing activities under the jurisdiction of SCDHEC must be performed in a manner in which erosion is controlled and sediment is retained on the site to the maximum extent feasible and stormwater is managed in a manner such that no significant on-site or off-site damage and/or problem are caused or increased. Approval of a stormwater management and sediment control plan is necessary prior to engaging in any land-disturbing activity related to residential, commercial, industrial, or institutional land use. This regulation is applicable if remedial action/corrective measures involve land-disturbance activities.

General Objectives and Components of Contamination Assessments and Remedial Actions (SCDHEC, 1994) is a TBC that provides guidance for conducting contamination assessments and remedial action activities.

Soil/Groundwater Remediation Guidance Document (SCDHEC, 1992) is a TBC that provides guidance for conducting groundwater and soil remediation.

Stormwater Management and Sediment Control Handbook for Land Disturbance Activities (SCDHEC, 1997a) is a compilation of existing South Carolina stormwater management regulations and supporting information for land disturbance permitting.

3.3 PRESUMPTIVE REMEDY

The Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills (U.S. EPA, 1996c) discusses the decision criteria for the application of this presumptive remedy. Based on U.S. EPA's scientific and engineering evaluation of past remedies selected for military landfills, preferred technologies or presumptive remedies have been developed for similar sites. Presumptive remedies are expected to be used when circumstances are suitable. In 1993, U.S. EPA established source containment as the preferred remedial action for CERCLA municipal landfill sites. In 1996, this remedial action was also chosen for military landfills (U.S. EPA, 1996c). The guidance document presents a

decision tree for selection of the presumptive remedy. The following is an evaluation of the decision tree results for Site 12:

- **Collect Available Information: waste type, operating history, monitoring data, state permit/closure, size/volume, etc.** The majority of wastes reportedly disposed in the landfill during 1955 to 1968 were routine domestic refuse including small metal cans, beer and soda bottles, hubcaps, tires, buckets, cinderblocks, rusted metal 5-gallon cans, sheet metal, paper, plastic, and wood. The presence of military waste [i.e., unexploded ordnance (UXO)] is not expected at Site 12. Based on the types of waste reportedly disposed in the landfill, the presumptive remedy of containment is appropriate.

- **Consider the Effects of Land Reuse Plans on Remedy Selection.** The final reuse of Site 12 has not been determined. In general, smaller landfills that are generally defined as fewer than 2 acres make the option of excavation more practical than containment. The Site 12 total disposal area is estimated to be approximately 2.10 acres, so the application of the presumptive remedy is not to be considered for this criterion.

- **Do Landfill Contents Meet Municipal Landfill-Type Waste Definition?** The wastes are mainly nonhazardous debris, which can be considered as municipal wastes; therefore, treatment is not warranted.

- **Are Military-Specific Wastes Present?** Military wastes (i.e., UXO) were not reportedly disposed at Site 12 and have not been encountered during previous investigations.

- **Is Excavation Practical?** Landfills with waste volumes that exceed 100,000 cubic yards of material are usually suitable for the presumptive remedy of containment. Conversely, excavation is usually practical for landfills with volumes of waste less than that limit. Site 12 is estimated to have approximately 4,325 cubic yards of waste and contaminated material. This small volume would not make the decision subject to determination for either the application of the presumptive remedy of containment or the implementation of removal and disposal. The application of the presumptive remedy is not considered for this criterion. The detailed evaluation alternatives presented in Section 5.0 will aid in the determination of the practical application of excavation.

- **Is Containment Practical?** The determination as to the practical application of containment is similar to the discussion above for the practical application of excavation. Containment is practical and is implementable at Site 12.

Based on the results of the evaluation, the presumptive remedy of containment is very marginally appropriate for Site 12 and it will be considered in this FS/CMS.

3.4 MEDIA OF CONCERN

A baseline HHRA and ERA were performed for the Site 12 RI/RFI to quantify potential human health risks in the absence of remedial action and to assess the potential adverse effects of site contamination on the environment. Media that were investigated during the RI/RFI consisted of surface soil, groundwater, surface water, sediment, and sediment wastes. In accordance with U.S. EPA's Presumptive Remedy for CERCLA Municipal Landfill Sites (U.S. EPA, 1993) and Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills (Interim Guidance) (U.S. EPA, 1996c), the Site 12 RI/RFI characterized media where the potential for off-site migration of contamination was suspected but did not characterize the disposal area contents. Site 12 was investigated under the Presumptive Remedy since there are waste type piles at several locations at the site.

As discussed previously, the U.S. EPA directives for municipal landfills and military landfills with similar characteristics establish containment as the presumptive remedy. The primary medium of concern under a presumptive remedy is the soil, fill, and waste within the landfill that contain the source of contaminants that present an unacceptable risk to human health and the environment. Where a presumptive landfill remedy of containment is being applied, the remedy components to be considered may be limited to a landfill cap, source area groundwater control, leachate collection and treatment, landfill gas collection and treatment, and institutional controls, unless site conditions dictate otherwise. The presumptive remedy does not address exposure pathways outside the landfill, nor does it include any long-term response actions for groundwater. A response action for exposure pathways outside the source may be selected together with the presumptive remedy, thereby developing a comprehensive site response, or the exposure pathways may be addressed as an operable unit separate from the presumptive remedy. For Site 12, which is a burial area where there are several different waste piles and not a lot of waste associated with the site, the presumptive remedy probably will not be selected as a site response.

The following sections provide the rationale for retaining specific media for this FS/CMS.

3.4.1 Soil and Debris

The soil and debris that contain the source of contaminants within the Site 12 disposal area are the primary media of concern. The contaminants within the soil and debris of the Site 12 disposal area are a concern because of the following:

- Contaminants may leach to shallow groundwater.
- Contaminants in surface soils are migrating to surface water and sediment via surface water runoff, erosion of unstable slopes, and leaching.
- Contaminants present a direct contact threat.

In accordance with the U.S. EPA guidance for the presumptive remedy, the estimated 4,325 cubic yards of contaminated soil and debris in the disposal areas were not fully characterized during the RI/RFI. Surface soil sampling was completed throughout the site but primarily along the perimeter of the disposal areas. The results of the HHRA showed that, under some exposure scenarios, arsenic and iron were leading risk drivers in a localized area of PAI-10-SS-14. In addition, lead was identified at a concentration of 1,100 milligrams per kilogram (mg/kg), which exceeds the Office of Solid Waste and Emergency Response (OSWER) soil screening level of 400 mg/kg for residential land use. However, based on lead modeling, no adverse effects are anticipated for children or women workers exposed to lead in surface soil at Site 12.

The results of the ecological risk assessment indicated that copper, iron, lead, and mercury pose potential risks to terrestrial invertebrates and/or terrestrial plants in the vicinity of surface soil sample PAI-SS-14-01. Iron, lead, and mercury concentrations in soil sample PAI-SS-14-01 also pose potential risks to some upper-level terrestrial receptors.

3.4.2 Sediment

In the RI/RFI, sediment was evaluated in two ways: sediment where surficial waste materials were present and sediment where surficial waste materials were not present. The following subsections provide the rationale for retaining each medium in this FS/CMS.

3.4.2.1 Sediment - No Surficial Waste Present

Based on the nature and extent of contamination and the results of the HHRA and ERA presented in the Site 12 RI/RFI, sediment in the area of Site 12 is retained as a medium of concern for this FS/CMS. A remedial action/corrective measure (e.g., excavation of sediment with COC concentrations in excess of RGOs and consolidation of the material under an engineered landfill cap) is necessary to address this medium.

The results of the HHRA showed that risks associated with chemicals detected in sediment samples are within acceptable risk ranges.

The maximum concentrations of chemicals detected in sediment were compared to Region IV ecological screening levels (ESVs). Chemicals exceeding ESVs were retained as ecological COPCs and HQ values were calculated. HQs are the ratio of the exposure point contaminant concentration to the ESV.

The results of the ERA indicated that 4,4'-DDT, aluminum, antimony, arsenic, barium, chromium, cobalt, copper, iron, lead, mercury, nickel, selenium, thallium, vanadium, and zinc had at least one HQ greater than 1.0 for the aquatic food chain modeling, using samples collected in 1998 and 1999.

3.4.2.2 Sediment - Surficial Waste Present (Sediment Waste)

Two sediment waste samples were collected at Site 12; Aroclor-1254, antimony, arsenic, cadmium, copper, iron, lead, and manganese were identified as human health COPCs.

The results of the ERA indicated that di-n-octyl phthalate, bis(2-ethylhexyl)phthalate, 4,4'-DDE, 4,4'-DDT, dieldrin, endrin, Aroclor-1254, antimony, arsenic, cadmium, chromium, copper, iron, lead, nickel, silver, and zinc exceed ecological screening criteria.

Based on these potential risks and the presence of surficial waste material, sediment waste will be retained as a medium of concern.

3.4.3 Surface Water

Based on the results of the RI, surface water is not retained as a medium of concern in this FS/CMS. The results of the HHRA indicate that surface water does not pose unacceptable risks to human health, and the ERA indicates that surface water poses minimal risks to ecological receptors. However, incidental risks posed to human and ecological receptors from exposure to surface water will be indirectly addressed through actions taken to address contaminated soil, sediment, surface debris (i.e., through source removal or containment). Actions taken to address these contaminated media will reduce the potential for migration of COCs in these media to surface water. For example, if contaminated sediment was excavated and consolidated with the soil and debris and the entire consolidated mass was capped with an engineered landfill cap, the source of the surface water contamination would be contained. The remedial action/corrective measure would also minimize vertical contaminant migration to groundwater, which in turn would result in a decrease in contaminant migration to surface water. Consequently, surface water will be addressed through the management of soil, debris, groundwater, and sediment.

The results of the ERA indicate that only thallium and vanadium exceeded ecological screening values in filtered samples and surface water contaminants do not pose potential risks to ecological receptors.

3.4.4 Groundwater

Groundwater is not currently used as a potable water supply at the site and it is not expected to be used in the future as a potable water supply. This scenario is based on the high salinity (salinity readings greater than 0.048 percent) and total dissolved solids (TDS) [average TDS of 13,875 mg/L (i.e., 1.39%)] of the groundwater. A drinking water well is located on Jericho Island; however, this well is scheduled to be abandoned in conjunction with the other field activities on the Depot.

As determined in the HHRA, acetone, chloroform, aluminum, arsenic, cadmium, iron, manganese, and thallium were identified as human health COPCs based on a comparison of maximum site concentrations to risk-based screening levels and State and federal MCLs. However, as shown in Table 3-3, only thallium in one unfiltered groundwater sample and cadmium in filtered and unfiltered groundwater samples exceeded State and federal MCLs.

Groundwater will not be retained as a medium of concern for human health and ecological concerns; however, incidental risks posed to human and ecological receptors from exposure to groundwater will be indirectly addressed through actions taken to address contaminated soil, sediment, surface debris (i.e., through source removal or containment). In accordance with the presumptive remedy guidance, a containment remedial action/corrective measure may be selected for the Site 12 disposal area that minimizes infiltration through the soil and debris material and therefore will significantly reduce vertical contaminant migration to the shallow groundwater. A groundwater monitoring program would also be implemented as part of the remedial action/corrective action to evaluate the effectiveness of the containment remedy. The landfill containment remedial action/corrective measure would need to be engineered so that groundwater containment could be implemented in the future, if it is determined to be necessary. The remedial action/corrective measure would also require that restrictions be placed on Site 12 to prevent the installation of wells for potable water supply.

The results of the ERA did not indicate that groundwater poses a concern to ecological receptors. As a result, groundwater was not retained as a medium of concern for ecological concerns.

3.5 CHEMICALS OF CONCERN

The following section presents the human health and ecological COCs that were identified during the Site 12 RI/RFI. Based on the information presented in Section 3.4, COCs are only identified for the soil, sediment, and sediment waste media. The soil, sediment, and sediment waste COCs were identified in the HHRA and ERA completed for the Site 12 RI/RFI.

3.5.1 Surface Soil

Even though soils will be addressed with the debris at the site, soil COCs have also been developed.

Human Health

Surface soil COCs for protection of human health were selected from the chemicals identified in the Site 12 RI/RFI HHRA that exceeded an ILCR of 1.0E-06 or a HI of 1.0 for exposure to soil by a receptor. Two chemicals [arsenic and carcinogenic PAHs (CPAHs)] exceeded the ILCR of 1.0E-06 and two chemicals (arsenic and iron) exceeded an HI of 1. The receptors that had ILCRs greater than 1.0E-06 due to concentrations of chemicals in soil included the construction worker, adolescent trespasser, adolescent recreational user, adult recreational user, child resident, adult resident, and on-site lifelong resident. The chemicals retained as COCs are as follows:

Organics - Carcinogenic PAHs [Benzo(a)pyrene Equivalents (BaP Eq)]

It should be noted that a sample-specific B(a)P Eq concentration is calculated with sample-specific concentrations of the following carcinogenic PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and toxicity equivalent factors (TEFs). Derivation of these concentrations are presented in Appendix D.

Inorganics - arsenic and iron

Ecological

Soil COCs for ecological receptors (macroinvertebrates and upper food-chain receptors) were selected during the Site 12 RI/RFI ERA. The following chemicals were selected as ecological COCs for soil.

Organics - Total PAHs and 4,4'-DDE

Inorganics - Antimony, Chromium, Lead, Nickel, Arsenic, Copper, Manganese, Zinc, Cadmium, Iron, and Mercury

For the ERA, the following 13 PAHs were included in total PAHs: low molecular weight PAHs (2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene) and high molecular weight PAHs [benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, and pyrene]. Derivation of total PAH concentrations are presented in Appendix D.

3.5.2 Sediment

Human Health

Sediment COCs for protection of human health were selected from the chemicals identified in the Site 12 RI/RFI HHRA that exceeded an ILCR of 1.0E-06 or an HI of 1.0 for exposure to sediment by a receptor. Arsenic exceeded the ILCR of 1.0E-06; however, no chemicals exceed an HI of 1.0. The receptors that had ILCRs greater than 1.0E-06 due to concentrations of chemicals in sediment included child resident, adult resident, and lifelong resident. The chemicals retained as COCs are as follows:

Inorganics - Arsenic

Ecological

Sediment COCs for ecological receptors (macroinvertebrates and upper food-chain receptors) were selected during the Site 12 RI/RFI ERA. The following chemicals were selected as ecological COCs for sediment.

Organics - Bis(2-ethylhexyl)phthalate, 4,4'-DDT, and Gamma Chlordane

Inorganics - Antimony, Copper, Mercury, Arsenic, Chromium, Nickel, Cadmium, Lead, and Zinc

3.5.3 Sediment Waste

Human Health

Sediment waste COCs for protection of human health were selected from the chemicals identified in the Site 12 RI/RFI HHRA that exceeded an ILCR of 1.0E-06 or an HQ of 1.0 for exposure to sediment by a receptor. Aroclor-1254 and arsenic exceeded the ILCR of 1.0E-06; however, no chemicals exceeded an HI of 1.0. The receptors that had ILCRs greater than 1.0E-06 due to concentrations of chemicals in sediment waste included adolescent trespassers, adolescent recreational users, adult recreational users, child resident, adult resident, and lifelong resident. The chemicals retained as COCs are as follows:

Organics - Aroclor-1254

Inorganics - Arsenic and Iron

Ecological

Sediment waste COCs for ecological receptors (macroinvertebrates and upper food-chain receptors) were selected during the Site 12 RI/RFI ERA. The following chemicals were selected as ecological COCs for sediment waste.

Organics - Bis(2-ethylhexyl)phthalate, 4,4'-DDE , 4,4'-DDT, Dieldrin, and Endrin

Inorganics - Antimony, Arsenic, Cadmium, Copper, Chromium, Lead, Silver, Nickel, and Zinc

3.6 REMEDIAL ACTION OBJECTIVES/CORRECTIVE ACTION OBJECTIVES

Site-specific RAOs/CAOs consist of medium-specific goals for protecting human health and the environment. RAOs/CAOs are developed to permit consideration of a range of alternatives. The following RAOs/CAOs have been developed for Site 12.

- Eliminate contact with debris and impacted surface soils by human and ecological receptors.

- Eliminate the migration of COCs from the source material (impacted soil and debris) to downgradient media (i.e., sediment, surface water, and groundwater).

- Eliminate human exposure (i.e., direct exposure to construction worker, adolescent trespassers, adolescent recreational users, adult recreational users, child resident, adult resident, and lifelong resident) to COCs in sediment and sediment waste at concentrations in excess of RGOs. RGOs take into consideration an ILCR of 1.0E-06 for individual COCs. Additionally, RGOs take into consideration an HQ of 1.0 where noncarcinogenic effects would be expected. Elimination of COCs in sediment will also address human health concerns identified from chemicals detected in surface water.

- Comply with chemical-specific, location-specific, and action-specific federal and state ARARs.

3.7 REMEDIAL GOAL OPTIONS

RGOs were selected to aid in assessing impacted surface soil and sediment at Site 12. A summary of these site-specific RGOs is provided in the following sections.

3.7.1 Soil RGOs

Human health RGOs based on exposure to soil. Soil RGOs for the protection of human receptors were selected from Region 9 soil PRGs for residential use, OSWER soil screening levels for residential use, and background concentrations. MCRD Parris Island background/facility concentrations were used if the PRG or OSWER level was less than the background/facility concentration. Criteria were identified for the full list of human health COCs; however, RGOs were only selected for COCs identified as risk drivers during the HHRA. Criteria were identified for the remaining chemicals to preliminarily identify appropriate RGOs for chemicals that may subsequently be identified as COCs during the remedial action/corrective measure. The Region 9 soil PRGs correspond to an ILCR of 1.0E-06 or an HQ of 1.0 for a hypothetical residential receptor from each individual chemical. Compliance with the Region 9 soil PRGs would also achieve compliance with other reasonable human health risk scenarios (i.e., maintenance worker, future construction workers, and future recreational users). The selected human health RGOs for soil are presented in Table 3-4. For carcinogenic PAHs, RGOs were selected for individual PAHs and for B(a)P equivalents. The method for calculating B(a)P equivalents is provided in the notes of Table 3-4. Compliance with the B(a)P equivalent RGO would correspond to a cumulative cancer risk of 1.0E-06 for a hypothetical residential receptor.

Ecological RGOs. Soil RGOs for the protection of ecological receptors were selected from Region 4 ESVs. MCRD Parris Island background/facility concentrations were used if the ESV was less than the background/facility concentration. The selected ecological RGOs for soil are presented in Table 3-4. For PAHs, ESVs are presented for individual PAHs and total PAHs; however, only an RGO for total PAHs was developed. This approach is consistent with U.S. EPA Region 4 guidance. The PAHs included in the total PAH calculation are detailed in the notes of Table 3-4. Achievement of these values will also be protective of upper-level receptors.

3.7.2 Sediment RGOs

Human health RGOs based on exposure to sediment. Sediment RGOs for the protection of human receptors were selected from Region 9 soil PRGs for residential use, OSWER soil screening levels for residential use, and background concentrations. MCRD Parris Island background/facility concentrations were used if the PRG or OSWER level was less than the background/facility concentration. Criteria were identified for the full list of human health and ecological COCs; however, RGOs were only selected for COCs identified as risk drivers during the HHRA. Criteria were identified for the remaining chemicals to preliminarily identify appropriate RGOs for chemicals that may subsequently be identified as COCs during the remedial action/corrective measure. The Region 9 soil PRGs are appropriate for Site 12 sediment because sediment is not continuously inundated. The Region 9 soil PRGs correspond to an ILCR of 1.0E-06 or an HQ of 1.0 for a hypothetical residential receptor from each individual chemical.

Compliance with the Region 9 soil PRGs would also achieve compliance with other reasonable human health risk scenarios (i.e., maintenance workers, future construction workers, and future recreational users). The selected human health RGOs for sediment are presented in Table 3-5. For carcinogenic PAHs, RGOs were selected for individual PAHs and for B(a)P equivalents. The method for calculating B(a)P equivalents is provided in the notes of Table 3-5. Compliance with the B(a)P equivalent RGO would correspond to a cumulative cancer risk of 1.0E-06 for a hypothetical residential receptor.

Ecological RGOs. Sediment RGOs for the protection of ecological receptors were selected from Region 4 ESVs. MCRD Parris Island background/facility concentrations were used if the ESV was less than the background/facility concentration. The Region 4 ESVs are conservative values. For example, some are based on Effects Range-Low (ER-L) values obtained from Long et al. (1995). The ER-L is the 10th percentile of sediment concentrations associated with effects to benthic organisms. The selected ecological RGOs for sediment are presented in Table 3-5. For PAHs, ESVs are presented for individual PAHs and total PAHs; however, only an RGO for total PAHs was selected. This approach is consistent with U.S. EPA Region 4 guidance. The PAHs included in the total PAH sum are detailed in the notes of Table 3-5. Achievement of these values will also be protective of upper-level receptors.

3.8 QUANTITY OF IMPACTED MEDIA

The total area and volume of debris and the extent of impacted soil, sediment, and sediment waste were estimated by comparison of the RGO sets identified in Section 3.7 to soil and sediment analytical results. The supporting calculations for these quantities are presented in Appendix A.

3.8.1 Existing Debris

Figure 3-1 illustrates the estimated limit of the surface debris. This limit was estimated from historical information and information acquired during site visits. This limit, along with existing and historic topography information, was used to calculate the area and volume of the Site 12 – Disposal Area. The supporting calculations and assumptions for the calculations are provided in Appendix A. The calculated area and volume are provided below.

Area of Existing Debris Piles (acres)	Depth (feet)	Volume of Existing Debris Piles (cubic yards)
1.18	1	2,286

3.8.2 Impacted Soil and Sediment

COC concentrations detected in soil and sediment were compared against RGOs that represent a human health ILCR equal to 1.0E-06 and low risk to ecological receptors. COC concentrations at two soil sample locations and one sediment sample location exceeded RGOs. For this scenario, RGOs that represent a human health ILCR equal to 1.0E-06 were exceeded at 2 locations (see Figure 3-2), and RGOs that represent a low risk to ecological receptors were exceeded at 3 locations (see Figure 3-2).

The area and volume of impacted soil and sediment delineated on Figure 3-2 were estimated. The impacted sediment was delineated by Area 4 (sample PAI-10-SD-08) and soil by Area 5 (PAI-10-SS-08) and Area 6 [PAI-012-03(37)]. Estimated areas of contamination were assumed as shown on Figure 3-2. The supporting calculations of area and volume calculations are provided in Appendix A.

Area	Area (acres)	Depth (feet)	Volume (yd^3)
4	0.23	1	372
5	0.35	2	1,111
6	0.35	1	556

TABLE 3-1

FEDERAL ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
SITE 12/SWMU 10 - JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

ARAR	Citation/Reference	ARAR Type	Rationale for Use at MCRD Parris Island
Chemical-Specific ARARs			
Safe Drinking Water Act MCLs, MCLGs, and SMCLs	40 CFR 140-143	Not applicable	Would be used as protective levels for groundwater that is a current or potential drinking water source; however, groundwater is saline to brackish and is not a viable drinking water source.
Ambient Water Quality Criteria	Section 304 of the Clean Water Act	Relevant and appropriate	Criteria for assessing the need for surface water remedial action/corrective measures.
RCRA Subtitle C – Hazardous Waste Identifications and Listing Regulations	40 CFR 261	Potentially applicable	Would be used to identify a material as a hazardous waste and thus determine the applicability and relevance of RCRA C Hazardous Waste Rules.
U.S. EPA Health Advisories	U.S. EPA, 1996a	To be considered criteria (TBC)	Benchmark values for assessing the need for groundwater remedial action/corrective measures.
Preliminary Remediation Goals (PRGs)	U.S. EPA Region 9, 2000	TBC	Benchmark values for assessing the need for soil, groundwater, and air remedial action/corrective measures.
Generic Soil Screening Levels	U.S. EPA, 1996b	TBC	Benchmark values for assessing the need for soil remedial action/corrective measures.
Dutch Soil Clean-Up Act Ecological Screening Values	Beyer, 1990	TBC	Benchmark values for assessing the need for soil remedial action/corrective measures.
Dutch Ministry of Housing Intervention Values and Target Values – Soil Quality Standards	MHSPE, 1994	TBC	Benchmark values for assessing the need for soil remedial action/corrective measures.
Oak Ridge National Laboratory Toxicity Benchmarks for Soil	Efroymson, 1997a and 1997b	TBC	Benchmark values for assessing the need for soil remedial action/corrective measures.
Canadian Council of Ministers of the Environment Soil Quality Guidelines	CCME, 1997	TBC	Benchmark values for assessing the need for soil remedial action/corrective measures.
Ecological Risk Assessment at Military Bases	U.S. EPA Region 4, 1998a	TBC	Memorandum consists of benchmark values for assessing the need for surface soils, sediment and surface water remedial action/corrective measures.
ER-L and ER-M Levels	Long et al., 1995	TBC	Benchmark values for assessing the need for sediment remedial action/corrective measures.
PELs and TELs	FDEP, 1994	TBC	Benchmark values for assessing the need for sediment remedial action/corrective measures.

TABLE 3-1

FEDERAL ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
SITE 12/SWMU 10 - JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

ARAR	Citation/Reference	ARAR Type	Rationale for Use at MCRD Parris Island
Location-Specific ARARs			
U.S. EPA's Groundwater Protection Strategy	U.S. EPA, 1984	TBC	Surficial groundwater at Site 12 is likely designated Class II.
CWA Section 404 River and Harbors Act, Section 10	40 CFR 230, 33 CFR 320-330	Applicable	Prohibits the unauthorized obstruction or alteration of any navigable waters of the United States. The waters within the vicinity of Site 12, most notably Archers Creek, are classified as navigable waters and, therefore, the Act is applicable.
Floodplain Management	Executive Order 11988	Applicable	Site 12 is located within the 100-year floodplain.
Protection of Wetlands	Executive Order 11990	Applicable	Site 12 is located within a saltwater marshland.
Endangered Species Act	16 U.S.C 1531 et seq.	Applicable	Wood storks and alligators are known to live in the general area.
Fish and Wildlife Coordination Act	16 U.S.C 661 et seq., 40 CFR Part 122.49	Applicable	Ensures that remedial action/corrective measures protect nearby wetlands and protected habitats.
Coastal Zone Management Act	16 U.S.C. 1451 et seq.	Applicable	Ensures that remedial action/corrective measures protect coastal resources.
Historic Sites, Buildings, and Antiquities Act of 1935	16 U.S.C. 461 et seq.	Potentially Applicable	This Act would be applicable if information is found to classify Site 12 as a historic or prehistoric property of national significance.
Archaeological and Historic Preservation Act of 1974	16 U.S.C. 469 et seq.	Potentially Applicable	This Act would be applicable if historic and archaeological artifacts were to be affected by remedial activities. No such artifacts are known to exist within the boundaries of Site 12 and none are expected because the disposal area consists primarily of routine domestic waste.
Archeological Resources Protection Act of 1979	16 U.S.C. 479(aa) et seq.	Potentially Applicable	This Act would be applicable if archeological artifacts were discovered during remedial activities. No such artifacts are known to exist within the boundaries of Site 12 and none are expected because the disposal area consists primarily of routine domestic waste.
Native American Grave Protection and Repatriation Act of 1990	25 U.S.C. 3001 et seq.	Potentially Applicable	This Act would be applicable if human remains were discovered during remedial activities.
Bald Eagle Protection Act of 1940, as Amended	16 U.S.C. 688 et seq.	Not Applicable	This Act includes provisions for prohibiting the disturbance of bald eagles. A bald eagle is known to nest within 1,000 feet of Site 1, however, Site 12 is approximately 2.3 miles from the nest.
Conservation Programs on Military Reservations (Sikes Act) of 1960, as Amended	16 U.S.C. 670(a) et seq.	Applicable	This act requires that military installations manage natural resources for multipurpose uses and public access appropriate for those uses consistent with the military department's mission.

TABLE 3-1

FEDERAL ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
SITE 12/SWMU 10 - JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

ARAR	Citation/Reference	ARAR Type	Rationale for Use at MCRD Parris Island
Marine Mammal Protection Act of 1972 as Amended	16 U.S.C. 1361 et seq.	Not Applicable	Marine mammals are not known to inhabit Archers Creek.
Action-Specific ARARs			
Solid Waste Disposal Act (SWDA)/ RCRA Subtitle C	42 U.S.C 6905, 6912a, 6924-6925	–	–
• Standards for Hazardous Waste Generators	40 CFR 262	Potentially applicable	Applicable for removed site wastes determined to be hazardous.
• Standards for Hazardous Waste	40 CFR 263	Potentially applicable	Applicable for site wastes determined hazardous that are transported off site.
• Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR 264	Potentially applicable	These regulations would be applicable to waste removed from the site including both on-site and off-site management.
• Interim status standards for owners and operators of hazardous waste TSD facilities	40 CFR 265	Relevant and appropriate	Establishes design and operating criteria for hazardous landfills. Because the type of waste disposed in the Site 12 disposal area was primarily nonhazardous in nature, these requirements are not applicable; however, certain aspects are relevant and appropriate.
• RCRA Land Disposal Restrictions (LDR) Requirements	40 CFR 268	Potentially applicable	If off-site treatment or disposal of contaminated media and/or disposal of treatment residuals that may be considered hazardous waste is necessary, it would be subject to land disposal restrictions.
Hazardous and Solid Waste Amendments of 1984	42 U.S.C. 6926	Potentially Applicable	Establishes a corrective actions program requiring four basic elements (assessment, investigation, CMS, implementation).
RCRA Subtitle D	40 U.S.C 6901	Relevant and appropriate	Establishes design and operating criteria for solid waste (nonhazardous) landfills; however, disposal activities ceased prior to the effective date of the regulation.
The Clean Water Act (CWA) National Pollution Discharge Elimination System	40 CFR 122	Potentially applicable	These requirements are applicable for all alternatives that include a surface water discharge.
Toxic Substances Control Act	40 CFR 761	Not an ARAR	Remedial action/corrective measures may be driven by reducing PCB concentrations in affected media to meet published levels.
Clean Air Act National Ambient Air Quality Standards (NAAQs)	42 U.S.C §7401- 7642, 40 CFR Part 50	Potentially applicable	Remedial action/corrective measures involving treatment of media could result in emissions to the atmosphere.

TABLE 3-1

FEDERAL ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
SITE 12/SWMU 10 - JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

ARAR	Citation/Reference	ARAR Type	Rationale for Use at MCRD Parris Island
U.S. EPA Clean Air Act New Source Performance Standards (NSPS)	40 CFR 60	Not an ARAR	Remedial action/corrective measures involving treatment of media could result in emissions to the atmosphere.
Clean Air Act National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR 60	Potentially applicable	Existing source types are not present on site.
DOT Hazardous Materials Transportation	49 CFR	Potentially applicable	These rules are considered potentially applicable depending on whether wastes are shipped off site for laboratory analysis, treatment, or disposal.
OSHA Standards	29 CFR 1910.120	Applicable	On-site activities are required to follow OSHA requirements.
National Environmental Policies Act	42 U.S.C 4321 et seq.	Relevant and appropriate	Remedial action/corrective measures could constitute significant activities, thereby making NEPA requirements ARARs; however, activities conducted in accordance with the NCP are considered to meet the substantive NEPA requirements.
Soil Conservation Act	U.S.C. 5901 et seq.	Applicable	During remedial activities, implementation of soil conservation practices would be required.
Presumptive Remedy for CERCLA Municipal Landfill Sites	U.S. EPA, 1993	TBC	Through this directive, U.S. EPA has identified containment as the presumptive remedy for such landfill sites.
Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills	U.S. EPA, 1996c	TBC	Provides the framework for determining the applicability of the containment presumptive remedy to military landfills.
Policy on Land Use Controls Associated with Environmental Restoration Activities	DOD, 2001	TBC	Requires that feasibility studies that consider a remedy requiring a land use restriction shall include the costs of implementing and maintaining the LUC, as well as an evaluation of an “unrestricted use” alternative.
Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions	DON, 2003	Applicable	Outlines Navy policy for specifying, monitoring, and enforcing land use controls.
U.S. EPA Region 4 - Memorandum: Assuring Land Use Controls at Federal Facilities	U.S. EPA, 1998b	Potentially Applicable	Outlines U.S. EPA Region 4 policy for enforcing land use controls.

TABLE 3-2

STATE OF SOUTH CAROLINA ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
SITE 12/SWMU 10 - JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

ARAR	Citation/Reference	ARAR Type	Rationale for Use at MCRD Parris Island
Chemical-Specific ARARs			
State Primary Drinking Water Regulations Groundwater Sources and Treatment Surface Water Sources and Treatment MCL in Drinking Water Control of cloroform, arsenic, cadmium, and thallium	R.61-58 to R.61-58.11 R.61-58.2 R.61-58.3 R.61-58.5 R.61-58.11	Applicable	Although it is unlikely that site groundwater could be used as a drinking water source, it would be used as protective levels for groundwaters that are current or potential drinking water sources. A drinking water well does exist on Jericho Island.
South Carolina Hazardous Waste Management Act Hazardous Waste Management Regulations	§44-56-30 R.61-79	Potentially applicable	Would be used to identify a material as a hazardous waste and thus determine the applicability and relevance of Hazardous Waste Management Regulations.
Location-Specific ARARs			
Water Classifications and Standards Classified Water	R.61-68 R.61-69	Applicable	Surficial groundwater is not an underground source of drinking water due to salinity and TDS levels. The surface water at Site 12 is classified as SA (tidal saltwaters).
Coastal Zone Management Act	§48-39-10	Applicable	Ensures that remedial action/corrective measures protect coastal resources.
Groundwater Mixing Zone Application Guidance	SCDHEC, 1997b	TBC	Guidance for completing an application to obtain groundwater waiver for non-attainment of MCLs.
Action-Specific ARARs			
Well Standards	R.61-71	Potentially applicable	Applicable if remedial action/corrective measures involve the installation or abandonment of monitoring wells.
Hazardous Waste Management Act	§44-56-30	-	-
• Standards for Hazardous Waste Generators	R.61-79.262	Potentially applicable	Applicable for removed site wastes determined to be hazardous.
• Standards for Hazardous Waste Transporters	R.61-79.263	Potentially applicable	Applicable for removed site wastes determined to be hazardous that are transported off site.
• Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal (TSD) Facilities	R.61-79.264	Potentially applicable	These regulations would be applicable to waste removed from the site including both on-site and off-site management.

TABLE 3-2

STATE OF SOUTH CAROLINA ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
SITE 12/SWMU 10 - JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

ARAR	Citation/Reference	ARAR Type	Rationale for Use at MCRD Parris Island
• Interim status standards for owners and operators of hazardous waste TSD facilities	R.61-79.265	Relevant and appropriate	Establishes design and operating criteria for hazardous landfills. Because the type of waste disposed in the landfill was primarily nonhazardous in nature, these requirements are not applicable; however, certain aspects are relevant and appropriate.
• Land Disposal Restrictions (LDR) Requirements	R.61-79.268	Potentially applicable	If off-site treatment or disposal of contaminated media and/or disposal of treatment residuals that may be considered hazardous waste is necessary, it would be subject to land disposal restrictions.
Air Pollution Control Regulations and Standards	R.61-62	Potentially applicable	Remedial action/corrective measures involving treatment of media could result in emissions to the atmosphere.
Solid Waste Management: Collection, Temporary Storage, and Transportation of Solid Waste	R.61-107.5	Potentially applicable	Applicable if solid waste is generated during remedial action/corrective measures.
Solid Waste Management: Construction, Demolition, and Land Clearing Debris Landfills	R.61-107.11	Relevant and appropriate	Construction, demolition, and land-clearing debris is co-mingled with other wastes.
Solid Waste Management: Municipal Solid Waste Landfills	R.61-107.258	Relevant and appropriate	Contains design and construction requirements for municipal landfills; however, disposal activities ceased prior to the effective date of the regulation.
Sanitary Landfill Design, Construction, and Operation	R.61-70	Relevant and appropriate	Contains design and construction requirements for sanitary landfills; however, disposal activities ceased prior to the effective date of the regulation.
Standards for Stormwater Management and Sediment Reduction	R.72-300 and R.72-405	Potentially applicable	Applicable if remedial action/corrective measures involve land-disturbance activities.
General Objectives and Components of Contamination Assessments and Remedial Actions	SCDHEC, 1994	TBC	Provides guidance for conducting remedial action activities.
Soil/Groundwater Remediation Guidance Document	SCDHEC, 1992	TBC	Provides guidance for conducting groundwater and soil remediation.
Stormwater and Management and Sediment Control Handbook for Land Disturbance Activities	SCDHEC, 1997a	TBC	Guidance document to be followed if remedial action/corrective measures involve land-disturbance activities.

TABLE 3-3

COMPARISON OF GROUNDWATER HUMAN HEALTH COPCs[1]
TO FEDERAL AND STATE GROUNDWATER CRITERIA
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

Human Health COPCs	Maximum Concentration	Detection Frequency	Federal MCLs[2]	State MCLs[3]	Background Surface Water
VOCs (µg/L)					
Acetone	650	4/10	---	---	ND
Chloroform	4.5	4/14	80	100	ND
INORGANICS (UNFILTERED) (µg/L)					
Aluminum	5140	6/13	--	--	3113
Arsenic	35.4	12/14	50	50	5.13
Cadmium	8.1	7/14	**5**	**5**	ND
Iron	122000	13/13	--	--	2091
Manganese	1530	13/13	--	--	53.1
Thallium	10	1/14	**2**	**2**	ND
INORGANICS (FILTERED) (µg/L)					
Aluminum	391	2/13	--	--	NA
Arsenic	35.9	14/14	50	50	NA
Cadmium	9.2	4/14	**5**	**5**	NA
Iron	124000	13/13	--	--	NA
Manganese	1530	13/13	--	--	NA
Thallium	ND	0/13	2	2	NA

1 Site groundwater was not found to be a potential threat to ecological receptors.
2 U.S. EPA Drinking Water Regulations and Health Advisories, Summer 2000.
3 South Carolina State Drinking Water Regulations, Chapter 61-58.
"--" Not available.
NA Not applicable.
ND Not detected.
Bolding indicates that a criterion was exceeded.

TABLE 3-4

SELECTION OF SURFACE SOIL RGOs
FOR THE PROTECTION OF HUMAN AND ECOLOGICAL RECEPTORS
SITE 12/SWMU 10 - JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

Surface Soil COCs	Maximum Concentration	Background/ Typical Facility Concentration (1)	Region 9 Residential Soil PRG (2)	Selected Human Health Surface Soil RGO	Region 4 ESV (3)	Selected Ecological RGO
PAHs (ug/kg)						
B(a)P Equivalents (4)	3286	NA	434(6)	434(6)	NA	NR
Total PAHs (5)	16888	NA	NA	NA	1000	1000
VOLATILES (ug/kg)						
Chloroform	7.5	NA	240	NR	1	NR
SEMIVOLATILES (ug/kg)						
Bis(2-ethylhexyl)phthalate	480	NA	35000	NR	NA	NR
Pentachlorophenol	240	NA	3000	NR	2	NR
PESTICIDES/PCBs (ug/kg)						
4,4'-DDE	43	31.6	1700	NR	2.07	31.6 (1)
INORGANICs (mg/kg)						
Antimony	8	ND	31	NR	3.5	3.5
Arsenic	50.8	1.44	0.39	1.83 (8)	10	10
Cadmium	3.2	NA	37	NR	1.6	1.6
Chromium	18.1	6.23	210	NR	10	10
Copper	189	1.52	2900	NR	40	40
Iron	99700	3920	23000	23000	200	3920 (1)
Lead	1100	12.5	400 (7)	400	50	50
Manganese	522	129	1,800	NR	100	129 (1)
Mercury	0.89	0.11	23	NR	0.1	0.1
Nickel	26.5	1.8	1600	NR	30	30
Zinc	1020	9.7	23000	NR	50	50

1 Background/typical facility concentrations taken from Site 1 RI/RFI (TtNUS, 2000). Pesticide values are typical facility concentrations.
2 U.S. EPA Region 9 PRG Residential Soil Table (U.S. EPA, 2000).
3 U.S. EPA Region 4 Ecological Screening Values (U.S. EPA, 1998).
4 BAP equivalents = benzo(a)anthracene (0.1) + benzo(a)pyrene (1.0) + benzo(b)fluoranthene (0.1) + benzo(k)fluoranthene (0.01) + chyrsene (0.001) + dibenzo(a,h)anthracene (1.0) + indeno(1,2,3-cd)pyrene (0.1).
5 Total PAHs = low molecular weight PAHs + high molecular weight PAHs.
* Low molecular weight = 2-methylnaphthalene + acenaphthene + acenaphthylene + anthracene + fluorene + naphthalene + phenanthrene.
* High molecular weight PAHs = benzo(a)anthracene + benzo(a)pyrene + chyrsene + dibenzo(a,h)anthracene + fluoranthene + pyrene.
* One-half of the detection limit is used for nondetected PAHs to calculate total PAHs and BAP equivalents.
6 Calculated as 7 x benzo(a)pyrene Region 9 PRG.
7 OSWER Soil Screening Level for Residential Landuse (U.S. EPA, 1994).
8 RGO is PRG + Background per U.S. EPA guidance.
ND = Nondetect.
NA = Not available.
NR = Not relevant.

TABLE 3-5

SELECTION OF SEDIMENT RGOs
FOR THE PROTECTION OF HUMAN AND ECOLOGICAL RECEPTORS
SITE 12/SWMU 10 - JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

COCs	Maximum Concentration In Sediment	Maximum Concentration In Sediment Wastes	Background/ Typical Facility Sediment Concentration (1)	Region IX Residential Soil PRG (2)	Selected Site 12 Human Health Sediment RGO	Region IV ESV (3)	Selected Site 12 Ecological RGO
PAHs (ug/kg)							
Benzo(a)pyrene Equivalents (4)	113	ND	NA	434 (6)	NR	NA	NR
Total PAHs (5)	1878	ND	NA	NA	NR	1684	1684
SEMIVOLATILES (ug/kg)							
Bis(2-ethylhexyl)phthalate	440	10000	NA	35000	NR	182	182
Di-n-octyl phthalate	63	900	NA	1200000	NR	NA	NA
Pentachlorophenol	180	ND	NA	3000	NR	NA	NA
PESTICIDES (ug/kg)							
4,4'-DDE	ND	520	31.6	1700	NR	2.07	31.6
4,4'-DDT	66	38	34.5	1700	NR	1.19	34.5
Alpha Chlordane	12	ND	13.9	1600 (7)	NR	0.5 (7)	NR
Arochor-1254	ND	24000	NA	220	220	NA	NR
Dieldrin	ND	6.2	ND	30	NR	0.02	0.02
Endrin	ND	1200	ND	18000	NR	0.02	0.02
Gamma Chlordane	14	ND	13.2	1600 (7)	NR	0.5 (7)	13.2
INORGANICs (mg/kg)							
Antimony	6.8	9.4	ND	31	NR	2	2
Arsenic	18.5	49.7	12.2	0.39	12.59 (9)	7.24	12.2
Cadmium	0.84	4.7	0.278	37	NR	0.676	0.676
Chromium	75	119	35.2	210	NR	52.3	52.3
Hexavelent Chromium	ND	NA	NA	30(10)	NR	0.4	NR
Copper	113	489	10.1	2900	NR	18.7	18.7
Iron	43100	307000	21450	23000	23000	NA	NR
Lead	203	2930	20.6	400 (8)	400	30.2	30.2
Manganese	210	1480	186	1800	NR	NA	NR
Mercury	0.35	ND	0.09	23	NR	0.13	0.13
Nickel	1060	86.9	5.95	1600	NR	15.9	15.9
Silver	ND	1.2	ND	390	NR	0.733	0.733
Zinc	197	1520	45	23000	NR	124	124

1 Background/typical facility sediment concentrations taken from Site 1 RI/RFI (TtNUS, 2000). Pesticide values are typical facility concentrations.
2 U.S. EPA Region IX PRG Residential Soil Table (U.S. EPA, 2000).
3 U.S. EPA Region IV Ecological Screening Values (U.S. EPA, 1998).
4 BAP equivalents = benzo(a)anthracene (0.1) + benzo(a)pyrene (1.0) + benzo(b)fluoranthene (0.1) + benzo(k)fluoranthene (0.01) + chyrsene (0.001) + dibenzo(a,h)anthracene (1.0) + indeno(1,2,3-cd)pyrene (0.1).
5 Total PAHs = low molecular weight PAHs + high molecular weight PAHs.
* Low Molecular Weight = 2-methylnaphthalene + acenaphthene + acenaphthylene + anthracene + fluorene + naphthalene + phenanthrene.
* High Molecular Weight PAHs = benzo(a)anthracene + benzo(a)pyrene + chyrsene + dibenzo(a,h)anthracene + fluoranthene + pyrene.
* If a PAH is detected, one half of the detection limit should be used for nondetected PAHs to calculate total PAHs and BAP equivalents.
6 Calculated as 7 x benzo(a)pyrene Region IX PRG.
7 Based on total chlordane.
8 OSWER Soil Screening Level for Residential Landuse (U.S. EPA, 1994).
9 RGO is PRG + Background per EPA guidance.
10 Strictest value for Region IX hexavelent chromium.

ND = Nondetect.
NA = Not available.
NR = Not relevant.

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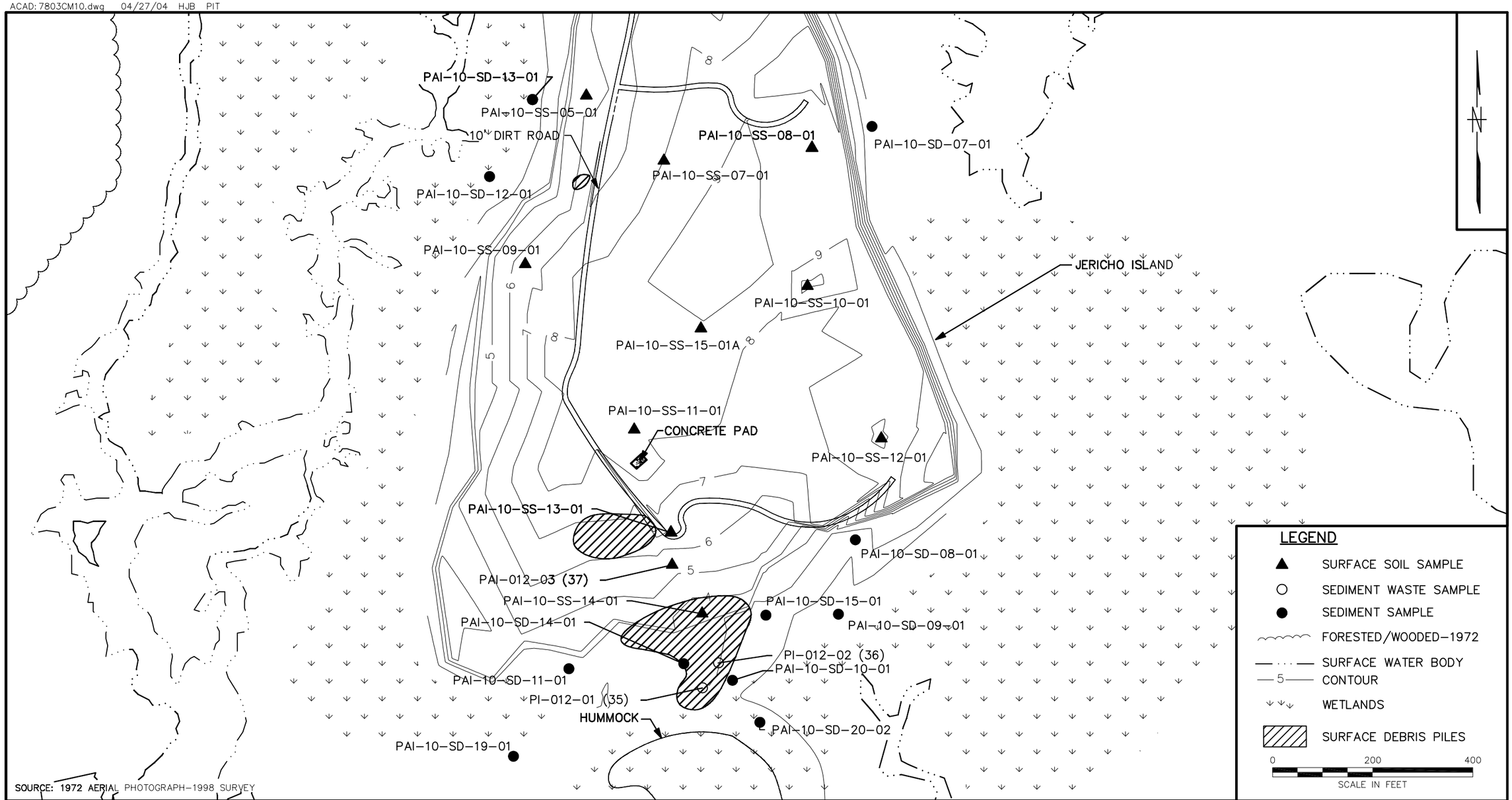

SOURCE: 1972 AERIAL PHOTOGRAPH-1998 SURVEY

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 7/19/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SURFACE DEBRIS
SITE 12/SWMU 10
JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7803
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 3-1
REV. 1

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DRAWING NO. FIGURE 3-2 REV. 0

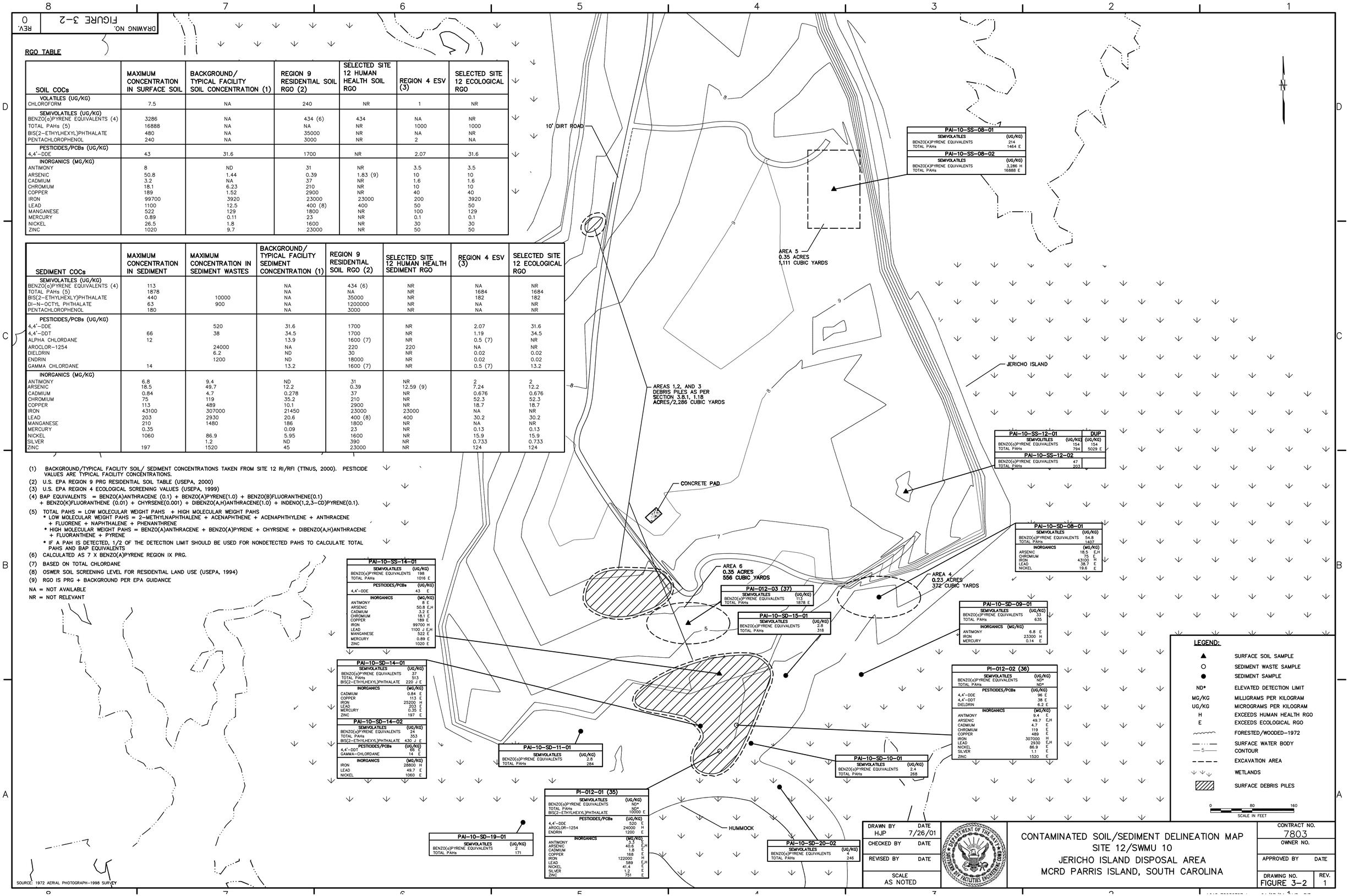
RGO TABLE

SOIL COCs	MAXIMUM CONCENTRATION IN SURFACE SOIL	BACKGROUND/ TYPICAL FACILITY SOIL CONCENTRATION (1)	REGION 9 RESIDENTIAL SOIL RGO (2)	SELECTED SITE 12 HUMAN HEALTH SOIL RGO	REGION 4 ESV (3)	SELECTED SITE 12 ECOLOGICAL RGO
VOLATILES (UG/KG)						
CHLOROFORM	7.5	NA	240	NR	1	NR
SEMIVOLATILES (UG/KG)						
BENZO(a)PYRENE EQUIVALENTS (4)	3286	NA	434 (6)	434	NA	NR
TOTAL PAHs (5)	16888	NA	NA	NR	1000	1000
BIS(2-ETHYLHEXYL)PHTHALATE	480	NA	35000	NR	NA	NR
PENTACHLOROPHENOL	240	NA	3000	NR	2	NA
PESTICIDES/PCBs (UG/KG)						
4,4'-DDE	43	31.6	1700	NR	2.07	31.6
INORGANICS (MG/KG)						
ANTIMONY	8	ND	31	NR	3.5	3.5
ARSENIC	50.8	1.44	0.39	1.83 (9)	10	10
CADMIUM	3.2	NA	37	NR	1.6	1.6
CHROMIUM	18.1	6.23	210	NR	10	10
COPPER	189	1.52	2900	NR	40	40
IRON	99700	3920	23000	23000	200	3920
LEAD	1100	12.5	400 (8)	400	50	50
MANGANESE	522	129	1800	NR	100	129
MERCURY	0.89	0.11	23	NR	0.1	0.1
NICKEL	26.5	1.8	1600	NR	30	30
ZINC	1020	9.7	23000	NR	50	50

SEDIMENT COCs	MAXIMUM CONCENTRATION IN SEDIMENT	MAXIMUM CONCENTRATION IN SEDIMENT WASTES	BACKGROUND/ TYPICAL FACILITY SEDIMENT CONCENTRATION (1)	REGION 9 RESIDENTIAL SOIL RGO (2)	SELECTED SITE 12 HUMAN HEALTH SEDIMENT RGO	REGION 4 ESV (3)	SELECTED SITE 12 ECOLOGICAL RGO
SEMIVOLATILES (UG/KG)							
BENZO(a)PYRENE EQUIVALENTS (4)	113		NA	434 (6)	NR	NA	NR
TOTAL PAHs (5)	1878		NA	NA	NR	1684	1684
BIS(2-ETHYLHEXYL)PHTHALATE	440	10000	NA	35000	NR	182	182
DI-N-OCTYL PHTHALATE	63	900	NA	1200000	NR	NA	NR
PENTACHLOROPHENOL	180		NA	3000	NR	NA	NR
PESTICIDES/PCBs (UG/KG)							
4,4'-DDE		520	31.6	1700	NR	2.07	31.6
4,4'-DDT	66	38	34.5	1700	NR	1.19	34.5
ALPHA CHLORDANE	12		13.9	1600 (7)	NR	0.5 (7)	NR
AROCLOR-1254		24000	NA	220	220	NA	NR
DIELDRIN		6.2	ND	30	NR	0.02	0.02
ENDRIN		1200	ND	18000	NR	0.02	0.02
GAMMA CHLORDANE	14		13.2	1600 (7)	NR	0.5 (7)	13.2
INORGANICS (MG/KG)							
ANTIMONY	6.8	9.4	ND	31	NR	2	2
ARSENIC	18.5	49.7	12.2	0.39	12.59 (9)	7.24	12.2
CADMIUM	0.84	4.7	0.278	37	NR	0.676	0.676
CHROMIUM	75	119	35.2	210	NR	52.3	52.3
COPPER	113	489	10.1	2900	NR	18.7	18.7
IRON	43100	307000	21450	23000	23000	NA	NR
LEAD	203	2930	20.6	400 (8)	400	30.2	30.2
MANGANESE	210	1480	186	1800	NR	NA	NR
MERCURY	0.35		0.09	23	NR	0.13	0.13
NICKEL	1060	86.9	5.95	1600	NR	15.9	15.9
SILVER		1.2	ND	390	NR	0.733	0.733
ZINC	197	1520	45	23000	NR	124	124

(1) BACKGROUND/TYPICAL FACILITY SOIL/ SEDIMENT CONCENTRATIONS TAKEN FROM SITE 12 RI/RFI (TTNUS, 2000). PESTICIDE VALUES ARE TYPICAL FACILITY CONCENTRATIONS.
(2) U.S. EPA REGION 9 PRG RESIDENTIAL SOIL TABLE (USEPA, 2000)
(3) U.S. EPA REGION 4 ECOLOGICAL SCREENING VALUES (USEPA, 1999)
(4) BAP EQUIVALENTS = BENZO(A)ANTHRACENE (0.1) + BENZO(A)PYRENE(1.0) + BENZO(B)FLUORANTHENE(0.1) + BENZO(K)FLUORANTHENE (0.01) + CHYRSENE(0.001) + DIBENZO(A,H)ANTHRACENE(1.0) + INDENO(1,2,3-CD)PYRENE(0.1).
(5) TOTAL PAHS = LOW MOLECULAR WEIGHT PAHS + HIGH MOLECULAR WEIGHT PAHS
* LOW MOLECULAR WEIGHT PAHS = 2-METHYLNAPHTHALENE + ACENAPHTHENE + ACENAPHTHYLENE + ANTHRACENE + FLUORENE + NAPHTHALENE + PHENANTHRENE
* HIGH MOLECULAR WEIGHT PAHS = BENZO(A)ANTHRACENE + BENZO(A)PYRENE + CHYRSENE + DIBENZO(A,H)ANTHRACENE + FLUORANTHENE + PYRENE
* IF A PAH IS DETECTED, 1/2 OF THE DETECTION LIMIT SHOULD BE USED FOR NONDETECTED PAHS TO CALCULATE TOTAL PAHS AND BAP EQUIVALENTS
(6) CALCULATED AS 7 X BENZO(A)PYRENE REGION IX PRG.
(7) BASED ON TOTAL CHLORDANE
(8) OSWER SOIL SCREENING LEVEL FOR RESIDENTIAL LAND USE (USEPA, 1994)
(9) RGO IS PRG + BACKGROUND PER EPA GUIDANCE

NA = NOT AVAILABLE
NR = NOT RELEVANT



DRAWN BY HJP	DATE 7/26/01
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REVISED BY	DATE
SCALE AS NOTED	

CONTAMINATED SOIL/SEDIMENT DELINEATION MAP
SITE 12/SWMU 10
JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7803	
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4.0 IDENTIFICATION, SCREENING, AND DEVELOPMENT OF REMEDIAL ACTION/CORRECTIVE MEASURE ALTERNATIVES

4.1 INTRODUCTION

This section presents the identification and screening of remedial technologies and the development of remedial action/corrective measure alternatives formulated to achieve RAOs/CAOs for Site 12. The identification and screening of technologies and the development of alternatives are based upon the information presented in Section 3.0 and involve the following activities:

- Identification of technologies and applicable process options.
- Screening of potential technologies and applicable process options.
- Development of alternatives by assembling the remaining technologies into alternatives that have the potential to achieve the defined RAOs/CAOs.

4.2 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

This section identifies potential remedial technologies and process options that may be used to achieve RAOs/CAOs. Technologies and process options can be grouped according to general response actions (GRAs). Alternatives are then formulated by combining GRAs to address the RAOs/CAOs. The categories of GRAs that could be implemented to achieve or address the RAOs/CAOs for Site 12 include

- No action
- Institutional controls (land use controls)
- Containment
- Removal
- Treatment
- Disposal

The application of containment at the site would meet the requirements of the guidance for the presumptive remedy for landfills. The application of the presumptive remedy for this site would typically eliminate most of the GRAs from further consideration; however, each of the GRAs is briefly discussed to evaluate unrestricted use of the property in accordance with DOD guidance (DOD, 2001). Also, for Site 12, which is a surface disposal area with several small waste piles, other potentially viable options will be considered. Furthermore, remedial actions pertaining to impacted soil and sediment will be defined and evaluated with the remedial alternatives for the waste piles. Each of the GRAs is discussed below.

4.2.1 No Action

No action is a general response action wherein the status quo is maintained at the site. No action is normally retained to provide a baseline for comparison with other alternatives. No additional activities would be conducted at the site to address existing waste and sediment contamination. There are no implementability concerns because the contaminated media are considered to be left "as is." Institutional controls, containment, removal, treatment, or other mitigating actions are not provided to reduce the potential for exposure.

4.2.2 Institutional Controls (Land Use Controls)

Access controls (e.g., physical barriers) and/or site development through the MCRD Parris Island Master Plan, Land Use Control Assurance Plan (LUCAP), and the Site 12 Land Use Control Implementation Plan (LUCIP) are institutional control options that may be considered for implementation to reduce or control pathways of exposure to hazardous substances at the site. Controls could involve the use of such measures as groundwater use restriction or surface soil, sediment, and groundwater monitoring networks. The application of institutional controls alone does not reduce the volume, mobility, and toxicity of the contaminants.

4.2.3 Containment

Containment involves the application of physical measures to reduce the potential for contaminant migration and thereby reduce the risk from both chemical and physical exposure to the public and the environment. The contaminated media must be isolated from the primary transport mechanisms (i.e., wind, erosion, surface water, and groundwater) to reduce the migration of contaminants. Contaminated media are isolated by the installation of surface and subsurface barriers that either block or divert any transport media from the contaminants.

4.2.4 Removal

Removal action is a general response action in which technologies are used to move contaminated media from its present location in order to be treated and/or disposed elsewhere. Treatment and/or disposal process options can be combined with removal process options to develop alternatives.

4.2.5 Treatment

The treatment response action, including both in-situ and ex-situ treatment process options, includes physical, chemical, biological, solidification, or thermal technologies designed to reduce the mobility,

toxicity, and/or volume of the contaminants present. Treatment can be used with removal and disposal process options to develop alternatives.

4.2.6 Disposal

Disposal technologies include placement of removed or treated materials in an on-site or an off-site permanent disposal facility. Removal options and possibly treatment options can be used with disposal process options to develop alternatives. The toxicity, mobility, or volume of the contaminants is not reduced through the singular application of disposal. This response action would reduce or control exposure pathways related to direct human and ecological contact with contaminated material.

4.3 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR WASTE, SOIL, AND SEDIMENT

In this section, technologies and process options are identified under each GRA and screened at a preliminary level to focus on relevant technologies and process options. Screening is conducted at a more detailed level based on certain evaluation criteria. Finally, process options are selected to represent the technologies that have passed the detailed evaluation and screening.

Table 4-1 summarizes the preliminary screening of technologies and process options applicable to waste, soil, and sediment. The tables present the GRAs, identify the technologies and process options, and provide a brief description of each process option followed by the screening comments. All technologies and process options that are not eliminated because of implementation concerns will be evaluated in greater detail in Section 4.5.

4.4 EVALUATION CRITERIA

The evaluation criteria for detailed screening of technologies and process options that have been retained after the preliminary screening in Section 4.3 are effectiveness, implementability, and cost. The following are descriptions of the evaluation criteria:

- Effectiveness
  - Protection of human health and environment; reduction in toxicity, mobility, and volume; and permanence of solution.
  - Ability of the technology to address the estimated areas or volumes of contaminated media.
  - Ability of the technology to meet the remediation goals identified in the remedial action objectives.
  - Technical reliability (innovative versus well-proven) with respect to contaminants and site conditions.

- Implementability
  - Overall technical feasibility at the site
  - Availability of vendors, mobile units, storage and disposal services, etc
  - Administrative feasibility
  - Special long-term maintenance and operation requirements

- Cost (Qualitative)
  - Capital cost
  - Operation and maintenance (O&M) costs

As a rule of thumb used in the discussion in the following sections, technologies and process options are considered low if less than $500,000, medium if between $500,000 to $5,000,000, and high if greater than $5,000,000.

All the items listed above may not apply directly to each technology and, therefore, will be addressed only as appropriate. Screening evaluations at this stage generally focus on effectiveness and implementability, with less emphasis on cost evaluations. Technologies whose use would be precluded by waste characteristics and inapplicability under the given site conditions are screened and eliminated from further consideration. Each technology presented in this section is not necessarily intended to be implemented alone because it may be combined with other technologies into remedial action alternatives.

4.5 FINAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR WASTE MATERIALS, SOIL, AND SEDIMENT

4.5.1 Technologies and Process Options for Waste Materials

The final screening of technologies and process options is based on the evaluation criteria described in Section 4.4. The following are the technologies and process options for waste material that passed preliminary screening and remain for final screening.

General Response Action	Remedial Technology	Process Options
No Action	None	Not applicable
Institutional Controls (Land Use Controls)	Access/use restrictions	Limited site access Site development restrictions
	Monitoring	Sediment, surface water, and groundwater monitoring
Containment	Capping	Single-layer cap/multilayer cap

General Response Action	Remedial Technology	Process Options
Removal	Bulk excavation of waste materials	Bulk excavation of waste materials
Disposal	On-site consolidation/ disposal	On-site consolidation/disposal
	Off-site disposal	Permitted treatment/storage/disposal facility

4.5.1.1 No Action

The no-action option consists of no remedial action at the site and is typically considered in an FS to serve as a baseline comparison or to address sites that do not require any active remediation to meet RAOs/CAOs.

Effectiveness

The no-action option would not be effective in achieving the RAOs/CAOs for waste material where human and ecological exposure to impacted waste material would continue. Migration of waste contaminants to the adjacent soils, sediment, surface water, and groundwater would continue.

Implementability

The no-action alternative would be readily implementable. Because no action would be implemented, potential constraints, such as the need for permits, constructability, and equipment and resource availability, are not concerns. There would be no additional risks to human health and the environment from implementation.

Cost

There are no costs associated with no action.

Conclusion

The no-action option will be retained throughout the screening process, as required by the NCP, to provide a baseline comparison.

4.5.1.2 Institutional Controls

Institutional controls (or land use controls) are measures for reducing contact with contaminated media. Such measures could include restrictions to on-site access, such as signs, fencing, and/or security gates. Site development restrictions may be imposed to allow only non-residential development, to restrict

construction practices, and to prohibit the use of groundwater as a drinking water source. Post-action assessments, 5-year reviews, and other evaluation activities may be required to develop complete alternatives.

Effectiveness

Institutional controls would be partially effective. Fencing and security gates may be effective in minimizing human exposure with waste material but would not be effective for protecting ecological receptors. Site wastes would continue to erode and impact the surrounding area. Site development restrictions, such as allowing only nonresidential development, would be effective in reducing exposure risks. Restrictions could be implemented to prohibit use of groundwater as a drinking water source. Because the groundwater is predominantly saline, residential use of the groundwater is unlikely. A drinking water well is located on Jericho Island; however, this well is scheduled to be abandoned in conjunction with other field activities on the Depot. Restrictions for prohibiting unauthorized intrusive activity could include a provision for site workers to wear proper personal protection equipment (PPE) during remedial activities.

Implementability

The institutional controls listed above are readily available and would be implementable. Currently, there are no formal institutional controls in place at Jericho Island; however, access is effectively restricted by poor vehicle access and dense forestation. Site access and development restrictions could be implemented by incorporating the restrictions into the MCRD Parris Island Master Plan and LUCAP, as well as in the LUCIP for the site.

Cost

The costs of access and use restrictions would be low.

Conclusion

For waste, retain the use of institutional controls to enforce access and use restrictions. Controls could include restrictions on unauthorized intrusive activities, groundwater usage, and residential development. Institutional controls alone may not be protective of ecological receptors; however, they could be combined with other process options to form remedial alternatives.

4.5.1.3 Monitoring

Monitoring would involve the collection of environmental samples from various media at the site such as groundwater, surface water, and sediment. Samples would be collected in accordance with federal and

State guidance and would be analyzed for target contaminants. These results would then be used to assess contaminant trends.

Effectiveness

Monitoring via sampling and analysis of environmental media would be ineffective in minimizing the migration of contaminants in the environment, but it can be used for assessing the migration of contaminants. In particular, it can be used to determine if contaminants are migrating or are attenuating through natural processes such as biodegradation, advection, adsorption, and dilution. Sampling and analysis of environmental samples would also be required to aid in assessing the effectiveness of remedial activities.

Implementability

Sampling equipment and analytical test methods are readily available and implementable.

Cost

Costs associated with sampling and analysis would be low.

Conclusion

Monitoring will be retained as a process option for waste. Monitoring could be implemented to ensure that remedial actions are effective and could be combined with other process options discussed in this FS/CMS.

4.5.1.4 Containment

The technologies considered under containment are soil cover with native soil (e.g., a RCRA D cap) and multilayer capping (e.g., a RCRA C cap).

4.5.1.4.1 Soil Cover with Native Soil

This technology involves covering impacted areas with native soils to minimize human and ecological exposure. The native soil cover would also reduce the transport of impacted media. This technology would be coupled with revegetation and other control measures to minimize erosion. A typical cap would consist of a 6-inch biotic base layer of crushed gravel followed by an 18-inch layer of native soil and a 6-inch topsoil layer.

Effectiveness

This alternative would reduce risk associated with human and ecological exposure to waste at the site, as well as reduce the erosion of waste due to surface water runoff and/or wind.

Implementability

Applying a native soil cover is fully implementable. It is anticipated that borrow sources of cover soil can be identified on or relatively close to the MCRD. The main concern with the implementation of the soil cover is the maintenance of the cover under the influence of natural (erosion and slope failure) and human (uncontrolled excavations) interferences.

Cost

This alternative has moderate capital costs compared to other alternatives. Capital costs would include the purchase cost (if any) and transportation costs of the native soil, labor associated with applying the soil, and equipment (e.g., loaders) costs. O&M costs are relatively low and would involve periodic application of soil to areas that have been eroded through rainfall or wind.

Conclusion

Retain native soil cover for use with other remedial alternatives for impacted waste at Site 12.

4.5.1.4.2 Multilayer caps

Multilayer caps consist of layers of soil, clay, and/or synthetic materials placed over contaminated areas. Materials used in the construction of such caps include clay or synthetic, low-permeability material such as linear low-density polyethylene (LLDPE) or polyvinyl chloride (PVC). Low-permeability caps composed of synthetic material or clay are also suited for reducing contaminant migration to groundwater due to rainfall infiltration and surface runoff. The purposes of a cap at Site 12 would be to minimize the potential for human and ecological contact with waste material, to reduce erosion of impacted surface soil as a result of surface water runoff and/or wind, and to minimize infiltration and vertical containment migration. Biotic barriers to impede burrowing animals would also be considered during design of an appropriate cap system.

Effectiveness

Multilayer caps can be effective as a physical barrier in reducing risk associated with human and ecological exposure to contaminated media beneath the cap. Multilayer caps can also be effective in

reducing the infiltration of rainfall and surface water runoff into the wastes beneath the cover, which in turn reduces vertical contaminant migration.

Implementability

Capping is a common remedial alternative and would be fully implementable. Synthetic materials are readily available from several vendors and the materials are commonly used. It is anticipated that borrow sources can be identified relatively close to the base. The main concern with the implementation of the cap would be its maintenance under the influence of natural (e.g., storms and burrowing animals) and human interferences (e.g., development). Proper engineering and continued Operation and Maintenance (O&M) would minimize the impacts of natural interferences. Because the site is under federal control, human interferences could also be minimized.

Cost

Costs of caps are moderate to high, depending on the materials and labor involved in placement. O&M costs for caps are typically low to moderate.

Conclusion

A soil layer is retained as a containment alternative, but the waste material would need further evaluation to determine if it is non-hazardous.

Multilayer capping is retained for development as an alternative. This technology meets the requirements of the presumptive remedy for landfills.

4.5.1.5 Excavation

Excavation may be implemented for the removal alternative that is under consideration for waste material. Excavation can be performed by a variety of equipment, such as hydraulic excavators, track loaders, backhoes, grade-alls, etc. The type of equipment selected must take into consideration several factors, such as type of material, load-supporting ability of the soil, rate of excavation required, depth of excavation, etc.

Effectiveness

Excavation can be effective in removing contaminated materials from the site because it is applicable to the complete range of contaminant groups with no particular target group. Additionally, the volume and depth of contaminated material do not prohibit the use of such measures. Confirmatory sampling may be

required to verify the completion of the removal action. Samples must be taken from the exposed faces of the excavation area and analyzed for COCs to ensure that the residual material is not contaminated at unacceptable levels. Bulk excavation may require the use of temporary containment measures to minimize the migration of contaminated material into the surrounding surface waters and sediments (e.g., cofferdams or silt fences) during removal activities.

Implementability

The availability of excavation equipment is not of concern. The technology is well proven and established in the construction and remediation industry. Because some waste is located below the elevation of tidal fluctuations and the normal water-table elevation, area and waste dewatering would need to be employed to facilitate total excavation of the waste material. Coffer dams and waste dewatering are expected to be effective. Planning would be required to perform excavation activities during periods of acceptable weather conditions. During excavation, OSHA requirements must be met to ensure that the exposure of the workers to COCs is minimized.

Cost

Excavation costs are directly proportional to the extent of excavation required but are typically low. However, because dewatering is a concern at this site, excavation costs would be moderate to high.

Conclusion

Excavation of waste materials will be retained for further consideration in the development of remedial alternatives/corrective measures. Although the application of the presumptive remedy for this site would typically eliminate this option from further consideration, removal is retained to evaluate unrestricted use of the property in accordance with DOD guidance (DOD, 2001).

4.5.1.6 Disposal

4.5.1.6.1 On-Site Consolidation/Disposal

On-site consolidation of waste material would involve excavating waste from the debris piles and consolidating the waste at a newly constructed on-site disposal area above the high tide line.

Effectiveness

On-site consolidation or disposal can be effective for the small volumes and isolated pockets of waste materials in the debris piles. This technology is especially effective if the wastes are nonhazardous.

Implementability

Consolidation and placement of excavated material under a cap system are easy to moderate to implement. The geotechnical properties of the waste can be an important factor in the consolidation of waste material. Excavation and deposition activities may expose the workers to the contaminants present in the waste materials, but adequate PPE and observance of OSHA requirements can address potential health concerns. Potentially, land use controls and the base master plan would be required on any site where wastes are allowed to remain with or without treatment.

Cost

Capital and O&M costs of on-site consolidation with a cover are low to moderate. Creation of an on-site disposal area is moderate to high.

Conclusion

On-site consolidation is retained as a technology for development of a remedial alternative. On-site disposal (i.e., constructed disposal cell) is also retained for the development of remedial alternatives.

4.5.1.6.2 Off-Site Disposal

Off-site disposal involves transport of excavated waste material to an appropriate off-site disposal facility. A permitted treatment, storage, and disposal facility would be required for any hazardous waste, as defined by RCRA. In addition, LDRs currently require that some hazardous wastes be treated to render them nonhazardous prior to disposal. A permitted, solid waste disposal facility would be used for all nonhazardous waste, as defined by RCRA.

Effectiveness

Off-site disposal is effective because contaminated media are taken off site, and minimal residual risks would remain. Landfills are effective at isolating wastes from the environment. The waste-specific requirements vary from state to state and by individual landfills. The selection is based on waste-specific effectiveness, permitting, and cost considerations.

Implementability

Off-site disposal of waste material is implementable. Permitting requirements are variable based on the particular state and landfill. In general, the more protective a landfill is, the easier it is to obtain waste approval.

Cost

The cost of off-site disposal is highly variable, ranging from low to high for nonhazardous and hazardous waste landfills, respectively.

Conclusion

Off-site disposal of excavated waste materials will be retained for further consideration in the development of remedial alternatives. Although the application of the presumptive remedy for this site would typically eliminate this option from further consideration, off-site disposal is retained to evaluate unrestricted use of the property in accordance with DOD guidance (DOD, 2001).

4.5.2 Technologies and Process Options for Soil

The final screening of technologies and process options is based on the evaluation criteria described in Section 4.4. The following are the technologies and process options for soil that passed preliminary screening and remain for final screening.

General Response Action	Remedial Technology	Process Options
No Action	None	Not applicable
Institutional Controls (Land Use Controls)	Access/use restrictions	Limited site access Site development restrictions
	Monitoring	Sediment, surface water, and groundwater monitoring
Containment	Capping	Single layer cap/multilayer cap
Removal	Bulk excavation of soil	Bulk excavation of soil
In-Situ Treatment	Biological	Monitored natural recovery
	Biological	Enhanced biodegradation
Disposal	On-site consolidation/ disposal	On-site consolidation/disposal
	Off-site disposal	Permitted treatment/storage/disposal facility

4.5.2.1 No Action

The no-action option consists of no remedial action at the site and is typically considered in an FS to serve as a baseline comparison or to address sites that do not require any active remediation to meet RAOs/CAOs.

Effectiveness

The no-action option would not be effective in achieving the RAOs/CAOs for soil where human and ecological exposure to impacted soil would continue. Migration of surface soil COCs to the adjacent sediment and surface water and to the groundwater would continue.

Implementability

The no-action alternative would be readily implementable. Because no action would be implemented, potential constraints, such as the need for permits, constructability, and equipment and resource availability, are not concerns. There would be no additional risks to human health and the environment from implementation.

Cost

There are no costs associated with no action.

Conclusion

The no-action option will be retained throughout the screening process, as required by the NCP, to provide a baseline comparison.

4.5.2.2 Institutional Controls

Institutional controls (or land use controls) are measures for reducing contact with contaminated media. Such measures could include restrictions to on-site access, such as signs, fencing, and/or security gates. Site development restrictions may be imposed to allow only non-residential development, to restrict construction practices, and to prohibit the use of groundwater as a drinking water source. Post-action assessments, 5-year reviews, and other evaluation activities may be required to develop complete alternatives.

Effectiveness

Institutional controls would be partially effective. Fencing and security gates may be effective in minimizing human exposure with contaminated soils but would not be effective for protecting ecological receptors. Contaminated soils would continue to erode and impact the surrounding area. Site development restrictions, such as allowing only nonresidential development, would be effective in reducing exposure risks. Restrictions could be implemented to prohibit use of groundwater as a drinking water source. Because the groundwater is predominantly saline, residential use of the groundwater is unlikely. A drinking water well is located on Jericho Island; however, this well is scheduled to be abandoned in conjunction with other field activities on the Depot. Restrictions for prohibiting unauthorized intrusive activity could include a provision for site workers to wear proper PPE during remedial activities.

Implementability

The institutional controls listed above are readily available and would be implementable. Currently, there are no formal institutional controls in place at Jericho Island; however, access is effectively restricted by poor vehicle access and dense forestation. Site access and development restrictions could be implemented by incorporating the restrictions into the MCRD Parris Island Master Plan and LUCAP, as well as in the LUCIP for the site.

Cost

The costs of access and use restrictions would be low.

Conclusion

For soil, retain the use of institutional controls to enforce access and use restrictions. Controls could include restrictions on unauthorized intrusive activities, groundwater usage, and residential development. Institutional controls alone may not be protective of ecological receptors; however, they could be combined with other process options to form remedial alternatives.

4.5.2.3 Monitoring

Monitoring would involve the collection of environmental samples from various media at the site such as groundwater, surface water, and sediment. Samples would be collected in accordance with federal and State guidance and would be analyzed for target contaminants. These results would then be used to assess contaminant trends.

Effectiveness

Monitoring via sampling and analysis of environmental media would be ineffective in minimizing the migration of contaminants in the environment, but it can be used for assessing the migration of contaminants. In particular, it can be used to determine if contaminants are migrating or are attenuating through natural processes such as biodegradation, advection, adsorption, and dilution. Sampling and analysis of environmental samples would also be required to aid in assessing the effectiveness of remedial activities.

Implementability

Sampling equipment and analytical test methods are readily available and implementable.

Cost

Costs associated with sampling and analysis would be low.

Conclusion

Monitoring will be retained as a process option for soil. Monitoring could be implemented to ensure that remedial actions are effective and could be combined with other process options discussed in this FS/CMS.

4.5.2.4 Containment

The technologies considered under containment are soil cover with native soil (e.g., a RCRA D cap) and multilayer capping (e.g., a RCRA C cap).

4.5.2.4.1 Soil Cover with Native Soil

This technology involves covering impacted areas with native soils to minimize human and ecological exposure. The native soil cover would also reduce the transport of impacted media. This technology would be coupled with revegetation and other control measures to minimize erosion. A typical cap would consist of a 6-inch biotic base layer of crushed gravel followed by an 18-inch layer of native soil and a 6-inch topsoil layer.

Effectiveness

This alternative would reduce risk associated with human and ecological exposure to impacted surface soil at the site, as well as reduce the erosion of impacted surface soil due to surface water runoff and/or wind.

Implementability

Applying a native soil cover is fully implementable. It is anticipated that borrow sources of cover soil can be identified on or relatively close to the MCRD. The main concern with the implementation of the soil cover is the maintenance of the cover under the influence of natural (erosion and slope failure) and human (uncontrolled excavations) interferences.

Cost

This alternative has moderate capital costs compared to other alternatives. Capital costs would include the purchase cost (if any) and transportation costs of the native soil, labor associated with applying the soil, and equipment (e.g., loaders) costs. O&M costs are relatively low and would involve periodic application of soil to areas that have been eroded through rainfall or wind.

Conclusion

Retain native soil cover for use with other remedial alternatives for impacted surface soils at Site 12.

4.5.2.4.2 Multilayer caps

Multilayer caps consist of layers of soil, clay, and/or synthetic materials placed over contaminated areas. Materials used in the construction of such caps include clay or synthetic, low-permeability material such as LLDPE or PVC. Low-permeability caps composed of synthetic material or clay are also suited for reducing contaminant migration to groundwater due to rainfall infiltration and surface runoff. The purposes of a cap at Site 12 would be to minimize the potential for human and ecological contact with the soil and waste material, to reduce erosion of impacted surface soil as a result of surface water runoff and/or wind, and to minimize infiltration and vertical containment migration. Biotic barriers to impede burrowing animals would also be considered during design of an appropriate cap system.

Effectiveness

Multilayer caps as a physical barrier can be effective in reducing risk associated with human and ecological exposure to contaminated media beneath the cap. Multilayer caps can also be effective in

reducing the infiltration of rainfall and surface water runoff into the wastes beneath the cover, which in turn reduces vertical contaminant migration.

Implementability

Capping is a common remedial alternative and would be fully implementable. Synthetic materials are readily available from several vendors and the materials are commonly used. It is anticipated that borrow sources can be identified relatively close to the base. The main concern with the implementation of the cap would be its maintenance under the influence of natural (e.g., storms and burrowing animals) and human interferences (e.g., development). Proper engineering and continued O&M would minimize the impacts of natural interferences. Because the site is under federal control, human interferences could also be minimized.

Cost

Costs of caps are moderate to high, depending on the materials and labor involved in placement. O&M costs for caps are typically low to moderate.

Conclusion

Multilayer capping is retained for development as an alternative. This technology meets the requirements of the presumptive remedy for landfills.

4.5.2.5 Excavation

Excavation may be implemented for the removal alternative that is under consideration for contaminated soil. Excavation can be performed by a variety of equipment, such as hydraulic excavators, track loaders, backhoes, grade-alls, etc. The type of equipment selected must take into consideration several factors, such as type of material, load-supporting ability of the soil, rate of excavation required, depth of excavation, etc.

Effectiveness

Excavation can be effective in removing contaminated materials from the site because it is applicable to the complete range of contaminant groups, with no particular target group. Additionally, the volume and depth of contaminated material do not prohibit the use of such measures. Confirmatory sampling may be required to verify the completion of the removal action. Samples must be taken from the exposed faces of the excavation area and analyzed for COCs to ensure that the residual material is not contaminated at unacceptable levels. Bulk excavation may require the use of temporary containment measures to

minimize the migration of contaminated material into the surrounding surface waters and sediments (e.g., cofferdams or silt fences) during removal activities.

Implementability

The availability of excavation equipment is not of concern. The technology is well proven and established in the construction and remediation industry. Because some soil is located below the elevation of tidal fluctuations and the normal water-table elevation, area and soil dewatering would need to be employed to facilitate total excavation of the contaminated soil. Coffer dams and soil dewatering are expected to be effective. Planning would be required to perform excavation activities during periods of acceptable weather conditions. During excavation, OSHA requirements must be met to ensure that the exposure of the workers to COCs is minimized.

Cost

Excavation costs are directly proportional to the extent of excavation required but are typically low. However, because dewatering is a concern at this site, excavation costs would be moderate to high.

Conclusion

Excavation of soil for further consideration will be retained in the development of remedial alternatives/corrective measures. Although the application of the presumptive remedy for this site would typically eliminate this option from further consideration, removal is retained to evaluate unrestricted use of the property in accordance with DOD guidance (DOD, 2001).

4.5.2.6 In-Situ Treatment

Based on the results of the preliminary screening section, this section evaluates two in-situ treatment technologies for soil, monitored natural recovery and enhanced biodegradation.

4.5.2.6.1 Monitored Natural Recovery

Under monitored natural recovery, concentrations of site COCs may gradually decrease due to processes such as biodegradation, advection, dispersion, adsorption, and dilution.

Effectiveness

Organic chemicals such as PAHs, pesticides, and PCBs can biodegrade naturally. The concentrations of PAHs in soil would be expected to be effectively reduced through biodegradation. Half-lives for PAHs in

soil range from 50 days to 2.72 years (Howard, 1991). Pesticides and PCBs in soil would also biodegrade but at a much slower rate [half-lives for several site pesticides are reported in periods of years (Howard, 1991)]. To determine whether concentrations of soil contaminants are attenuating over time, it would be necessary to monitor the soil. Uptake may be effective with certain combinations of contaminants and vegetation types. Monitored natural recovery is not effective in the remediation of inorganic chemicals. Concentrations of inorganic chemicals can diminish over time due to natural processes such as advection and dispersion.

Implementability

For monitored natural recovery, methods, equipment, and personnel to conduct monitoring activities are readily available and implementable.

Cost

Costs associated with sampling and analysis would be moderate.

Conclusion

Monitored natural recovery will be retained as a remedial alternative technology based on its effectiveness with PAHs.

4.5.2.6.2 Enhanced Biodegradation

Under biodegradation, concentrations of COCs would decrease by a process in which microorganisms degrade organic contaminants. This technology is similar in process to monitored natural recovery except that it should be faster with the addition of microorganisms to aid in degradation and it is more controlled.

Effectiveness

Bioremediation is effective in remediating soils with organic chemicals including PAHs. Biodegradation cannot degrade inorganic contaminants. Clean-up goals may not be attained if the soil prohibits contaminant-microorganism contact, and bioremediation slows at low temperatures.

Implementability

For enhanced biodegradation, treatability tests would be performed to determine whether bioremediation is feasible in the given situation.

Cost

Costs are medium to high, depending on variables affecting the costs such as the nature and depth of contaminants, use of bioaugmentation, and/or hydrogen peroxide addition.

Conclusion

Enhanced biodegradation will be retained as a remedial alternative technology based on its effectiveness with PAHs.

4.5.2.7 Disposal

4.5.2.7.1 On-Site Consolidation and Disposal

On-site consolidation of contaminated soil would involve excavating soil from contaminated areas and consolidating the soil at a newly constructed on-site disposal area above the high tide line.

Effectiveness

On-site consolidation or disposal can be effective for the small volumes and isolated pockets of contaminated soil.

Implementability

Consolidation and placement of excavated material under a cap system are easy to moderate to implement. The geotechnical properties of the soil can be an important factor in the consolidation of the soil. Excavation and deposition activities may expose the workers to the contaminants present in the soil, but adequate personal protective equipment (PPE) and observance of OSHA requirements can address potential health concerns. Potentially, land use controls and the base master plan would be required on any site where contaminated soil is allowed to remain with or without treatment.

Cost

Capital and O&M costs of on-site consolidation with a cover are low to moderate. Creation of an on-site disposal area is moderate to high.

Conclusion

On-site consolidation is retained as a technology for development of a remedial alternative. On-site disposal (i.e., constructed disposal cell) is also retained for the development of remedial alternatives.

4.5.2.7.2 Off-Site Disposal

Off-site disposal involves transport of excavated contaminated soil to an appropriate off-site disposal facility. A permitted treatment, storage, and disposal facility would be required for any hazardous material, as defined by RCRA. In addition, LDRs currently require that some hazardous material be treated to render them nonhazardous prior to disposal. A permitted, solid waste disposal facility would be used for all nonhazardous material, as defined by RCRA.

Effectiveness

Off-site disposal is effective because contaminated media are taken off site, and minimal residual risks would remain. Landfills are effective at isolating contaminated media from the environment. The waste-specific requirements vary from state to state and by individual landfills. The selection is based on waste-specific effectiveness, permitting, and cost considerations.

Implementability

Off-site disposal of contaminated soil is implementable. Permitting requirements are variable based on the particular state and landfill. In general, the more protective a landfill is, the easier it is to obtain waste approval.

Cost

The cost of off-site disposal is highly variable, ranging from low to high for nonhazardous and hazardous waste landfills, respectively.

Conclusion

Off-site disposal of excavated contaminated soil will be retained for further consideration in the development of remedial alternatives. Although the application of the presumptive remedy for this site would typically eliminate this option from further consideration, off-site disposal is retained to evaluate unrestricted use of the property in accordance with DOD guidance (DOD, 2001).

4.5.3 Technologies and Process Options for Sediment

The final screening of technologies and process options is based on the evaluation criteria described in Section 4.4. The following are the sediment technologies and process options that passed preliminary screening and remain for final screening.

General Response Action	Remedial Technology	Process Options
No Action	None	Not applicable
Institutional Controls (Land Use Controls)	Access/use restrictions	Limited site access Site development restrictions
	Monitoring	Sediment monitoring
Containment	Capping	Single layer cap/multilayer cap
Removal	Bulk excavation	Bulk excavation
Disposal	On-site consolidation and disposal	On-site consolidation/disposal
	Off-site disposal	Permitted treatment/storage/disposal facility

4.5.3.1 No Action

The no-action option consists of no remedial action at the site and is typically considered in an FS to serve as a baseline comparison or to address sites that do not require any active remediation to meet RAOs/CAOs.

Effectiveness

The no-action alternative would not achieve RAOs/CAOs for sediment where human and ecological exposure to impacted sediment would continue. Migration of sediment COCs to surface water would continue.

Implementability

The no-action alternative would be readily implementable. Because no action would be implemented, potential constraints, such as the need for permits, constructability, and equipment and resource availability, are not concerns. There would be no additional risks to human health and the environment from implementation.

Cost

There are no costs associated with no action.

Conclusion

The no-action option will be retained throughout the screening process, as required by the NCP, to provide a baseline comparison.

4.5.3.2 Institutional Controls

Institutional controls (or land use controls) are measures for reducing contact with contaminated media. Such measures could include restrictions to on-site access, such as signs, fencing, and/or security gates near the access points to the contaminated saltwater marsh. Site development restrictions may be imposed to allow only non-residential development, to restrict construction practices, and to prohibit the use of groundwater as a drinking water source. Post-action assessments, 5-year reviews, and other evaluation activities may be required to develop complete alternatives.

Effectiveness

Institutional controls would be effective in minimizing human exposure with contaminated sediments but would not be effective for protecting ecological receptors. Contaminated sediments would continue to erode and impact the surrounding saltwater marsh. Warning signs could be an effective method for reducing risks to the adult recreational user.

Implementability

The institutional controls listed above are readily available and would be implementable. Currently, there are no formal institutional controls in place at Jericho Island; however, access is effectively restricted by poor vehicle access and dense forestation. Site access and development restrictions could be implemented by incorporating the restrictions into the MCRD Parris Island Master Plan and LUCAP, as well as in the LUCIP for the site.

Cost

The costs of access and use restrictions would be low.

Conclusion

For sediment, retain the use of institutional controls to enforce access and use restrictions. Controls could include restrictions on unauthorized intrusive activities, groundwater usage, and residential development. Institutional controls alone may not be protective of ecological receptors; however, they could be combined with other process options to form remedial alternatives.

4.5.3.3 Monitoring

Monitoring would involve the collection of environmental samples from various media at the site such as groundwater, surface water, and sediment. Samples would be collected in accordance with federal and State guidance and would be analyzed for target contaminants. These results would then be used to assess contaminant trends.

Effectiveness

Monitoring via sampling and analysis of environmental media would be ineffective in minimizing the migration of contaminants in the environment, but it can be used for assessing the migration of contaminants. In particular, it can be used to determine if contaminants are migrating or are attenuating through natural processes such as biodegradation, advection, adsorption, and dilution. Sampling and analysis of environmental samples would also be required to aid in assessing the effectiveness of remedial activities.

Implementability

Sampling equipment and analytical test methods are readily available and implementable.

Cost

Costs associated with sampling and analysis would be low.

Conclusion

Monitoring will be retained as a process option for sediment. Monitoring could be implemented to ensure that remedial actions are effective and could be combined with other process options discussed in this FS/CMS.

4.5.3.4 Containment

The technologies considered under containment are soil cover with native soil (e.g., a RCRA D cap) and multilayer capping (e.g., a RCRA C cap).

4.5.3.4.1 Soil Cover with Native Soil

This technology involves covering impacted areas with native soils to minimize human and ecological exposure. The native soil cover would also reduce the transport of impacted media. This technology would

be coupled with revegetation and other control measures to minimize erosion. A typical cap would be constructed over excavated and consolidated sediment and consist of a 6-inch biotic base layer of crushed gravel followed by an 18-inch layer of native soil and a 6-inch topsoil layer.

Effectiveness

This alternative would reduce risk associated with human and ecological exposure to impacted surface sediment at the site, as well as reduce the transport of contaminated sediment to adjacent areas of the salt water marsh.

Implementability

Applying a native soil cover is fully implementable. It is anticipated that borrow sources of cover soil can be identified on or relatively close to the MCRD. The main concern with the implementation of the soil cover is the maintenance of the cover under the influence of natural (erosion and slope failure) and human (uncontrolled excavations) interferences.

Cost

This alternative has moderate capital costs compared to other alternatives. Capital costs would include the purchase cost (if any) and transportation costs of the native soil, labor associated with applying the soil, and equipment (e.g., loaders) costs. O&M costs are relatively low and would involve periodic application of soil to areas that have been eroded through rainfall or wind.

Conclusion

Retain native soil cover for use with other remedial alternatives for impacted surface soils at Site 12.

4.5.3.4.2 Multilayer caps

Multilayer caps consist of layers of soil, clay, and/or synthetic materials placed over contaminated areas. Materials used in the construction of such caps include clay or synthetic, low-permeability material such as LLDPE or polyvinyl chloride PVC. Low-permeability caps composed of synthetic material or clay are also suited for reducing contaminant migration to groundwater due to rainfall infiltration and surface runoff. The purposes of a cap at Site 12 would be to minimize the potential for human and ecological contact with the sediment and waste material, to reduce erosion of impacted surface soil as a result of surface water runoff and/or wind, and to minimize infiltration and vertical containment migration. Biotic barriers to impede burrowing animals would also be considered during design of an appropriate cap system.

Effectiveness

Multilayer caps as a physical barrier can be effective in reducing risk associated with human and ecological exposure to contaminated media beneath the cap. Multilayer caps can also be effective in reducing the infiltration of rainfall and surface water runoff into the wastes beneath the cover, which in turn reduces vertical contaminant migration.

Implementability

Capping is a common remedial alternative and would be fully implementable. Synthetic materials are readily available from several vendors and the materials are commonly used. It is anticipated that borrow sources can be identified relatively close to the base. The main concern with the implementation of the cap would be its maintenance under the influence of natural (e.g., storms and burrowing animals) and human interferences (e.g., development). Proper engineering and continued O&M would minimize the impacts of natural interferences. Because the site is under federal control, human interferences could also be minimized.

Cost

Costs of caps are moderate to high, depending on the materials and labor involved in placement. O&M costs for caps are typically low to moderate.

Conclusion

Multilayer capping is retained for development as an alternative. This technology meets the requirements of the presumptive remedy for landfills.

4.5.3.5 Excavation

Bulk excavation is the only type of removal option that is under consideration for sediment. Bulk excavation would apply to sediment when water levels in the salt marsh are low or controlled to accommodate removal. The site sediments vary from being moderately dry at low tide to saturated at high tide. The typical depth of water expected to cover sediments during high tide ranges from 1 to 3 feet. Migration of some contaminated sediment may occur during excavation activities. Excavation can be performed by a variety of equipment, such as hydraulic excavators, backhoes, grade-alls, etc. The type of equipment that is selected must take into consideration several factors, such as type of material, load-supporting ability of the soil, rate of excavation required, depth of excavation, etc. Usually hydraulic excavators, draglines, clamshells, or backhoes are used for deep excavation and/or when required excavation rates are high.

Effectiveness

Excavation can be effective in removing contaminated material from the site because it is applicable to the complete range of contaminant groups, with no particular target group. Additionally, the volume of contaminated sediment does not prohibit the use of such measures. Confirmatory sampling is required to verify the completion of the removal action. Samples must be taken from the exposed faces of the excavation area and analyzed for the COCs to ensure that the residual material is not contaminated at unacceptable levels. Bulk excavation may require the use of temporary containment measures to minimize the migration of contaminated sediment into the surface waters (e.g., cofferdams or silt fences) during removal activities.

Implementability

The availability of excavation equipment is not of concern. The technology is well proven and established in the construction and remediation industry. Because the area of impacted sediment is within a low-lying salt marsh that is tidally influenced, implementation of excavation could be difficult but feasible with respect to saturated sediments and accessibility for excavation and transportation equipment. Some method of dewatering would need to be employed to minimize or eliminate tidal influence on the area and facilitate excavation of the saturated sediments. During sediment removal, OSHA requirements must be met to ensure that the exposure of the workers to COCs is minimized.

Cost

Excavation costs are directly proportional to the extent of excavation required but are typically low. Excavation costs also depend upon the accessibility of the sediments, which could make excavation costs moderate to high.

Conclusion

Bulk excavation of sediment will be retained for further consideration during the development of remedial alternatives/corrective measures.

4.5.3.6 Disposal

4.5.3.6.1 On-Site Consolidation and Disposal

On-site consolidation and disposal of contaminated sediment would involve excavation of impacted areas (discussed in removal) followed by dewatering and consolidation in one location. Disposal would be

combined with other actions for the debris and contaminated soil that would involve containment. Monitoring of groundwater would be required to detect any migration of contaminants.

Effectiveness

On-site consolidation and disposal can be effective for the impacted sediment. This technology is especially effective if the wastes are nonhazardous.

Implementability

On-site disposal technologies can be implemented. Consolidation within the high elevation area of Site 12 is easily implementable. Excavation and deposition activities may expose the workers to the contaminants present in the sediment, but adequate PPE and observance of OSHA requirements can address potential health concerns. Potentially, land use controls and the base master plan would be required on any site where wastes are allowed to remain with or without treatment.

Cost

Capital and O&M costs of on-site consolidation within a contiguous area are low to moderate.

Conclusion

On-site consolidation and disposal of sediment will be retained for further consideration in the development of remedial alternatives. Sediment may require dewatering prior to the placement of the material within the contiguous area. The option is dependent on the combination of technologies (such as containment) for the soil and waste debris.

4.5.3.6.2 Off-Site Disposal

Off-site disposal involves transport of excavated sediment to an off-site disposal facility. A permitted treatment, storage, and disposal facility would be required for any hazardous waste, as defined by RCRA. In addition, LDRs currently require that some hazardous wastes be treated to render them nonhazardous prior to disposal. A permitted, solid waste disposal facility would be used for all nonhazardous waste, as defined by RCRA.

Effectiveness

Off-site disposal is effective because contaminated sediments are taken off site, and minimal residual risks would remain. Landfills are effective at isolating wastes from the environment. The waste-specific

requirements vary from state to state and by individual landfill. The selection is based on waste-specific effectiveness, permitting, and cost considerations.

Implementability

Off-site disposal of sediment is implementable. Permitting requirements are variable based on the particular state and landfill. In general, the more protective a landfill is, the easier it is to obtain waste approval. Dewatering of the sediment may be required prior to transportation and disposal.

Cost

The cost of off-site landfilling is highly variable, ranging from low to high for nonhazardous and hazardous waste landfills, respectively.

Conclusion

Off-site disposal of excavated sediment will be retained for further consideration in the development of remedial alternatives. Off-site disposal is retained to evaluate unrestricted use of the property in accordance with DOD guidance (DOD, 2001).

4.6 SUMMARY OF SCREENING AND SELECTION OF REPRESENTATIVE PROCESS OPTIONS FOR WASTE MATERIAL, SOIL, AND SEDIMENT

Based on the screening process conducted in Sections 4.5, the following technologies have been retained:

Selected Technologies and Process Options for Waste Material

General Response Action	Remedial Technology	Process Options
No Action	None	Not applicable
Institutional Controls (Land Use Controls)	Access/use restrictions	Limited site access Site development restrictions
	Monitoring	Monitoring
Containment	Capping	Single-layer cap/multilayer cap
Removal	Excavation of waste materials	Excavation of waste materials
Disposal	On-site consolidation/ disposal	On-site consolidation/ disposal
	Off-site disposal	Permitted treatment/storage/disposal facility

Selected Technologies and Process Options for Soil

General Response Action	Remedial Technology	Process Options
No Action	None	Not applicable
Institutional Controls (Land Use Controls)	Access/use restrictions	Limited site access Site development restrictions
	Monitoring	Monitoring
Containment	Capping	Single-layer cap/multilayer cap
Removal	Excavation of waste materials	Excavation of waste materials
In-Situ Treatment	Biological	Monitored natural recovery
	Biological	Enhanced biodegradation
Disposal	On-site consolidation/ disposal	On-site consolidation/disposal
	Off-site disposal	Permitted treatment/storage/disposal facility

Selected Technologies and Process Options for Sediment

General Response Action	Remedial Technology	Process Options
No Action	None	Not applicable
Institutional Controls (Land Use Controls)	Access/use restrictions	Limited site access Site development restrictions
	Monitoring	Monitoring
Containment	Capping	Single-layer cap/multilayer cap
Removal	Excavation of sediment materials	Excavation of sediment materials
Disposal	On-site consolidation/ disposal	On-site consolidation/ disposal
	Off-site disposal	Permitted treatment/storage/disposal facility

4.7 IDENTIFICATION OF REMEDIAL ACTIONS/CORRECTIVE MEASURE ALTERNATIVES FOR SITE 12

This section describes alternatives for Site 12 considering the information provided in the previous sections. Alternatives are briefly explained in this section and a detailed description and evaluation of each alternative are provided in Section 5.0.

The alternatives were developed to address the COCs and exposure pathways in order to achieve the RAOs/CAOs. The alternatives were developed to show a range of alternatives to address all contaminants that could potentially affect ecological and human receptors.

The following alternatives have been developed for Site 12:

- Alternative 1 - No Action: This alternative is developed in accordance with the NCP to provide a baseline for comparison to other alternatives.

- Alternative 2a – Monitored Natural Recovery for PAH-contaminated Soil and Excavation/ Consolidation/Capping of Contaminated Sediment and Waste Materials/Land Use Controls and Monitoring.

- Alternative 2b – Enhanced Biodegradation of PAH-contaminated Soil and Excavation/Consolidation/ Capping of Contaminated Sediment and Waste Materials/Land Use Controls and Monitoring.

- Alternative 3 – Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials/Land Use Controls and Monitoring.

- Alternative 4 – Excavation and Off-Site Disposal of Waste Materials, Soil, and Sediment (follows unrestricted land use evaluation).

These alternatives are briefly described as follows.

4.7.1 Alternative 1 - No Action

The no-action alternative would maintain the site at status quo. This alternative is retained to provide a baseline for comparison to other alternatives and, therefore, does not address the wastes present or impacted soil and sediment.

4.7.2 Alternative 2a – Monitored Natural Recovery of PAH-Contaminated Soil and Excavation/ Consolidation/Capping of Contaminated Sediment and Waste Materials/Land Use Controls and Monitoring

Alternative 2a consists of the following components:

- Monitored natural recovery of soil with concentrations of PAHs above the RGOs for the protection of ecological and human receptors.

- Excavation of waste materials in the debris pile areas and impacted soil and sediment with concentrations above the RGOs for protection of human and ecological receptors and consolidation within a designated area of Site 12.

- Installation of a low-permeability cover system over the consolidated and regraded waste materials and sediment.

- Removal and off-site disposal of oversized debris from within the debris piles.

- Restoration of the site where excavation was performed according to the restoration plan developed during the remedial design.

- Implementation of land use controls for the limits of the proposed cover and the areas of soil contaminated with PAHs, long-term monitoring of the groundwater and the PAH-contaminated soil, 5-year reviews of the site, and operation and maintenance of the cover system.

4.7.3 Alternative 2b – Enhanced Biodegradation of PAH-Contaminated Soil and Excavation/ Consolidation/Capping of Contaminated Sediment and Waste Materials/Land Use Controls and Monitoring

Alternative 2b consists of the following components:

- Enhanced biodegradation of the soil with concentrations of PAHs above the RGOs for the protection of ecological and human receptors.

- Excavation of waste materials in the debris pile areas and impacted soil and sediment with concentrations above the RGOs for protection of human and ecological receptors and consolidation within a designated area of Site 12.

- Installation of a low-permeability cover system over the consolidated and regraded soil, waste materials, and sediment.

- Removal and off-site disposal of oversized debris from within the debris piles.

- Restoration of the site where excavation was performed according to the restoration plan developed during the remedial design.

- Implementation of land use controls for the limits of the proposed cover and the areas of soil contaminated with PAHs, long-term monitoring of the groundwater and the PAH-contaminated soil, 5-year reviews of the site, and operation and maintenance of the cover system.

4.7.4 Alternative 3 – Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials/Land Use Controls and Monitoring

Alternative 3 consists of the following components:

- Excavation of waste materials in the debris pile areas and impacted soil and sediment with concentrations above the RGOs for protection of human and ecological receptors and excavation of soil contaminated with PAHs above RGOs for protection of human and ecological receptors and consolidation within a designated area of Site 12.

- Installation of a low-permeability cover system over the consolidated and regraded soil, waste materials, and sediment.

- Removal and offsite disposal of oversized debris from within the debris piles.

- Restoration of site where excavation was performed according to the restoration plan developed during the remedial design.

- Implementation of land use controls for the limits of the proposed cover, long-term monitoring of the groundwater, 5-year reviews of the site, and operation and maintenance of the cover system.

4.7.5 Alternative 4 – Excavation and Off-Site Disposal of Waste Materials, Soil, and Sediment (follows unrestricted land use evaluation)

Alternative 4 consists of the following components:

- Excavation of sediment with concentrations of inorganic chemicals and PAHs above the RGOs for protection of human and ecological receptors.

- Excavation of soil with concentrations of PAHs above the RGOs for protection of human and ecological receptors.

- Excavation of waste materials and impacted soil and sediment in the debris pile areas.

- Transportation and disposal of soil, sediment, and waste materials to approved off-site disposal facilities.

- Restoration of the site according to the restoration plan developed during the remedial design.

TABLE 4-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA
PAGE 1 OF 4

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED		
				Waste Materials	Soil	Sediment
GENERAL RESPONSE ACTION: NO ACTION						
No Action	No Action	No activities conducted to address contamination.	Required as baseline for comparison.	Yes	Yes	Yes
GENERAL RESPONSE ACTION: INSTITUTIONAL CONTROLS						
Institutional Controls (Land Use Controls)	Limited Site Access	Physical barrier (fence) used to restrict access to the site.	Physical restrictions could be effective in reducing human exposure to site contaminants. Does not reduce contaminant exposure to ecological receptors.	Yes	Yes	Yes
	Site Development Restrictions	Administrative action used to restrict future site use.	Administrative action is used to reduce human exposure to site contaminants. Does not reduce contaminant exposure to ecological receptors.	Yes	Yes	Yes
	Monitoring	Sampling and analysis of environmental media to assess contaminant migration and future environmental impacts.	Effective only to assess contaminant levels on site and migration off site. Can be used to determine if conditions are changing and to determine whether remedial actions/corrective measures are effective.	Yes	Yes	Yes
GENERAL RESPONSE ACTION: CONTAINMENT						
Soil Cover	Native Soil	Layer of native soil is placed over the contaminated media to reduce human and ecological exposure to impacted media. The soil layer also reduces migration of contaminants.	Would provide a barrier for potential human and ecological exposure pathways and reduce transport of COCs in soil to sediment and surface water. Does not comply with landfill requirements or limit vertical contaminant migration of soluble contaminants. Need to confirm waste is non-hazardous. The sediments are present in an environmentally sensitive area. Barriers placed at the site would destroy wetlands and the cover would not be permanent in the long term because of erosion.	Yes	Yes	Yes
Capping	Clay Cap/Synthetic Membrane/ Asphalt/ Concrete	Use of low permeability materials constructed over the debris piles to provide a barrier to water infiltration and also reduce direct contact with and ingestion of chemicals, as well as migration to surface water.	Would provide a barrier for potential human and ecological exposure pathways and reduce transport of COCs in soil to sediment and surface water. Would also reduce contaminant migration via infiltrating water. Groundwater is currently not significantly impacted by site contaminants. The sediments are present in an environmentally sensitive area. Barriers placed at the site would destroy the wetlands and the cover would not be permanent in the long term because of erosion.	Yes	Yes	No

TABLE 4-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED		
				Waste Materials	Soil	Sediment
Vertical Barrier	Slurry Wall	Soil/bentonite or soil/cement barriers are installed around waste area to isolate waste materials. This low permeable barrier restricts lateral contaminant migration via groundwater.	Groundwater is not significantly impacted by site contaminants.	No	No	No
Horizontal Barrier	Grout Injection	Pressure injection of cement at depth through closely spaced drill holes to reduce contaminant migration to groundwater.	Groundwater is not significantly impacted by site contaminants.	No	No	No
GENERAL RESPONSE ACTION: REMOVAL						
Dredging	Dredging	Use of mechanical, hydraulic, or pneumatic dredge to remove sediments or saturated soils.	Sufficient water is not available where the contaminants are present. Therefore, not applicable to the site.	No	No	No
Bulk Excavation	Bulk Excavation	Mechanical removal of solid materials using common construction equipment such as bulldozers and highlifts.	Not typically retained if the presumptive remedy for landfills is applied; however, it is an appropriate technology to be considered for the development of an unrestricted landuse alternative or consolidation of materials. Effective in removing contaminated soil. Effective in removing contaminated sediment; however some method must be implemented to control or dewater the sediments during excavation activities. A cofferdam system would likely need to be implemented to reduce contaminant migration during dredging.	Yes	Yes	Yes
GENERAL RESPONSE ACTION: IN-SITU TREATMENT						
Biological	Monitored Natural Recovery	In-situ degradation of organics using naturally-occuring microorganisms in an aerobic/anaerobic environment.	Potentially viable alternative for soil contaminated with PAHs only. Not applicable for waste materials or sediment inorganic contaminants.	No	Yes	No
	Enhanced Biodegradation	In-situ degradation of organics using microorganisms in an aerobic/anaerobic environment. Nutrients are added to the effected media to promote biological activity. Materials may be tilled to aerate.	Low permeability of sediment may impede distribution of nutrients and decrease the effectiveness of this technology. Also, not applicable to inorganics found in sediments and waste. Potentially viable alternative for PAH contaminated soil.	No	Yes	No

TABLE 4-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED		
				Waste Materials	Soil	Sediment
Thermal	Vitrification	Electrodes for applying electricity are used to melt contaminated media, producing a glass and crystalline structure with very low leaching characteristics and destroys organics.	High water content of soil and sediment would make vitrification or any other thermal treatment technology impractical. Not applicable for waste materials and soils found at the site.	No	No	No
Physical/ Chemical	Stabilization/ Solidification	Pressure injection or mechanical mixing of cement/pozzolanic materials to form an impermeable solid and mobilize contaminants.	Solidified/stabilized mass would be in contact with brackish surface water which may compromise the integrity of the solidified mass. Potential issues with loss of salt marsh area with stabilized mass.	No	No	No
GENERAL RESPONSE ACTION: EX-SITU TREATMENT						
Physical/ Chemical	Stabilization/ Solidification	Excavated media is mixed with cement lime, fly ash, or other pozzolanic materials to immobilize contaminants.	The leachable concentration of inorganics in sediments, wastes, and soil are too low to consider this technology. In addition, the presence of organic compounds may reduce the effectiveness of this technology.	No	No	No
	Soil Washing/ Soil Extraction	Separating hazardous contaminants from media by using an organic chemical as a solvent, therby reducing the volume of hazardous waste.	The target contaminant groups for soil washing are SVOCs, fuels, and heavy metals. The technology can be used on selected VOCs and pesticides. The technology offers the ability for recovery of metals and can clean a wide range of organic and inorganic contaminants from coarse-grained soil/sediment; however, soil washing has limited effectiveness where soil/sediment is composed of large percentages of silt and clay. Not applicable for pesticide and PCB contamination.	No	No	No
Thermal	Thermal Desorption	Application of heat at high temperature (200 to 1,000°F) to remove organics from excavated media by volatilization. Vapor phase, typically is treated by incineration or carbon adsorption.	Technology targets remediation of high concentrations of PAHs, PCBs, and pesticides. Concentrations of organics and inorganics in soil, waste, and sediment is too low to consider this technology. Requires dewatering of sediment prior to treatment.	No	No	No
	Incineration	Media is excavated and treated by on-site or off-site incinerator that employs thermal decomposition via thermal oxidation at high temperature to destroy organics.	Potentially applicable. An effective technology for PAHs, pesticides, and PCBs; however, the concentration of organics in sediment, waste, and soil is too low to consider this technology. Additional treatment may be required for inorganics. Dewatering of sediments would be required prior to treatment.	No	No	No
	Vitrification	Excavated media is melted at high temperature to form a glass and crystalline structure with very low leaching characteristics and destroys organics.	The concentration of organics in sediments, waste, and soil is too low to consider this technology. Additional treatment may be required for inorganics. Dewatering of sediments would be required prior to treatment.	No	No	No

TABLE 4-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED		
				Waste Materials	Soil	Sediment
GENERAL RESPONSE ACTION: DISPOSAL						
Disposal	On-site Consolidation/ Disposal	Media is excavated and characterized as required. Media is then disposed of/consolidated on site.	Consolidate waste from debris piles and soil/sediment impacted areas.	Yes	Yes	Yes
	Off-site Landfill	Media is excavated and characterized as required. Hazardous wastes are treated to meet either RCRA or non-RCRA treatment standards prior to land disposal. Media is then disposed of in a secure, off-site, RCRA-permitted facility.	Not typically retained if the presumptive remedy for landfills is applied; however, it is an appropriate technology to be considered for the development of an unrestricted landuse alternative.	Yes	Yes	Yes

5.0 EVALUATION OF REMEDIAL ACTION/CORRECTIVE MEASURES ALTERNATIVES

This section presents a detailed description of each remedial action/corrective measures alternative developed in Section 4.0, the rationale used to evaluate each alternative, and the results of the evaluation for each specific evaluation standard. The evaluation of alternatives is conducted in accordance with the U.S. EPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (U.S. EPA, 1988) and the RCRA Corrective Action Plan (Final) (U.S. EPA, 1994).

5.1 REMEDIAL ACTION/CORRECTIVE MEASURES ALTERNATIVES

This section describes in detail the remedial action/correctives measure alternatives developed in Section 4.0. The following alternatives have been developed for Site 12:

- Alternative 1 - No Action: This alternative is developed in accordance with the NCP to provide a baseline for comparison to other alternatives.

- Alternative 2a – Monitored Natural Recovery for PAH-contaminated Soil and Excavation/ Consolidation/Capping of Contaminated Sediment and Waste Materials/Land use Controls and Monitoring.

- Alternative 2b – Enhanced Biodegradation of PAH-contaminated Soil and Excavation/ Consolidation/Capping of Contaminated Sediment and Waste Materials/Land use Controls and Monitoring

- Alternative 3 – Excavation/Consolidation/Capping of all Contaminated Sediment, Soil, and Waste Materials/Land use Controls and Monitoring

- Alternative 4 – Excavation and Off-Site Disposal of Waste Materials, Soil, and Sediment (follows unrestricted land use evaluation per Navy guidance).

These alternatives are described in the following sections.

5.1.1 Alternative 1 - No Action

The No Action alternative maintains the site at its current level of impact and environmental condition. This alternative is retained to provide a baseline for comparison to other alternatives and, therefore, does

not address the waste materials or debris that are present or the impacted surface soil and sediment. There would be no reduction in toxicity, mobility, or volume of the COCs at Site 12 other than that which would result from natural dispersion, dilution, or other attenuating factors.

5.1.2 Alternative 2a – Monitored Natural Recovery of PAH-Contaminated Soil and Excavation/ Consolidation/Capping of Contaminated Sediment and Waste Materials/Land use Controls and Monitoring

Alternative 2a consists of the following components:

- Monitored natural biodegradation of soil at sample locations PAI-10-SS-08 and PAI-012-03 (37) with concentrations of PAHs above the RGOs for the protection of ecological receptors and human receptors.

- Excavation of sediment at sample location PAI-10-SD-08 with concentrations of inorganic chemicals above the RGOs for ecological and human receptors and consolidation of the excavated sediment within the limits of the proposed cap system.

- Excavation of waste materials, soil, and sediment from the debris piles and consolidation of the material within a designated area of Site 12.

- Installation of a low-permeability cap system over the consolidated and regraded waste materials, soil, and sediment.

- Use of slope stabilization and erosion controls.

- Excavation and off-site disposal of oversized materials from the debris piles.

- Restoration of debris pile areas and sample locations where excavation was performed according to the restoration plan developed during the remedial design

- Implementation of land use controls for the limits of the proposed cap and the areas of soil contaminated with PAHs, long-term monitoring of the groundwater and the PAH-contaminated soil, 5-year review of the site, and operation and maintenance of the cap system.

Alternative 2a applies the presumptive remedy for landfills. A conceptual design of the alternative is presented in Figure 5-1. The figure depicts the location of the consolidation and cap area, as well as the

estimated limits of the natural biodegradation of soil and of the excavation of sediment and waste materials. The details of each of the components of this alternative are presented below:

Component 1 – Monitored natural recovery (biodegradation) of PAHs in soil at sample locations PAI-10-SS-08 and PAI-012-03 (37) with concentrations above the RGOs for the protection of ecological and human receptors

Soils that have concentrations of PAHs above the RGOs for protection of ecological and human receptors (0.7 acres, 1,667 cubic yards) would be left in place under Alternative 2a. These contaminants would be allowed to naturally degrade. The monitoring of this process would be part of the long-term monitoring and assessment activities. Final attainment of PAH RGOs might take 10 to more than 30 years, although degradation trends should be confirmable within 3 to 5 years. It is anticipated that soils would be tested annually. The following table is a summary of PAH half-life values in soil:

PAH Compound	Half-Life in Days
Naphthalene	108
Acenaphthylene	42.5 – 60
Acenaphthene	15 – 102
Anthracene	3.3 – 175 days
Fluorene	NA
Phenanthrene	2.5 – 26
Benzo(a)anthracene	4 – 6,250
Chrysene	371 – 1000
Fluoranthene	44 – 182
Pyrene	0.125 – 1.46
Benzo(a)pyrene	2 – 693
Benzo(b)fluoranthene	360 – 610
Benzo(k)fluoranthene	910 – 2,140
Dibenzo(a,h)anthracene	NA
Benzo(g,h)perylene	590 – 650
Indeno(1,2,3-cd)pyrene	NA

Source: Mackay, D., Shiu, W.Y., & Ma, K.C. Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals – PAHs, Polychlorinated Dioxins, and Dibenzofurans. 1992.
NA = Not Available

Component 2 - Excavation of sediment at sample location PAI-10-SD-08 with concentrations of inorganic chemicals above the RGOs for ecological and human receptors and consolidation of the excavated sediment within the limits of the proposed cap system

Sediments would be excavated to an average depth of approximately 1 foot to the horizontal extent indicated on Figure 5-1. Actual excavation depths may vary depending on the results of the verification sampling. It is estimated that approximately 372 cubic yards of sediment would require excavation under Alternative 2a at sample location PAI-10-SD-08 (Area 4, see Appendix A). The sediment excavation would also include the removal of any visible waste and debris in the area. Sediments impacted with inorganic chemicals that have concentrations above the RGOs for protection of human and ecological receptors would be excavated. Excavation equipment would consist of clam shells, bulldozers, or highlifts.

A temporary cofferdam system (e.g., Water Structures® or Portadam®) would be installed along the southeastern portion of the site below sediment sample location PAI-10-SD-08 to the hummock (Figure 5-1) to eliminate daily flooding of the area due to the tidal cycle. These structures are relatively easy to install and remove, and they would have generally no long-term impacts on the marsh. Some of the factors that should be considered during selection of the temporary cofferdam system include the following: depth of water to be retained, wave height, wave action, bedding material, length of system, time system will be required, and the potential for storm events. The cofferdam system would be installed and removed once during the excavation activities.

Over-excavation of sediment may be performed as a value engineering decision in order to minimize the potential for extensive and repeated sampling and excavation cycles. After the initial excavation is completed, verification sampling and laboratory analysis would be completed to ensure that material above the ecological RGO criteria was removed. This verification sampling would be performed prior to completion of the cap system to allow for additional excavation and consolidation, if required. A post-removal assessment would be performed after sediment and consolidation of the materials within the cap system. The ecological and human health RGOs would be used to confirm that any residual impacted materials remaining would not pose an unacceptable risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining sediment.

Excavated sediment would be transported and consolidated within the limits of the proposed cap system. The sediment may have to be dewatered and/or mixed with waste materials, soils, or other binding agents to improve stability.

Approximately 1.5 acres of wetlands would be restored under this alternative.

Component 3 - Excavation of waste materials, soil, and sediment from the debris piles and consolidation of the material within a designated area of Site 12

Similar to the excavated sediment in component 2, any soil/waste or sediment/waste material from the debris piles would be excavated and consolidated to areas within the cap system. The consolidation area would be located on an upgradient portion of the island so that flooding concerns would be minimized. An estimated 2,286 cubic yards of sediment/waste and soil/waste would require excavation and consolidation under Alternative 2a. Post-excavation sampling would be performed and the data used in a post-removal assessment. This sampling would be performed prior to the cap system completion to allow for additional excavation and consolidation, if required. The expected depth of excavation from the debris piles would be approximately 1 foot. All existing monitoring wells that are located on Jericho Island would be properly abandoned prior to excavation.

Component 4 – Installation of a low-permeability cover system over the consolidated and regraded waste materials, soil, and sediment

A low-permeability cap system that meets or exceeds the requirements of the Federal and state solid waste and hazardous waste landfill closure requirements would be placed over approximately 1.4 acres of consolidated and graded waste, soil, and sediment materials. The cover may consist of components similar to those shown on Figure 5-2. These components, from the waste materials up, are as follows:

- Intermediate cover/gas collection layer (12 inches)
- Geosynthetic clay liner
- Geomembrane liner
- Geosynthetic drainage layer
- Cover soil (18 inches)
- Vegetative layer (6 inches)

In lieu of a low-permeability cap system (e.g., RCRA cap), another consideration for a cover system would be one consisting of a 6-inch biotic layer of crushed gravel, an 18-inch layer of native soil, and a 6-inch topsoil layer (e.g., a RCRA D cap). However, for the purposes of analysis in this FS/CMS, the low-permeability cap system will be assumed.

The cap system would be placed over waste and impacted soil and sediment to eliminate the potential for human and ecological exposure. The system would also eliminate the migration of waste and impacted soil and sediment to surface water and groundwater due to surface water runoff, wind, tidal influence, and infiltration. The permeability of the cap system would be 1×10^{-7} cm/sec.

The available groundwater data do not show any significant impacts; therefore, a component was not included to address groundwater containment. If groundwater containment is determined to be necessary because of the results of the groundwater monitoring program, a contingency plan would be to install sumps within the interior of the cap to allow for pumping of groundwater and an impermeable vertical barrier along the outline of the final cap system. A treatment system would also be necessary to treat the groundwater that is removed from the sumps.

Landfill gas generation may be possible at the site; however, gas formation is expected to be minimal. Therefore, as a good engineering practice, the cap design would incorporate a minimum passive gas venting system (i.e., one vent per acre).

Slope stability analysis of the proposed cap system would be performed during the design of the cap. Issues that would need to be addressed in the cap design include stability and placement of sediments within the cap and consolidation of the underlying salt marsh soils.

The need for a biotic barrier should also be evaluated during the design of the cap. The type of animals present at MCRD Parris Island and their burrowing habits would be considered during the design. Typically, a biotic barrier would consist of a layer of cobbles or coarse gravel beneath the top layer of the cap system.

Component 5 – Use of slope stabilization and erosion controls

Slope stabilization and erosion control measures would be implemented along the sideslopes of the cover system to minimize the potential for failure of the sideslopes and to reduce the erosion rate of the cover due to surface water runoff and/or wind. Rip-rap would be installed along the side slopes to an approximate high, high-water elevation of 8 feet. The proposed location for consolidation shown on Figure 5-1 is 8 feet above mean sea level (msl) and rip-rap would therefore not be required. The 100-year flood elevation in this area is 15 feet above msl.

Component 6 - Excavation and off-site disposal of oversized materials from the debris piles

Oversized materials from the debris piles that would not be practical to be placed in the consolidation area would be excavated, characterized, and disposed off-site as required.

Component 7 – Restoration of debris pile areas and sample locations where excavation was performed

In accordance with the restoration plan developed during the remedial design, the debris pile areas would be restored to match grades with backfill material. The areas would be vegetated. Areas where sediment is removed from the marsh will be restored by filling with a clean sand material and revegetating. The sediment in the area would be temporarily stabilized to minimize erosion.

Contingencies for the salt marsh restoration may be considered that would be enacted based on inadequate vegetative establishment or re-establishment of soil conditions. Also, if verification testing indicates that residual sediment contamination remains, covering with soils may be considered to provide a barrier to reduce contact with contaminated sediment.

Component 8 – Implementation of land use controls, long-term monitoring, 5-year reviews, and operation and maintenance

Land use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the material consolidated under the cover system (e.g., dig restrictions), to restrict access to areas with PAH-contaminated soil, to prevent residential development of the site, and to ban the use of the groundwater as a drinking water supply. A gate would be placed at the dirt road entrance to Jericho Island to prohibit unauthorized vehicles and fencing would be placed around the consolidated material. Signs would be posted to alert users of the property about the presence of the SWMU.

A system of four new groundwater monitoring well clusters (shallow/deep) would be installed after completion of the cover system to allow for long-term groundwater monitoring. For the first year after completion of the remedial actions, quarterly groundwater sampling and inspections of the new cover system would be performed to ensure the integrity and effectiveness of the system and slope stabilization and erosion control measures. After the first year, the groundwater and the cover system would be monitored annually. Areas of soil contaminated with PAHs would be monitored annually to evaluate natural attenuation processes. A total of 24 soil samples would be collected during each sampling event. Sampling and inspection results would be reported to the regulatory agencies annually.

Because waste would be left on site under this alternative, unrestricted reuse of the site would not be allowed. A re-evaluation of the site would be performed every 5 years to determine whether changes to the land use controls, monitoring, and/or remedial action would be required.

Operation and maintenance may be required to prevent erosion of the cover system and to maintain the integrity. Routine inspection and vegetative maintenance of the cover system, perimeter areas and condition of slope protection, restored excavation areas, and other activities will be performed, and occasional repairs to the cover system and stabilization protection may be needed.

5.1.3 Alternative 2b – Enhanced Biodegradation of PAH-Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials/ Land use Controls and Monitoring

Alternative 2b consists of the following components:

- Enhanced biodegradation of the soil at sample locations PAI-10-SS-08 and PAI-012-03 (37) with concentrations of PAHs above the RGOs for the protection of ecological and human receptors.

- Excavation of sediment at sample location PAI-10-SD-08 with concentrations of inorganic chemicals above the RGOs for ecological and human receptors and consolidation of the excavated sediment within a designated area of Site 12.

- Excavation of waste materials, soil, and sediment from the debris piles and consolidation of the material within the limits of the proposed cap system.

- Installation of a low-permeability cap system over the consolidated and regraded waste materials, soil, and sediment.

- Use of slope stabilization and erosion controls.

- Excavation and off-site disposal of oversized materials from the debris piles.

- Restoration of debris pile areas and sample locations where excavation was performed according to the restoration plan developed during the remedial design.

- Implementation of land use controls for the limits of the proposed cap and the areas of soil contaminated with PAHs, long-term monitoring of the groundwater and the PAH-contaminated soil, 5-year review of the site, and operation and maintenance of the cap system.

Alternative 2b applies the presumptive remedy for landfills. A conceptual design of the alternative is presented in Figure 5-3. The figure depicts the location of the consolidation area and proposed cap

system, as well as the location of the enhanced biodegradation and the estimated limits of excavation of sediment and waste materials. The details of each of the components of this alternative are presented below:

Component 1 - Enhanced biodegradation of the soil at sample locations PAI-10-SS-08 and PAI-012-03 (37) with concentrations of PAHs above the RGOs for the protection of ecological and human receptors

In the area of sample locations PAI-10-SS-08 and PAI-012-03 (Figure 5-3), enhanced biodegradation would be used to aid in the degradation of the PAH concentrations (0.7 acres, 1,667 cubic yards). Clearing and grubbing of the area would be completed. Examples of enhanced biodegradation activities would be tilling the soil in the area of the high PAH concentrations and mixing the soil with manure to aid in the degradation process. The half-lives for PAH degradation in solid-phase treatment (i.e., land farming, composting, etc.) have been established for specific PAHs. Final attainment of PAH RGOs might take in excess of 5 years, although degradation trends should be confirmable within 1 to 3 years. It is anticipated that soils would be tested semiannually for the first year and annually thereafter. Once attainment is achieved the areas would be revegetated. The following table illustrates these rates:

PAH Compound	Half Life in Days
Naphthalene	10 – 45
Acenaphthylene	1 - 200
Acenaphthene	30 – 70
Anthracene	21 – 41
Fluorene	30 – 45
Phenanthrene	25 – 45
Benzo(a)anthracene	100 – 120
Chrysene	100 – 125
Fluoranthene	61 – 80
Pyrene	62 – 82
Benzo(a)pyrene	30 – 80
Benzo(b)fluroanthene	130 – 150
Benzo(k)fluoranthene	110 – 130
Dibenzo(a,h)anthracene	165 – 175
Benzo(g,h)perylene	145 – 160
Indeno(123-cd)pyrene	70 – 90

Source: Cookson, John T., Jr. Bioremediation Engineering Design and Application. 1995.

Component 2 - Excavation of sediment at sample location PAI-10-SD-08 with concentrations of inorganic chemicals above the RGOs for ecological and human receptors and consolidation of the excavated sediment within the limits of the proposed cap system

Sediments would be excavated to an average depth of approximately 1 foot to the horizontal extent indicated on Figure 5-3. Actual excavation depths may vary depending on the results of the verification sampling. An estimated 372 cubic yards of sediment would require excavation under Alternative 2a at sample location PAI-10-SD-08 (Area 4, see Appendix A). The sediment excavation would also include the removal of any visible waste and debris in the area. Sediments impacted with inorganic chemicals that have concentrations above the RGOs for protection of human and ecological receptors would be excavated.

A temporary cofferdam system (e.g., Water Structures® or Portadam®) would be installed along the southeastern portion of the site below sediment sample location PAI-10-SD-08 to the hummock (Figure 5-3) to eliminate daily flooding of the area due to the tidal cycle. These structures are relatively easy to install and remove, and they would have generally no impacts on the marsh. Some of the factors that should be considered during selection of the temporary cofferdam system include: depth of water to be retained, wave height, wave action, bedding material, length of system, time the system would be required, and the potential for storm events. The cofferdam system would be installed and removed once during the excavation activities.

Over-excavation of sediment may be performed as a value engineering decision in order to minimize the potential for extensive and repeated sampling and excavation cycles. After the initial excavation is completed, verification sampling and laboratory analysis would be completed to ensure that material above the ecological RGO criteria was removed. This verification sampling would be performed prior to completion of the cap system to allow for additional excavation and consolidation, if required. A post-removal assessment would be performed after sediment and consolidation of the materials within the cap system. The ecological and human health RGOs would be used to confirm that any residual impacted materials remaining would not pose an unacceptable risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining sediment.

Excavated sediment would be transported and consolidated within the limits of the proposed cap system. The sediment may have to be dewatered and/or mixed with waste materials, soils, or other binding agents to improve stability.

Approximately 1.5 acres of wetlands would be restored under this alternative.

Component 3 - Excavation of waste materials, soil, and sediment from the debris piles and consolidation of the material within a designated area of Site 12

Similar to the excavated sediment in Component 2, any soil/waste or sediment/waste material from the debris piles would be excavated and consolidated to areas within the cap system. The consolidation area would be located on an upgradient portion of the island so that flooding concerns would be minimized. An estimated 2,286 cubic yards of sediment/waste and soil/waste would require excavation and consolidation under Alternative 2a. Post-excavation sampling would be performed and the data used in a post-removal assessment. This sampling would be performed prior to the cap system completion to allow for additional excavation and consolidation, if required. The expected depth of excavation from the debris piles is approximately 1 foot. All existing monitoring wells that are located on Jericho Island would be properly abandoned prior to excavation.

Component 4 – Installation of a low-permeability cover system over the consolidated and regraded waste materials, soil, and sediment

A low-permeability cap system that meets or exceeds the requirements of the Federal and state solid waste and hazardous waste landfill closure requirements would be placed over approximately 1.4 acres of consolidated and graded waste, soil, and sediment materials. The cover may consist of components similar to those shown on Figure 5-2. These components, from the waste materials up, are as follows:

- Intermediate cover/gas collection layer (12 inches)
- Geosynthetic clay liner
- Geomembrane liner
- Geosynthetic drainage layer
- Cover soil (18 inches)
- Vegetative layer (6 inches)

In lieu of a low-permeability cap system (e.g., RCRA C cap), another consideration for a cover system would be one consisting of a 6-inch biotic layer of crushed gravel, an 18-inch layer of native soil, and a 6-inch topsoil layer (e.g., a RCRA D cap). However, for the purposes of analysis in the FS/CMS, the low-permeability cap system will be assumed.

The cap system would be placed over waste and impacted soil and sediment to eliminate the potential for human and ecological exposure. The system would also eliminate the migration of waste and impacted soil and sediment to surface water and groundwater due to surface water runoff, wind, tidal influence, and infiltration. The permeability of the cap system would be 1×10^{-7} cm/sec.

The available groundwater data do not show any significant impacts; therefore, a component was not included to address groundwater containment. If groundwater containment is determined to be necessary because of the results of the groundwater monitoring program, a contingency plan would be to install sumps within the interior of the cap to allow for pumping of groundwater and an impermeable vertical barrier along the outline of the final cap system. A treatment system would also be necessary to treat the groundwater that is removed from the sumps.

Landfill gas generation may be possible at the site; however, gas formation is expected to be minimal. Therefore, as a good engineering practice, the cap design would incorporate a minimum passive gas venting system (i.e., one vent per acre).

Slope stability analysis of the proposed cap system would be performed during the design of the cap. Issues that would need to be addressed in the cap design include stability and placement of sediments within the cap and consolidation of the underlying salt marsh soils.

The need for a biotic barrier should also be evaluated during the design of the cap. The type of animals present at MCRD Parris Island and their burrowing habits would be considered during the design. Typically, a biotic barrier would consist of a layer of cobbles or coarse gravel beneath the top layer of the cap system.

Component 5 – Use of slope stabilization and erosion controls

Slope stabilization and erosion control measures would be implemented along the sideslopes of the cover system to minimize the potential for failure of the sideslopes and to reduce the erosion rate of the cover due to surface water runoff and/or wind. Rip-rap would be installed along the side slopes to an approximate high, high-water elevation of 8 feet. The proposed location for consolidation shown on Figure 5-3 is above 8 feet mean sea level (msl) and rip-rap would therefore not be required. The 100-year flood elevation in this area is 15 feet.

Component 6 - Excavation and off-site disposal of oversized materials from the debris piles

Oversized materials from the debris piles that would not be practical to be placed in the consolidation area would be excavated, characterized, and disposed off-site as required.

Component 7 – Restoration of debris pile areas and sample locations where excavation was performed

In accordance with the restoration plan developed during the remedial design, the debris pile areas would be restored to match grades with backfill material. The areas would be vegetated. Areas where sediment is removed from the marsh will be restored by filling with a clean sand material and revegetating. The sediment in the area would be temporarily stabilized to minimize erosion.

Contingencies for the salt marsh restoration may be considered that would be enacted based on inadequate vegetative establishment or re-establishment of soil conditions. Also, if verification testing indicates that residual sediment contamination remains, covering with soils may be considered to provide a barrier to reduce contact with contaminated sediment.

Component 8 – Implementation of land use controls, long-term monitoring, 5-year reviews, and operation and maintenance

Land use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the material consolidated under the cover system (e.g., dig restrictions), to restrict access to areas with PAH-contaminated soil, to prevent residential development of the site, and to ban the use of the groundwater as a drinking water supply. A gate would be placed at the dirt road entrance to Jericho Island to prohibit unauthorized vehicles and fencing would be placed around the consolidated material. Signs would be posted to alert users of the property about the presence of the SWMU.

A system of four new groundwater monitoring well clusters (shallow/deep) would be installed after completion of the cover system to allow for long-term groundwater monitoring. For the first year after completion of the remedial actions, quarterly groundwater sampling and inspections of the new cover system would be performed to ensure the integrity and effectiveness of the system and of the slope stabilization and erosion control measures. After the first year, the groundwater and the cover system would be monitored annually. Areas of soil contaminated with PAHs would be monitored annually to evaluate natural attenuation processes. A total of 24 soil samples would be collected during each sampling event. Sampling and inspection results would be reported to the regulatory agencies annually.

Because waste would be left on site under this alternative, unrestricted reuse of the site would not be allowed. A re-evaluation of the site would be performed every 5 years to determine whether changes to the land use controls, monitoring, and/or remedial action would be required.

Operation and maintenance may be required to prevent erosion of the cover system and to maintain the integrity. Routine inspection and vegetative maintenance of the cover system, perimeter areas, and condition of slope protection, restored excavation areas, and other activities will be performed, and occasional repairs to the cover system and stabilization protection may be needed.

5.1.4 Alternative 3 – Excavation/Consolidation/Capping of all Contaminated Sediment, Soil, and Waste Materials/Land use Controls and Monitoring

Alternative 3 consists of the following components:

- Excavation of waste materials in all areas and impacted soil and sediment with concentrations of inorganic compounds, pesticides, and PAHs above the RGOs for the protection of ecological and human receptors; excavation of soil contaminated with PAHs above RGOs for protection of human and ecological receptors; and consolidation within a designated area of Site 12.

- Installation of a low-permeability cover system over the consolidated and regraded soil, waste materials, and sediments.

- Use of slope stabilization and erosion controls.

- Removal and off-site disposal of oversized debris.

- Restoration of the site where excavation was performed according to the restoration plan developed during the remedial design.

- Implementation of land use controls for the limits of the proposed cover, long-term monitoring of the groundwater, 5-year reviews of the site, and operation and maintenance of the cover system.

Alternative 3 constitutes the application of the presumptive remedy for landfills. A conceptual design of the alternative is presented in Figure 5-4. The figure depicts the area for consolidation and installation of the proposed cap system, as well as the estimated limits of excavation of waste, soil, and sediment material. The details of each of the components of this alternative are presented below:

Component 1 – Excavation of waste materials in all areas and impacted soil and sediment with concentrations of inorganic compounds, pesticides, and PAHs above the RGOs for protection of ecological and human receptors; and excavation of soil contaminated with PAHs above RGOs for

protection of human and ecological receptors; and consolidation within a designated area of Site 12

Sediment and waste materials would be excavated to a depth of approximately 1 foot to the horizontal extent indicated on Figure 5-4. In addition, soil would be excavated to a depth of approximately 1 foot at location PAI-012-03 and approximately 2 feet at location PAI-10-SS-08. Actual excavation depths may vary depending on the results of the verification sampling. An estimated 4,325 cubic yards of contaminated soil, sediment, and waste materials would require excavation under Alternative 3 (see Appendix A). The waste material excavation would also include the removal of any visible waste and debris in the area. Sediments impacted with concentrations of inorganics that have concentrations above the RGOs for ecological and human receptors would be excavated (PAI-10-SD-08). Soil impacted with concentrations of PAHs above RGOs for ecological and human health receptors would be excavated (PAI-10-SS-08 and PAI-012-03). All existing monitoring wells that are located on Jericho Island would be properly abandoned prior to excavation.

A temporary cofferdam system (e.g., Water Structures® or Portadam®) would be installed around the sediment excavation area to eliminate daily flooding of the areas due to the tidal cycle. These structures are relatively easy to install and remove and they would have generally no impacts on the marsh. Some of the factors that should be considered during selection of the temporary cofferdam system include the following: depth of water to be retained, wave height, wave action, bedding material, length of system, time the system would be required, and the potential for storm events. The cofferdam system would be installed and removed once during excavation activities.

Over-excavation of sediment may be performed as a value engineering decision in order to minimize the potential for extensive and repeated sampling and excavation cycles. After the initial excavation is completed, verification sampling and laboratory analysis would be completed to ensure that material above the ecological and human health RGOs was removed. This verification sampling would be performed prior to the cap system completion to allow for additional excavation and consolidation, if required. A post-removal assessment would be performed after sediment and waste excavation and consolidation of the materials within the cap system. The ecological and human health RGOs would be used to confirm that any residual impacted materials remaining would not pose a risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining sediments.

Excavated soil, sediment, and waste materials would be transported and consolidated at the proposed area for the cap system. The consolidation area would be located on an upgradient portion of the island so that flooding concerns would be minimized. The cap system design may consider the placement of the sediment within a confined location away from the sideslopes of the landfill to maintain the stability of

the cap. The sediments may have to be dewatered and/or mixed with waste materials, soils, or other binding agents to improve stability.

Approximately 1.5 acres of wetlands would be restored under this alternative.

Component 2 – Installation of a low-permeability cap system over the consolidated and regraded soil, waste materials and sediments

A low-permeability cap system that meets or exceeds the requirements of the Federal and state solid waste and hazardous waste landfill closure requirements would be placed over the 2.1 acres of consolidated and graded waste and soil and sediment materials. The cover may consist of components similar to those shown on Figure 5-2. These components, from the waste materials up, are as follows:

- Intermediate cover/gas collection layer (12 inches)
- Geosynthetic clay liner
- Geomembrane liner
- Geosynthetic drainage layer
- Cover soil (18 inches)
- Vegetative layer (6 inches)

In lieu of a low-permeability cap system (e.g., RCRA C cap), another consideration for a cover system would be one consisting of a 6-inch biotic layer of crushed gravel, an 18-inch layer of native soil, and a 6-inch topsoil layer (e.g., a RCRA D cap). However, for the purposes of analysis in this FS/CMS, the low-permeability cap system will be assumed.

Land use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the material consolidated under the cover system (e.g., dig restrictions), to restrict access to areas with PAH-contaminated soil, to prevent residential development of the site, and to ban the use of the groundwater as a drinking water supply. A gate would be placed at the dirt road entrance to Jericho Island to prohibit unauthorized vehicles and fencing would be placed around the consolidated material. Signs would be posted to alert users of the property about the presence of the SWMU.

The cap system would be placed over waste and impacted soil and sediment to eliminate the potential for human and ecological exposure. The system would also eliminate the migration of waste and impacted sediment to surface water and groundwater due to surface water runoff, wind, tidal influence, and infiltration. The permeability of the cap system would be 1×10^{-7} cm/sec.

The available groundwater data do not show any significant impacts; therefore, a component was not included to address groundwater containment. If groundwater containment is determined to be necessary because of the results of the groundwater monitoring program, a contingency plan would be to install sumps within the interior of the cap to allow for pumping of groundwater and an impermeable vertical barrier along the sideslopes of the final cap system. A treatment system would also be necessary to treat the groundwater that is removed from the sumps. Furthermore, due to the limited groundwater data available, the design of the cap should investigate the possible influence and gradient of groundwater flow through the site.

Gas generation may be possible at the site; however, gas formation is expected to be minimal. However, as a good engineering practice, the cap design would incorporate a minimum passive gas venting system (i.e., one vent per acre).

Slope stability analysis of the proposed cap system would be performed during the design of the cap. Issues that would need to be addressed in the cap design include stability and placement of sediments within the cap and consolidation of the underlying salt marsh soils.

The need for a biotic barrier should also be evaluated during the design of the cap. The types of animals present at MCRD Parris Island and their burrowing habits would be considered during the design. Typically, a biotic barrier would consist of a layer of cobbles or coarse gravel beneath the top layer of the cap system.

Additionally, if it is determined through leach testing that the waste material is not leachable a 2 foot soil cover may be evaluated for the containment instead of the low permeability portion of the cover system. Appendix B contains the cost of this alternative (3a) which includes only a soil cover. Groundwater monitoring would be evaluated to determine if contamination is detected after placement of the cover. If contamination is detected, the low permeability components would need to be included.

Component 3 – Use of slope stabilization and erosion controls

Slope stabilization and erosion control measures would be implemented along the sideslopes of the cover system to minimize the potential for failure of the sideslopes and to reduce the erosion rate of the cover due to surface water runoff, waves, and/or wind. Rip-rap would be installed along the side slopes to an approximate high, high-water elevation of 8 feet. The proposed location for consolidation shown on Figure 5-4 is above 8 feet mean sea level (msl) and rip-rap would therefore not be required. The 100-year flood elevation in this area is 15 feet.

Component 4 – Removal and off-site disposal of oversized debris.

Oversized materials that would not be practical to place in the consolidation area would be excavated, characterized, and disposed off site as required.

Component 5 – Restoration of site where excavation was performed

In accordance with the restoration plan developed during the remedial design, excavated areas would be restored to match grades with backfill material. The areas would be vegetated. Areas where sediment is removed from the marsh will be restored by filling with a clean sand material and re-vegetating. The sediment in the area would be temporarily stabilized to minimize erosion.

Contingencies for the salt marsh restoration may be considered that would be enacted based on inadequate vegetative establishment or re-establishment of soil conditions. Also, if verification testing indicates that residual sediment contamination remains, covering with soils may be considered to provide a barrier to reduce contact with contaminated sediment.

Component 6 – Implementation of land use controls, long-term monitoring, 5-year reviews, and operation and maintenance

Land use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the material consolidated under the cover system (e.g., dig restrictions), to prevent residential development of the site, and to ban the use of the groundwater as a drinking water supply. A gate would be placed at the dirt road entrance to Jericho Island to prohibit unauthorized vehicles and fencing would be placed around the consolidated material. Signs would be posted to alert users of the property about the presence of the landfill.

A system of 4 new groundwater monitoring well clusters (shallow/deep) would be installed after installation of the cap to allow for long-term groundwater monitoring. Any existing monitoring wells that are located within these areas would be properly abandoned prior to excavation. For the first year after completion of the remedial actions, quarterly groundwater sampling and inspections of the cap would be performed to ensure the integrity and effectiveness of the cap system and slope stabilization and erosion control measures. After the first year, the groundwater and the cap system would be monitored annually. Sampling and inspection results would be reported to the regulatory agencies annually.

Because waste would be left on site under this alternative, unrestricted reuse of the site would not be allowed. A re-evaluation of the site would be performed every 5 years to determine whether changes to the land use controls, monitoring, and/or remedial action would be required.

Operation and maintenance may be required to prevent cap erosion and to maintain the integrity of the cap system. Routine inspection and vegetative maintenance of the cap system, perimeter areas and condition of slope protection, restored salt marsh areas, and other activities would be performed, and occasional repairs to the cap system and toe stabilization protection may be needed.

5.1.5 Alternative 4 – Excavation and Off-Site Disposal of Waste Materials, Soil, and Sediment (follows unrestricted land use evaluation).

Alternative 4 allows for the unrestricted use of the site after completion of the remedial actions. Alternative 4 consists of the following components:

- Excavation of sediments with concentrations of inorganics compounds above the RGOs for ecological and human receptors.
- Excavation of soil with concentrations of PAHs above the RGOs for ecological and human receptors.
- Excavation of waste materials and impacted soil/sediment in the debris pile areas above RGOs for ecological and human receptors.
- Transportation and disposal of soil, sediment, and waste materials to approved off-site disposal facilities.
- Restoration of the site according to the restoration plan developed during the remedial design.

A conceptual design of the alternative is presented in Figure 5-5. The figure depicts the limits of the excavation of soil, sediment, and waste materials. The details of each of the components of this alternative are presented below:

Component 1 – Excavation of sediments with concentrations of inorganic compounds above the RGOs for protection of ecological and human receptors

Similar to the containment alternatives, sediments would be excavated to a depth of approximately 1 foot to the horizontal extent indicated on Figure 5-5 at PAI-10-SD-08. Actual excavation depths may vary depending on the results of the verification sampling. An estimated 372 cubic yards of sediment would

require excavation under Alternate 4 (see Appendix A). The sediment excavation would also include the removal of any visible waste/debris in the area. All existing monitoring wells that are located on Jericho Island would be properly abandoned prior to excavation.

Similar in extent to Alternative 2 and 3, sediments impacted with concentrations of inorganics that have concentrations above the RGOs for ecological and human receptors would be excavated.

A temporary cofferdam system (e.g., Water Structures® or Portadam®) would be installed along the southeastern portion of the site below sediment sample location PAI-10-SD-08 to the hummock (Figure 5-5) to eliminate daily flooding of the areas due to the tidal cycle. These structures are relatively easy to install and remove, and they would have generally no impacts on the marsh. Some of the factors that should be considered during selection of the temporary cofferdam system include depth of water to be retained, wave height, wave action, bedding material, length of system, time the system would be required, and the potential for storm events. The cofferdam system would be installed and removed once after all excavation activities are completed.

Over-excavation of sediment may be performed as a value engineering decision in order to minimize the potential for extensive and repeated sampling and excavation cycles. After the initial excavation is completed, verification sampling and laboratory analysis would be completed to ensure that material above the ecological and human health RGOs was removed. A post-removal assessment would be performed after sediment and waste excavation and disposal of the materials. The ecological and human health RGOs would be used to confirm that any residual impacted materials remaining would not pose a risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining sediments.

Excavated sediment would be loaded and transported to an appropriate off-site disposal facility. It is assumed that the sediment would require dewatering on site prior to loading and transport to the off-site facility. A dewatering pad and loadout area may be incorporated into the site plans.

Approximately 1.6 acres of wetlands would be restored under this alternative.

Component 2 – Excavation of soils with concentrations of PAHs

All PAH-contaminated soil at Site 12 would be excavated and transported with the excavated waste materials to an appropriate off-site disposal facility. An estimated 1,667 cubic yards of PAH-contaminated soil would be excavated and disposed off site under Alternative 4. Post-excavation sampling would be performed and the data would be used in a post-removal assessment. The expected depth of soil

excavation is 1 foot at PAI-012-03 (37) and approximately 2 feet at PAI-10-SS-08. All existing monitoring wells that are located within these areas would be properly abandoned prior to excavation.

Similar to Component 1, a temporary cofferdam system may need to be installed while excavation activities occur in the vicinity of PAI-012-03 (37) to eliminate daily flooding of the areas due to the tidal cycle. Some of the factors that should be considered during selection of the temporary cofferdam system include: depth of water to be retained, wave height, wave action, bedding material, length of system, time the system would be required, and the potential for storm events. The cofferdam system would be installed and removed once during all excavation activities.

Component 3 – Excavation of waste materials in the debris pile areas and of impacted soil and sediment

All waste materials and oversized debris would be excavated and transported to an appropriate off site disposal facility. An estimated 2,286 cubic yards of waste materials would be excavated and disposed off site under Alternative 4. The estimated depth of excavation is 1 foot with an additional 20 percent of volume for material above the surface. Any existing monitoring wells that are located within these areas would be properly abandoned prior to excavation.

Similar to Component 1, a temporary cofferdam system may need to be installed while excavation activities occur in the vicinity of the debris piles to eliminate daily flooding of the areas due to the tidal cycle. Some of the factors that should be considered during selection of the temporary cofferdam system include depth of water to be retained, wave height, wave action, bedding material, length of system, time the system would be required, and the potential for storm events. The cofferdam system would be installed and removed once during all excavation activities.

Component 4 – Transportation and disposal of soil, sediment, and waste materials to approved off-site disposal facilities

All excavated sediments and waste material would be loaded and transported to an approved off-site disposal facility. The transportation would require approximately 608 truck loads (10-ton truck loads). It is assumed that the sediment and some waste material will require dewatering on-site prior to loading and transport to the off site facility. A dewatering pad and loadout area may be incorporated into the site plans. Characterization of soil, sediment, and waste material would be required prior to disposal. It was assumed that 90 percent of the material would be non hazardous and 10 percent would be hazardous.

Component 5 – Restoration of site

In accordance with the restoration plan developed during the remedial design, the debris pile areas would be restored to match grades with backfill material. The areas would be vegetated. Areas where sediment is removed from the marsh would be restored by filling with a clean sand material and re-vegetated. The sediment in the area would be temporarily stabilized to minimize erosion. As part of site restoration activities, existing monitoring wells would also be abandoned in accordance with the State of South Carolina monitoring well regulations (R.61-71).

One year of surveillance and maintenance would be conducted to ensure adequate re-establishment of vegetation and soil conditions. Contingencies for the salt marsh restoration may be considered that would be enacted based on observations obtained from this surveillance. Also, if verification testing indicates that residual sediment contamination remains, covering with soils may be considered to provide a barrier to reduce contact with contaminated sediment.

5.2 CRITERIA FOR DETAILED ANALYSIS

The following criteria will be used for the detailed analysis for each alternative:

1. Overall protection of human health and the environment
2. Compliance with ARARs/media cleanup standards
3. Source control
4. Waste management standards
5. Other factors (long-term reliability and effectiveness; reduction in toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost)
6. State and U.S. EPA acceptance
7. Community acceptance

The first five criteria are specifically addressed in this FS/CMS. State and U.S. EPA acceptance will be evaluated after the state of South Carolina and U.S. EPA Region 4 have reviewed and commented on the draft FS/CMS Report. Community acceptance will be addressed in the Record of Decision/Response To Comments that will be finalized after the public comment period for the FS/CMS and Proposed Plan/Statement of Basis. State, U.S. EPA, and community acceptance must be considered during remedy selection. The following contains a description of each of the evaluation criteria.

5.2.1 Overall Protection of Human Health and the Environment

The purpose of this evaluation criterion is to assess whether each alternative provides adequate protection of human health and the environment. Evaluation of the overall protectiveness of an alternative focuses on whether a specific alternative achieves adequate protection and should describe how site risks posed through each pathway being addressed by the FS/CMS are eliminated, reduced, or controlled through treatment, engineering, or institutional/land use controls. This evaluation also allows for consideration of whether an alternative poses any unacceptable short-term impacts. Overall protection draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs/media cleanup standards.

5.2.2 Compliance with ARARs/Media Cleanup Standards

The purpose of this evaluation criterion is to assess whether each alternative will meet federal and state ARAR/media cleanup standards identified in Section 3.2. Each alternative will also be compared to the TBCs identified in Section 3.2. Compliance with ARARs/media cleanup standards is one of the statutory requirements for remedy selection. In the detailed analysis, requirements that are applicable or relevant and appropriate to an alternative will be summarized. Additionally, the detailed analysis will contain a description of how the alternative would meet ARARs/media cleanup standards and TBCs. Alternatives are developed and refined throughout the FS/CMS process to ensure that they will meet all their respective ARARs/media cleanup standards or that there is good rationale for obtaining a variance or exemption.

5.2.3 Source Control

The purpose of this criterion is to evaluate how the alternative addresses the source of the release so as to reduce or eliminate, to the extent practicable, further releases that may pose a threat to human health and the environment. This criterion addresses whether source control measures are necessary and what type of source control actions would be appropriate. In addition, for any source control measure that is proposed, a discussion is provided on how well the method is expected to work given the site situation and previous experiences of the specific technology.

5.2.4 Waste Management Standards

The purpose of this criterion is to evaluate how the alternative would comply with applicable standards for the management of wastes. This includes a description of how the specific waste management activities would be conducted in order to maintain compliance with all applicable state and federal regulations.

5.2.5 Other Factors

In addition to the first four standards, there are five general factors that are to be addressed as part of the evaluation of alternatives. The five general decision factors to be considered under this standard are

- Long-term reliability and effectiveness
- Reduction in toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost

5.2.5.1 Long-Term Reliability and Effectiveness

The purpose of this criterion is to ensure protection of human health and the environment in the future, as well as in the near term. In evaluating alternatives for their long-term effectiveness and the degree of permanence they afford, the analysis should focus on the residual risks that will remain at the site after the completion of the remedial action. This analysis should include consideration of the following:

- Degree of threat posed by treatment residuals or untreated waste remaining at the site.

- Adequacy and reliability of any controls (e.g., engineering and institutional controls) used to manage the hazardous substances remaining at the site.

- Potential impacts on human health and the environment should the remedy fail.

- Whether the alternative would have the flexibility to address uncontrollable changes at the site (e.g., heavy rainstorms, seismic tremors, etc.)

- The overall useful life of the alternative.

5.2.5.2 Reduction in Toxicity, Mobility, or Volume Through Treatment

This criterion addresses the statutory preference for remedies that employ treatment as a principal element by ensuring that the relative performance of the various treatment alternatives in reducing toxicity, mobility, or volume will be assessed. Specifically, the analysis examines the

- Treatment process and remedy
- Amount of hazardous material destroyed or treated

- Reduction in toxicity, mobility, or volume
- Irreversibility of the treatment
- Type and quantity of treatment residual
- Statutory preference for treatment as a principal element

There may be some situations (e.g., large, municipal-type landfills) where achieving substantial reductions in toxicity, mobility, or volume may not be practical or desirable (U.S. EPA, 1993 and 1994).

5.2.5.3 Short-Term Effectiveness

This purpose of this criterion is to examine the short-term impacts of the alternatives (i.e., impacts of the implementation) on the neighboring community, the on-site workers, or the surrounding environment, including the potential threat to human health and the environment associated with excavation, treatment, and transportation of hazardous substances. The time to achieve protection of human health and the environment is also evaluated.

5.2.5.4 Implementability

Implementability considerations include the technical and administrative feasibility of the alternatives, as well as the availability of the goods and services (e.g., treatment, storage, or disposal capacity) on which the viability of the alternative depends. Implementability considerations often affect the timing of various remedial alternatives (e.g., limitations on the season in which the remedy can be implemented, the number and complexity of materials-handling steps that must be followed, the need to obtain permits for off-site activities, and the need to secure technical services such as well drilling and excavation).

5.2.5.5 Cost

Cost encompasses all capital costs and operation and maintenance costs incurred over the life of the project. The focus during the detailed analysis is on the net present value of these costs. Costs were used to select the least expensive (or most cost-effective) alternative that will achieve the remedial action objectives. For purposes of calculating the present worth for the annual operating and maintenance costs, a 30-year maintenance life and a 7 percent annual discount factor are used. It should be noted that O&M is an ongoing obligation (i.e., past 30 years as necessary) even if the present worth of O&M beyond 30 years is negligible.

5.2.6 State and U.S. EPA Acceptance

This criterion, which is an ongoing concern throughout the remediation process, reflects the statutory requirement to provide for substantial and meaningful state involvement.

5.2.7 Community Acceptance

This criterion refers to the community's comments on the remedial alternatives under consideration, where "community" is broadly defined to include all interested parties. These comments are taken into account throughout the FS/CMS process. However, only preliminary assessment of community acceptance can be conducted during the development of the FS/CMS, since formal public comment will not be received until after the public comment period for the preferred alternative is held.

5.3 EVALUATION OF ALTERNATIVES

This section presents the results of the evaluation conducted for each alternative based on the specific standards described in Section 5.2.

5.3.1 Alternative 1 - No Action

5.3.1.1 Overall Protection of Human Health and the Environment

The No Action alternative would not be protective of human health and the environment. An ongoing release of contaminants through erosion would be expected under this alternative. The source of the contaminants at the site is surface debris and PAH contamination. The debris piles are partially covered with soil and vegetation. However, the existing cover material at the site would continue to erode and waste materials would continue to migrate to the adjacent sediment and surface water. Elevated concentrations of metals, SVOCs, and pesticides are currently present in the adjacent site sediments. Exposed surface debris is visible in the debris pile areas. Since the waste materials were not characterized during the RI, the exact magnitude of the potential impact cannot be determined. However, based on recent sampling of site media, arsenic and iron were observed above human health screening criteria in surface soil, and Aroclor-1254 and iron were leading risk drivers in sediment waste samples. Site access is limited to one dirt road from the north on Jericho Island, and residents have lived on the island in the past. Access via boat is also possible from tributaries leading from Archers Creek on the southern side of the site.

In addition, pesticides and several metals (e.g., aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, mercury, vanadium, and zinc) are present in site surface soil at concentrations that represent potential risks to terrestrial receptors and aquatic receptors. PAHs,

pesticides, and several metals are also present in sediment at concentrations that represent potential risks to aquatic receptors. Results of food chain modeling also indicated that thallium and vanadium were detected in surface water samples at concentrations that are a potential risk.

Several contaminants such as PAHs and pesticides would naturally degrade over time, and resulting risks to human health and the environment would decrease, although long periods of time would be required. However, metals at the site would not degrade and would only slowly attenuate through dispersion into the sediments and dissolution to the surface water.

5.3.1.2 Compliance with ARARs /Media Cleanup Standards

Alternative 1 attains all chemical-specific ARARs/media cleanup standards with two exceptions. In surface water, AWQCs promulgated under the Clean Water Act and Surface Water Standards contained in the South Carolina Regulation 61-68 are exceeded. For groundwater, the MCLs for cadmium and thallium are exceeded. Also, several soil, sediment, surface water, and groundwater chemical-specific TBCs would not be met, including the Dutch Soil Clean-up Act ecological soil screening values, RBCs for soil, sediment, and groundwater, and U.S. EPA's ecological screening values for soil, sediment, surface water, and groundwater.

Under the No Action alternative, the debris piles would not meet Federal and state regulations regarding the final cover requirements of landfills. These ARARs consist of final cover regulations under RCRA Subtitle C and D and South Carolina Regulations regarding Solid Waste Management: Construction, Demolition, and Land Clearing Debris Landfills (R.61-107.11); Solid Waste Management: Municipal Solid Waste Landfills (R.61-107.258); and Sanitary Landfill Design, Construction, and Operation (R.61-70).

5.3.1.3 Source Control

Alternative 1 would not provide any source control.

5.3.1.4 Waste Management Standards

No actions would be implemented for Alternative 1 and; therefore, no waste would be generated.

5.3.1.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

In the long term, Alternative 1 would not be reliable and may not be effective. The potential risks would not be reduced through removal or treatment. Risks would only be reduced through natural processes.

Risks that remain are attributed to the following:

- The potential future erosion of contaminants in the debris piles. This occurrence would result in a continuing uncontrolled release of waste material into the surrounding sediment and surface water.

- The migration of surface soil COCs to nearby salt marsh sediment and surface water and sediment COCs to surface water.

- The continued and potentially increased risk to human and ecological receptors.

There would be no long-term management controls under the No Action alternative; therefore, the adequacy and reliability of controls are not applicable.

Reduction in Toxicity, Mobility, and Volume

Alternative 1 would involve no reduction in toxicity, mobility, or volume of the COCs other than that which would result from natural dispersion, dilution, or other attenuating factors. There would be no treatment processes employed and therefore no materials would be treated or destroyed.

Short-Term Effectiveness

There would be no actions performed under Alternative 1; therefore, there would not be short-term risks to the nearby community and on-site workers attributable to remedial actions. Similarly, environmental impacts would not result from remedial actions.

Alternative 1 would not eliminate the migration of COCs from the debris piles to groundwater, surface water, and sediment and would not comply with ARARs. The RAOs/CAOs would not be achieved.

Implementability

Since no actions would occur, Alternative 1 would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Cost Analysis

There would be no costs associated with the No Action alternative.

5.3.2 Alternative 2a – Monitored Natural Recovery of PAH-Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials/ Land use Controls and Monitoring

5.3.2.1 Overall Protection of Human Health and the Environment

Alternative 2a features components that are protective of human health and the environment. Under Alternative 2a, a low-permeability cap system would be placed over consolidated waste materials. This action would minimize human and ecological exposure to impacted media as well as human health exposure to waste materials. The cap system would also prevent the exposure of ecological receptors (macroinvertebrates, site-specific food-chain receptors, and terrestrial plants) to sediment where concentrations of COCs are in excess of the RGOs that represent a risk to ecological receptors.

Excavation of approximately 1.4 acres of waste materials and contaminated sediment would occur for Alternative 2a. After remediation, these areas would be backfilled and seeded. This action would restore currently impacted sediments.

Verification sampling of the excavated areas would be performed under Alternative 2a. A post-removal assessment would be performed after sediment and waste excavation and consolidation of the materials within the cap system. The ecological and human health RGOs would be used to confirm that any residual impacted materials remaining would not pose an unacceptable risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining media.

Monitored natural recovery would be used to remediate remaining soils that are impacted with PAHs above ecological and human RGOs. The PAHs represent a potential threat to macroinvertebrates living within the impacted soil but not to upper food-chain receptors. In absence of a continuing source of the PAHs, the PAHs will biodegrade, although, based on conservative biodegradation rates, over 10 to more than 30 years may be required until the PAH RGOs are achieved.

Sampling of sediment and groundwater is included to determine the long-term effectiveness of the remedy and assess any impacts to human and ecological receptors. Periodic review and maintenance of the site would be necessary to determine that the remedy is effective.

Land use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the cap boundary, restrict access to areas with PAH-contaminated soil, and ban the use of the groundwater as a drinking water supply. Signs would also be posted to alert users of the property about the presence of the cap.

5.3.2.2 Compliance with ARARs/Media Cleanup Standards

Alternative 2a would attain all chemical-specific ARARs/media cleanup standards with two exceptions. For surface water, AWQCs promulgated under the Clean Water Act and Surface Water Standards contained in South Carolina Regulation 61-68 are exceeded. For groundwater, the MCL for cadmium and thallium are exceeded. Also, several soil, surface water, and groundwater chemical-specific TBCs would not be met in the short term, including PRGs for residential soil and tapwater and U.S. EPA's ecological screening values for soil. Over time, when the source areas are addressed, these values should be achieved. The excavation, consolidation, cap system, and erosion control measures would be expected to control the source of contamination to these media and eliminate the transport of impacted surface soil to sediment and surface water and mobile contaminants to groundwater and surface water. These measures, along with monitored natural recovery processes, are expected to reduce the concentration of chemicals in soil, sediment, surface water, and groundwater over time.

All location-specific and action-specific ARARs/media cleanup standards and TBCs would be attained.

5.3.2.3 Source Control

The source control would be implemented with the cap system, as described in the previous detailed description. The cap system would be effective in providing source control and would minimize infiltration of precipitation and therefore reduce impacts to groundwater. The cap system would also prevent erosion of waste material and the subsequent impact to sediments and surface water along the perimeter of the island.

The elevated concentrations of PAHs in soil at sample locations PAI-10-SS-08 and PAI-012-03 would be allowed to naturally degrade. The monitoring of this process would be part of the long-term monitoring and assessment activities.

5.3.2.4 Waste Management Standards

Minimal waste would be expected to be generated during remedial activities for Alternative 2a, except for oversize debris that would not fit under the cap. The cover system proposed under this alternative would comply with ARARs under federal and South Carolina regulations concerning final covers for landfills.

5.3.2.5 Other Factors

Long-Term Reliability and Effectiveness

In the long term, this alternative would be reliable and effective. However, monitored natural recovery of PAHs in soil is not always reliable and there is uncertainty in the period of time that is required for attenuation. Slope stabilization and erosion control measures would be installed to the approximate high, high-water elevation (i.e., 8 feet above msl) to minimize the potential failure of the sideslopes of the cap system and potential release of the waste material into the surrounding sediment and surface water. However, the proposed location for consolidation shown on Figure 5-1 is above 8 feet msl and rip-rap would therefore not be required. Additionally, under a severe storm event (i.e., 100-year storm elevation of 15 feet above msl), the proposed erosion control measures may not be completely effective.

The cap system would prevent concentrations of COCs in waste material from migrating to groundwater, sediment, and surface water. In the long term, minimal repair to slope stabilization and erosion control measures would be expected. Such repair needs would be identified during periodic inspections of these measures.

The controls used in this alternative are adequate and reliable. Containment, slope stabilization, and erosion control measures are commonly used as components of remedies.

The reliability and effectiveness of the remedy would be assessed through the long-term media monitoring program (groundwater and sediment), inspection of slope stabilization and erosion control measures, land use controls, and 5-year reviews. If it should be discovered during these actions that control measures have failed, actions to correct the remedy (i.e., replace an eroded portion of a cap system) would be easily implemented.

Additional geotechnical study would be required to determine whether the slope stabilization measures would be adequate in the long term to avoid failure of the sideslopes of the cap system due to factors such as normal storm events, hurricane-like weather patterns, weight of the soil cover, and minor seismic events that occasionally occur in the area. These issues would be addressed during the remedial design.

Reduction in Toxicity, Mobility, and Volume

The containment components that comprise Alternative 2a would prevent the migration of the waste materials. Alternative 2a would not reduce the toxicity or volume of the waste material COCs other than that which would result from natural dispersion, dilution, or other attenuating factors. No treatment

processes are employed, however PAHs would naturally degrade. Approximately 2,300 cubic yards of waste material and 380 cubic yards of contaminated sediment would be contained with this remedy.

Although a statutory preference for treatment exists for CERCLA remedial actions, the Presumptive Remedy for CERCLA Municipal Landfill Sites (U.S. EPA, 1993) establishes containment as the presumptive remedy for CERCLA municipal landfills because the volume and heterogeneity of the waste in municipal landfills generally make treatment impracticable.

Short-Term Effectiveness

Alternative 2a would be effective in the short term. Work areas would be marked and monitored to prevent entry by unauthorized personnel. Site workers would receive the appropriate health and safety training and would wear the required PPE during implementation. The workers would also follow a site-specific Health and Safety Plan. The time needed to complete remedial actions is anticipated to be within 6 months.

During implementation of the alternative, vegetation within the existing debris pile areas and sample locations would be removed. Measures would be conducted to minimize the impact of excavation on the area.

Use of excavation techniques would be relatively efficient at removing sediments. The area of impacted sediment is relatively small. Therefore, excavation would result in minimal short-term ecological impacts.

Additionally, Alternative 2a would eliminate the migration of COCs from the waste material to groundwater, surface water, and sediment and would comply with ARARs.

Implementability

Alternative 2a would be implementable. Contractors and equipment are readily available for conducting excavation and consolidation activities and installing the cap system, slope stabilization, and erosion control measures. In the long-term, minimal repair to the cap system, slope stabilization, and erosion control measures may be required; however, such repair actions would be easy to implement.

This alternative is administratively feasible. The MCRD Parris Island Partnering Team consists of representatives of the U.S. EPA, SCDHEC, South Carolina Department of Natural Resources (SCDNR), National Oceanic and Atmospheric Administration (NOAA), and USFWS, as well as the U.S. Navy and Marine Corps. Regulatory approval and permitting requirements could be coordinated via this partnering mechanism.

Cost Analysis

The following costs are estimated for Alternative 2a. As a point of departure, costs for both a RCRA C and RCRA D (soil) cover are presented. The cost estimate is provided in Appendix B.

	RCRA C Cap	RCRA D Cap
Estimated capital costs:	$1,286,000	$1,099,000
Estimated O&M costs:	$45,500 to $92,900	$45,500 to $92,900
Estimated 30-year present worth:	$1,938,000	$1,752,000

5.3.3 Alternative 2b – Enhanced Biodegradation of PAH-Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials/ Land use Controls and Monitoring

5.3.3.1 Overall Protection of Human Health and the Environment

Alternative 2b features components that are protective of human health and the environment. Under Alternative 2b, a low-permeability cap system would be placed over consolidated waste materials. This action would minimize human and ecological exposure to impacted media as well as human health exposure to waste materials. The cap system would also prevent the exposure of ecological receptors (macroinvertebrates, site-specific food-chain receptors, and terrestrial plants) to sediment where concentrations of COCs are in excess of the RGOs and represent a risk to ecological receptors.

Excavation of approximately 1.4 acres of waste materials and contaminated sediment would occur for Alternative 2a. After remediation, these areas would be backfilled and seeded. This action would restore impacted sediments.

Verification sampling of the excavated areas would be performed under Alternative 2b. A post-removal assessment would be performed after sediment and waste excavation and consolidation of the materials within the cap system. The ecological and human health RGOs would be used to confirm that any residual impacted materials would not pose an unacceptable risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining media.

Enhanced biodegradation would be used to remediate remaining soils that are impacted with PAHs above ecological and human RGOs. The PAHs represent a potential threat to macroinvertebrates living within the impacted soil but not to upper food-chain receptors. In absence of a continuing source of the PAHs, the PAHs will biodegrade, although, based on conservative biodegradation rates, 1 to 5 years may be required until the PAH RGOs are achieved.

Sampling of sediment and groundwater is included to determine the long-term effectiveness of the remedy and assess any impacts to human and ecological receptors. Periodic review and maintenance of the site would be necessary to determine that the remedy is effective.

Land use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the cap boundary, restrict access to areas with PAH-contaminated soil, and ban the use of the groundwater as a drinking water supply. Signs would also be posted to alert users of the property about the presence of the cap.

5.3.3.2 Compliance with ARARs/Media Cleanup Standards

Alternative 2b would attain all chemical-specific ARARs/media cleanup standards with two exceptions. For surface water, AWQCs promulgated under the Clean Water Act and surface water standards contained in South Carolina Regulation 61-68 are exceeded. For groundwater, the MCL for cadmium and thallium are exceeded. Also, several soil, surface water, and groundwater chemical-specific TBCs would not be met in the short term, including PRGs for residential soil and tapwater and U.S. EPA's ecological screening values for soil. Over time, when the source areas are addressed, these values should be achieved. The excavation, consolidation, cap system, and erosion control measures would be expected to control the source of contamination to these media and eliminate the transport of impacted surface soil to sediment and surface water and mobile contaminants to groundwater and surface water. These measures, along with enhanced biodegradation processes, would be expected to reduce the concentration of chemicals in soil, sediment, surface water, and groundwater over time.

All location-specific and action-specific ARARs/media cleanup standards and TBCs would be attained.

5.3.3.3 Source Control

The source control would be implemented with the cap system, as described in the previous detailed description. The cap system would be effective in providing source control and would minimize infiltration of precipitation and therefore reduce impacts to groundwater. The cap system would also prevent erosion of waste material and the subsequent impact to sediments and surface water along the perimeter of the island.

Use of enhanced biodegradation at soil sample locations PAI-10-SS-08 and PAI-012-03 would be performed to assist in degradation of the PAHs. The monitoring of this process would be part of the long-term monitoring and assessment activities.

5.3.3.4 Waste Management Standards

Minimal waste would be expected to be generated during remedial activities for Alternative 2b, except for oversize debris that would not fit under a cap. The cover system proposed under this alternative would comply with ARARs under federal and South Carolina regulations concerning final covers for landfills.

5.3.3.5 Other Factors

Long-Term Reliability and Effectiveness

In the long term, this alternative would be reliable and effective. Slope stabilization and erosion control measures would be installed to the approximate high, high-water elevation (i.e., 8 feet above msl) to minimize the potential failure of the sideslopes of the cap system and potential release of the waste material into the surrounding sediment and surface water. However, the proposed location for consolidation shown on Figure 5-3 is above 8 feet msl and rip-rap would therefore not be required. Additionally, under a severe storm event (i.e., 100-year storm elevation of 15 feet above msl), the proposed erosion control measures may not be completely effective.

The cap system would prevent concentrations of COCs in waste material from migrating to groundwater, sediment, and surface water. In the long term, minimal repair to slope stabilization and erosion control measures would be expected. Such repair needs would be identified during periodic inspections of these measures.

The controls used in this alternative are adequate and reliable. Containment, slope stabilization, and erosion control measures are commonly used as components of remedies.

The reliability and effectiveness of the remedy would be assessed through the long-term media monitoring program (groundwater and sediment), inspection of slope stabilization and erosion control measures, land use controls, and 5-year reviews. If it should be discovered during these actions that control measures have failed, actions to correct the remedy (i.e., replace an eroded portion of a cap system) would be easily implemented.

Additional geotechnical study would be required to determine whether the slope stabilization measures would be adequate in the long term to avoid failure of the sideslopes of the cap system due to factors such as normal storm events, hurricane-like weather patterns, weight of the soil cover, and minor seismic events that occasionally occur in the area. These issues would be addressed during the remedial design.

Reduction in Toxicity, Mobility, and Volume

The containment components that comprise Alternative 2b would prevent the migration of the waste materials. Alternative 2b would reduce the toxicity and volume of the waste material COCs by the use of enhanced biodegradation to attenuate the PAHs. Approximately 2,300 cubic yards of waste material and 380 cubic yards of contaminated sediment would be contained with this remedy.

Although a statutory preference for treatment exists for CERCLA remedial actions, the Presumptive Remedy for CERCLA Municipal Landfill Sites (U.S. EPA, 1993) establishes containment as the presumptive remedy for CERCLA municipal landfills because the volume and heterogeneity of the waste in municipal landfills generally make treatment impracticable.

Short-Term Effectiveness

Alternative 2b would be effective in the short term. Work areas would be marked and monitored to prevent entry by unauthorized personnel. Site workers would receive the appropriate health and safety training and would wear the required PPE during implementation. The workers would also follow a site-specific Health and Safety Plan. The time needed to complete remedial actions is anticipated to be within 6 months.

During implementation of the alternative, vegetation within the existing debris pile areas and sample locations would be removed. Measures would be conducted to minimize the impact of excavation on the area.

Use of excavation techniques would be relatively efficient at removing sediments. The area of impacted sediment is relatively small. Therefore, excavation would result in minimal short-term ecological impacts.

Additionally, Alternative 2b would eliminate the migration of COCs from the waste material to groundwater, surface water, and sediment and would comply with ARARs.

Implementability

Alternative 2b would be implementable. Contractors and equipment are readily available for conducting excavation and consolidation activities and installing the cap system, slope stabilization, and erosion control measures. In the long-term, minimal repair to the cap system, slope stabilization, and erosion control measures may be required; however, such repair actions would be easy to implement.

This alternative is administratively feasible. The MCRD Parris Island Partnering Team consists of representatives of the U.S. EPA, SCDHEC, SCDNR, NOAA, and USFWS, as well as the U.S. Navy and Marine Corps. Regulatory approval and permitting requirements could be coordinated via this partnering mechanism.

Cost Analysis

The following costs are estimated for Alternative 2b. As a point of departure, costs for both a RCRA C and RCRA D (soil) cover are presented. The cost estimate is provided in Appendix B.

	RCRA C Cap	RCRA D Cap
Estimated capital costs:	$1,458,000	$1,272,000
Estimated O&M costs:	$45,500 to $192,2900	$45,500 to $192,900
Estimated 30-year present worth:	$2,203,000	$2,018,000

5.3.4 Alternative 3 – Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials/Land use Controls and Monitoring

5.3.4.1 Overall Protection of Human Health and the Environment

Alternative 3 features components that are protective of human health and the environment. Under Alternative 3, a low-permeability cap system would be placed over consolidated soil, sediments, and waste material. This action would minimize human and ecological exposure to impacted sediments, as well as human health exposure to waste material. The cap system would also prevent the exposure of ecological receptors (macroinvertebrates, site-specific food-chain receptors, and terrestrial plants) to surface soil where concentrations of COCs are in excess of the RGOs that represent a risk to ecological receptors.

Excavation of approximately 2.1 acres of waste materials and contaminated soil and sediment would occur for Alternative 3. After remediation, these areas would be backfilled and seeded. This action would restore currently impacted sediments.

Verification sampling of the excavated areas would be performed under Alternative 3. A post-removal assessment would be performed after sediment, soil, and waste excavation and consolidation of the materials within the cap system. The ecological and human health RGOs would be used to confirm that any residual impacted materials remaining would not pose an unacceptable risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining soil and sediment.

Sampling of groundwater is included to determine the long-term effectiveness of the remedy and assess any impacts to human and ecological receptors. Periodic review and maintenance of the site would be necessary to determine that the remedy is effective.

Land use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the cap boundary and the use of the groundwater as a drinking water supply. Signs would also be posted to alert users of the property about the presence of the cap.

5.3.4.2 Compliance with ARARs/Media Cleanup Standards

Alternative 3 would attain all chemical-specific ARARs/media cleanup standards and TBCs with two exceptions. For surface water, AWQCs promulgated under the Clean Water Act and surface water standards contained in South Carolina Regulation 61-68 are exceeded. For groundwater, the MCLs for cadmium and thallium are exceeded. Over time, when the source areas are addressed, these values should be achieved. The excavation, consolidation, cap system, and erosion control measures would be expected to control the source of contamination to these media and eliminate the transport of impacted surface soil to sediment and surface water and mobile contaminants to groundwater and surface water. These measures would be expected to reduce the concentration of chemicals in surface water and groundwater.

All location-specific and action-specific ARARs/media cleanup standards and TBCs would be attained.

5.3.4.3 Source Control

The source control would be implemented with the cap system, as described in the previous detailed description. The cap system would be effective in providing source control and would minimize infiltration of precipitation and therefore reduce impacts to groundwater. The cap system would also prevent erosion of waste material and the subsequent impact to sediments and surface water along the perimeter of the landfill area.

5.3.4.4 Waste Management Standards

Minimal waste would be expected to be generated during remedial activities for Alternative 3 except for debris that would not fit under the cap. The cover system proposed under this alternative would comply with ARARs under Federal and South Carolina regulations concerning final covers for landfills.

5.3.4.5 Other Factors

Long-Term Reliability and Effectiveness

In the long term, this alternative would be reliable and effective. Slope stabilization and erosion control measures would installed to the approximate high, high-water elevation (i.e., 8 feet above msl) to minimize the potential failure of the sideslopes of the landfill cap system and potential release of the landfill waste into the surrounding sediment and surface water. However, the proposed location for consolidation shown on Figure 5-4 is above 8 feet msl and rip-rap would therefore not be required. Additionally, under a severe storm event (i.e., 100-year storm elevation of 15 feet above msl), the proposed erosion control measures may not be completely effective.

The cap system would prevent concentrations of COCs in waste material from migrating to groundwater, sediment, and surface water. In the long-term, minimal repair to slope stabilization and erosion control measures would be expected. Such repair needs would be identified during periodic inspections of these measures.

The controls used in this alternative are adequate and reliable. Containment, slope stabilization, and erosion control measures are commonly used as components of remedies.

The reliability and effectiveness of the remedy would be assessed through the long-term media monitoring program (groundwater), inspection of slope stabilization and erosion control measures, site restrictions, and 5-year reviews. If it should be discovered during these actions that control measures have failed, actions to correct the remedy (i.e., replace an eroded portion of a cap system) would be easily implemented.

Additional geotechnical study would be required to determine whether the slope stabilization measures would be adequate in the long term to avoid failure of the sideslopes of the cap system due to factors such as normal storm events, hurricane-like weather patterns, the weight of the soil cover, and minor seismic events that occasionally occur in the area. These issues would be addressed during the remedial design.

Reduction in Toxicity, Mobility, and Volume

The containment components that comprise Alternative 3 would prevent the migration of the waste materials and contaminated soil and sediment. Alternative 3 does not reduce the toxicity or volume of the materials other than that which would result from natural dispersion, dilution, or other attenuating factors. No treatment processes would be employed, and therefore no materials would be treated or destroyed.

Approximately 2,300 cubic yards of waste material, 380 cubic yards of sediment, and 1,700 cubic yards of soil would be contained with this remedy.

Although a statutory preference for treatment exists for CERCLA Remedial Actions, the Presumptive Remedy for CERCLA Municipal Landfill Sites (U.S. EPA, 1993) establishes containment as the presumptive remedy for CERCLA municipal landfills because the volume and heterogeneity of the waste in municipal landfills generally make treatment impracticable.

Short-Term Effectiveness

Alternative 3 would be effective in the short term. Work areas would be marked and monitored to prevent entry by unauthorized personnel. Site workers would receive the appropriate health and safety training and would wear the required PPE during implementation. The workers would also follow a site-specific Health and Safety Plan. The time needed to complete remedial actions is anticipated to be within 7 months.

During implementation of the alternative, vegetation within the debris pile areas and sample locations would be designated for excavation. Measures would be conducted to minimize the impact of excavation on the salt marsh.

Use of dredging or excavation techniques would be relatively efficient at removing sediments. The area of impacted sediment is relatively small. Therefore, excavation would result in minimal short-term ecological impacts.

Additionally, Alternative 3 would eliminate the migration of COCs from the waste material to groundwater, surface water, and sediment and would comply with ARARs.

Implementability

Alternative 3 would be implementable. Contractors and equipment are readily available for conducting excavation and consolidation activities and installing the cap system, slope stabilization, and erosion control measures. In the long term, minimal repair to the cap system, slope stabilization, and erosion control measures may be required; however, such repair actions would be easy to implement.

This alternative is administratively feasible. The MCRD Parris Island Partnering Team consists of representatives of the U.S. EPA, SCDHEC, SCDNR, NOAA, and USFWS, and the U.S. Navy and Marine Corps. Regulatory approval and permitting requirements could be coordinated via this partnering mechanism.

Cost Analysis

The following costs are estimated for Alternative 3. As a point of departure, costs for both a RCRA C and RCRA D (soil) cover are presented. The cost estimate is provided in Appendix B.

	RCRA C Cap	RCRA D Cap
Estimated capital costs:	$1,609,000	$1,342,000
Estimated O&M costs:	$45,500 to $91,500	$45,500 to $91,500
Estimated 30-year present worth:	$2,255,000	$1,988,000

5.3.5 Alternative 4 – Excavation and Off-Site Disposal of Waste Materials, Soil, and Sediment

5.3.5.1 Overall Protection of Human Health and the Environment

Alternative 4 would be protective of human health and the environment. Under Alternative 4, all impacted soil, sediment, and waste material would be excavated and placed within an appropriate off-site disposal facility. This action would prevent exposure to human and ecological receptors. Additionally, Alternative 4 would eliminate the migration of COCs from the waste material to groundwater, surface water, and sediment and would comply with ARARs.

Verification sampling of the excavated areas would be performed under Alternative 4. A post-removal assessment would be performed after soil, sediment, and waste excavation activities are completed to evaluate any residual contamination within the former sediment, soil, or debris areas. The ecological and human health RGOs would be used to confirm that any residual impacted materials remaining would not pose an unacceptable risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining sediment and soil.

5.3.5.2 Compliance with ARARs/Media Cleanup standards

Alternative 4 would attain all chemical-specific ARARs/media cleanup standards and TBCs. The excavation and off-site disposal of impacted soil, sediment, and waste material constitute the complete removal of the sources of contamination to the groundwater, surface water, and sediment and eliminates any future transport of impacted material to any medium, which is expected to reduce the concentrations of chemicals in surface water and groundwater.

All location-specific and action-specific ARARs/media cleanup standards and TBCs would be attained.

5.3.5.3 Source Control

The source of impacts to sediment, surface water, and groundwater would be eliminated with the implementation of this alternative. All impacted soil, sediment, and waste material would be removed from the site.

5.3.5.4 Waste Management Standards

Waste and impacted soil and sediment would be sampled, handled, loaded, transported, and disposed in accordance with appropriate regulations. It is expected that the material from Site 12 would generally be classified as nonhazardous material. It was assumed that 90 percent of the material would be nonhazardous and 10 percent would be hazardous.

5.3.5.5 Other Factors

Long-Term Reliability and Effectiveness

In the long term, this alternative would be reliable and effective. The complete removal of impacted material from the site would prevent any future releases from the existing source area.

The reliability and effectiveness of the remedy would not require any long-term programs, site restrictions, or 5-year reviews.

Reduction in Toxicity, Mobility, and Volume

Treatment may be performed off site as necessary to comply with Land Disposal Restrictions (LDRs).

Short-Term Effectiveness

Alternative 4 would be effective in the short term. There would be some short-term effects to the local base community during excavation and transportation of sediment and waste materials. Work areas would be marked and monitored to prevent entry by unauthorized personnel. Site workers would receive the appropriate health and safety training and would wear the required PPE during implementation.

Use of excavation techniques would also be relatively efficient at removing soil and sediments.

The time needed to complete remedial actions is anticipated to be 5 months. There would be short-term impacts to the local community during Alternative 4. Approximately 608 truck loads (10-ton truck loads) of

contaminated media would be transported off site. Traffic control and routine road maintenance would be required during this time.

Implementability

Alternative 4 would be implementable. Contractors and equipment are readily available for conducting excavation, loading, and transportation activities.

This alternative is administratively feasible. The MCRD Parris Island Partnering Team consists of representatives of the U.S. EPA, SCDHEC, SCDNR, NOAA, and USFWS, and the U.S. Navy and Marine Corps. Regulatory approval and permitting requirements could be coordinated via this partnering mechanism.

Cost Analysis

The following costs are estimated for Alternative 4. The cost estimate is provided in Appendix B.

Estimated capital costs:	$ 1,450,000
Estimated O&M costs:	$ 0 per year
Estimated 30-year present worth:	$ 1,450,000

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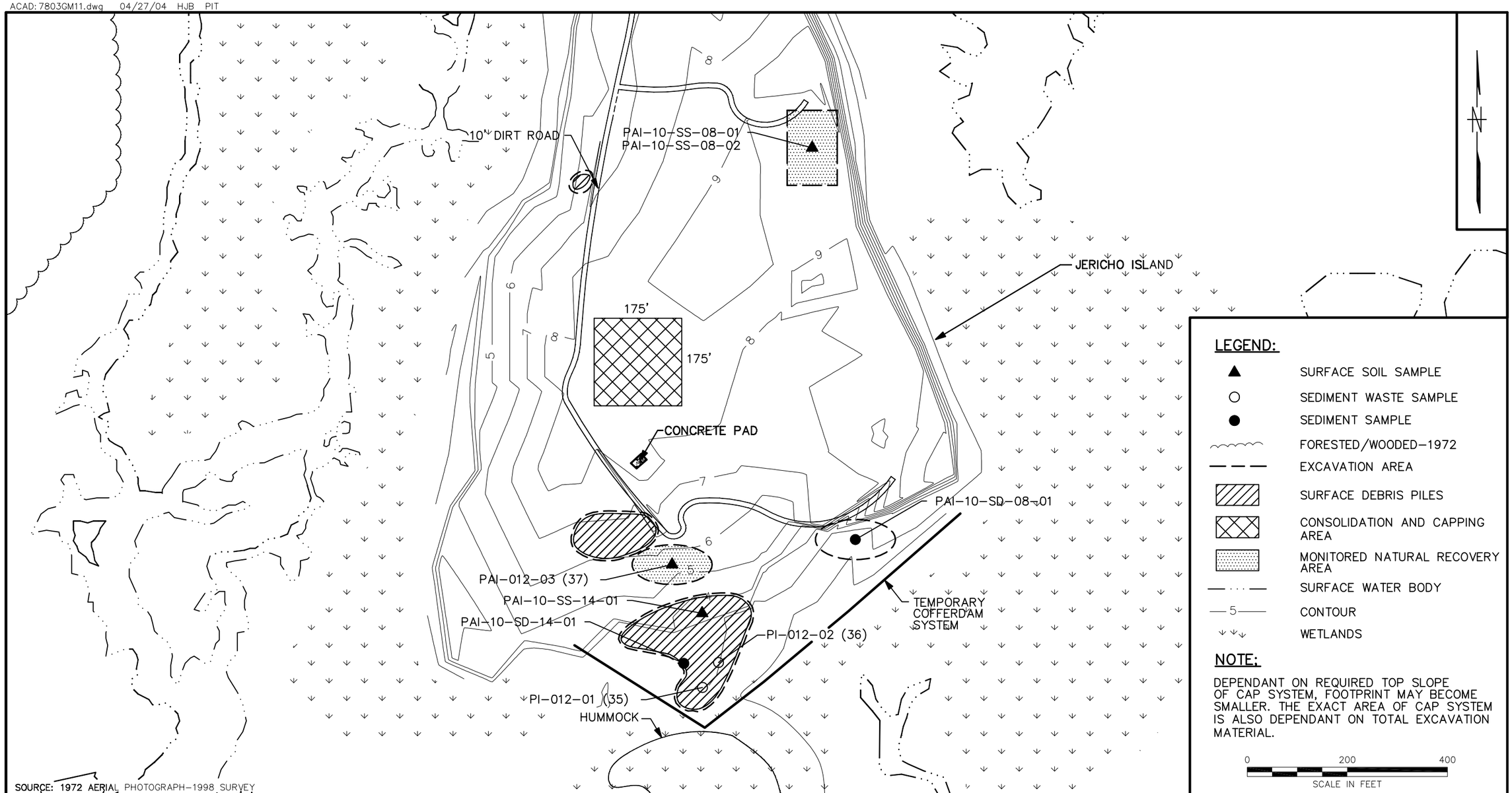

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 11/28/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

ALTERNATIVE 2A – MONITORED NATURAL RECOVERY AND EXCAVATION/CONSOLIDATION /CAPPING
SITE 12/SWMU 10
JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7803
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 5-1
REV. 1

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

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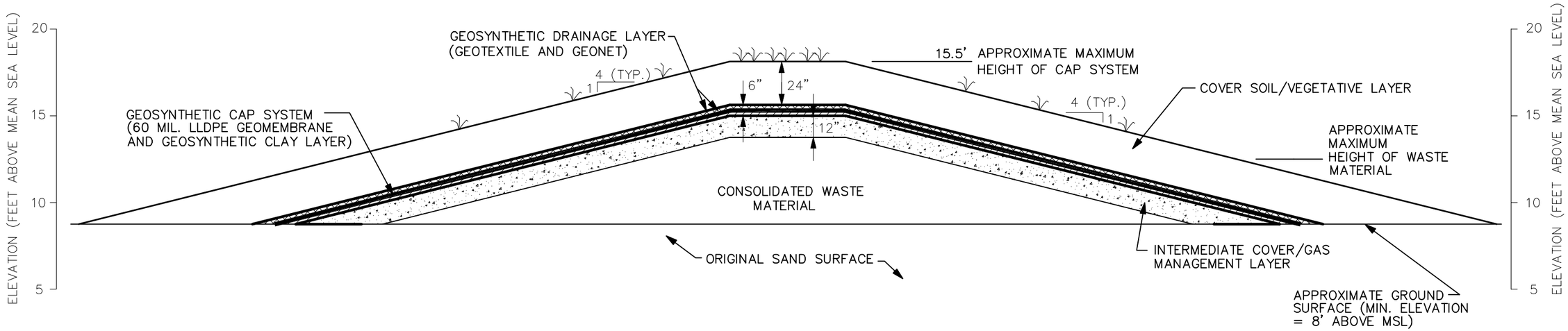


NOTE:

DEPENDANT ON REQUIRED TOP SLOPE OF CAP SYSTEM, AND TOTAL EXCAVATION MATERIAL ACTUAL ELEVATIONS MAY VARY.

0 5 10
SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

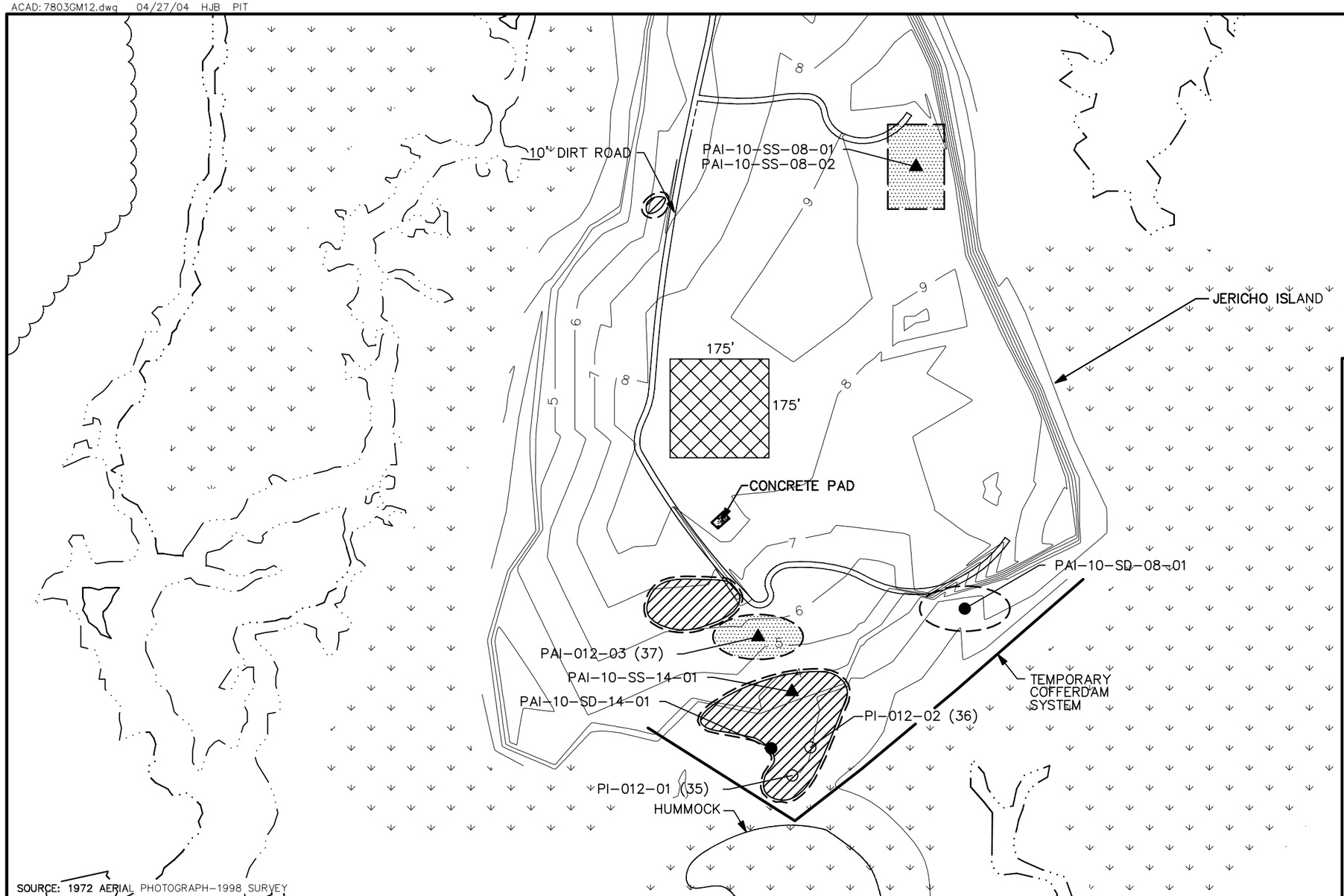
DRAWN BY HJB DATE 12/4/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

TYPICAL CAP SYSTEM SECTION
ALTERNATIVES 2A, 2B AND 3
SITE 12 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7803
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 5-2
REV. 1

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: 7803GM12.dwg 04/27/04 HJB PIT



LEGEND:

- ▲ SURFACE SOIL SAMPLE
- ○ SEDIMENT WASTE SAMPLE
- ● SEDIMENT SAMPLE
- FORESTED/WOODED-1972
- EXCAVATION AREA
- SURFACE DEBRIS PILES
- CONSOLIDATION AND CAPPING AREA
- ENHANCED BIODEGRADATION AREA
- SURFACE WATER BODY
- 5 CONTOUR
- WETLANDS

NOTE:

DEPENDANT ON REQUIRED TOP SLOPE OF CAP SYSTEM, FOOTPRINT MAY BECOME SMALLER. THE EXACT AREA OF CAP SYSTEM IS ALSO DEPENDANT ON TOTAL EXCAVATION MATERIAL.

0 200 400
SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

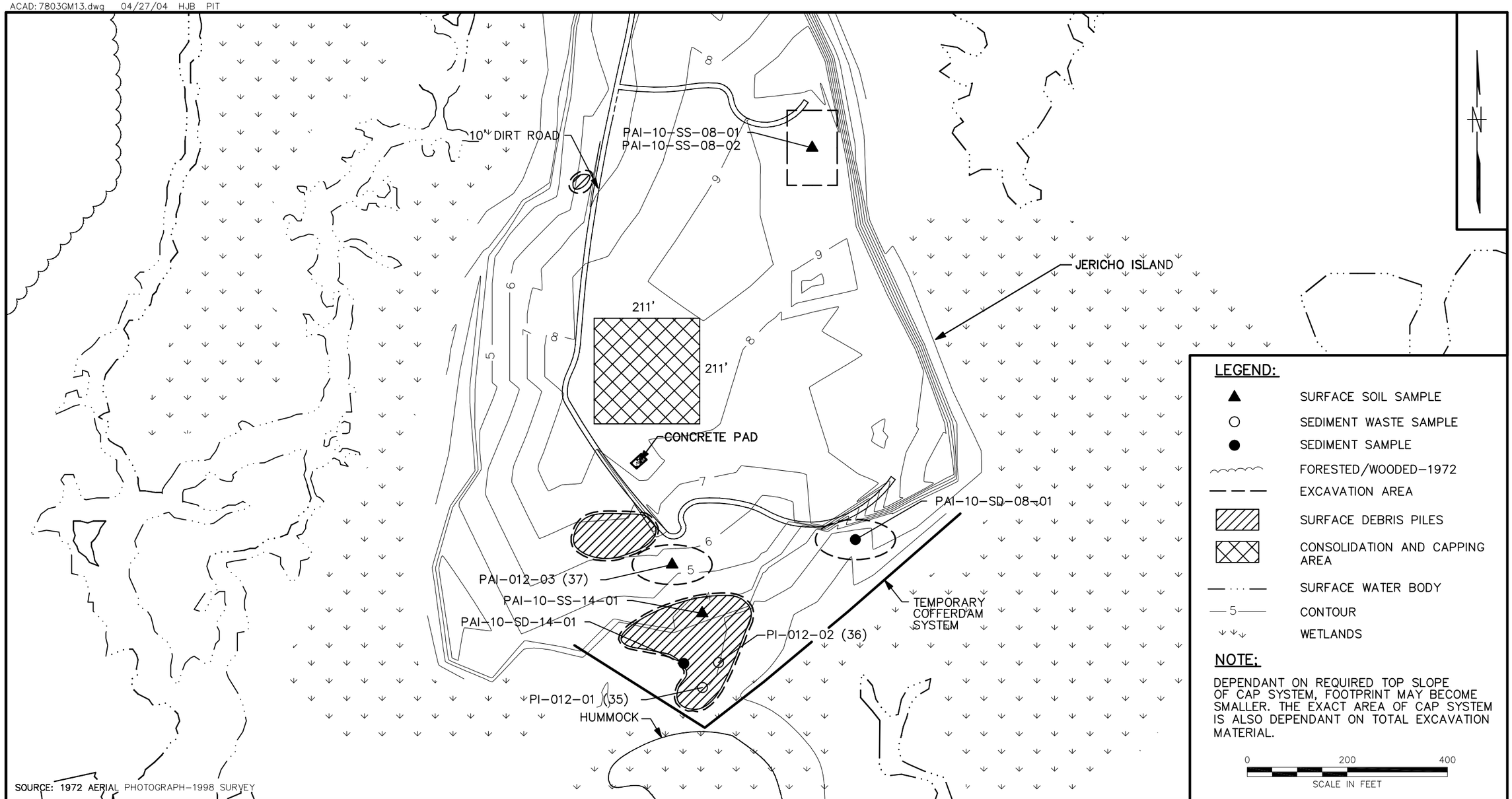
DRAWN BY HJB DATE 11/28/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

ALTERNATIVE 2B – ENHANCED BIODEGRADATION AND EXCAVATION/CONSOLIDATION /CAPPING
SITE 12/SWMU 10
JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7803
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 5-3
REV. 1

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: 7803GM13.dwg 04/27/04 HJB PIT



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

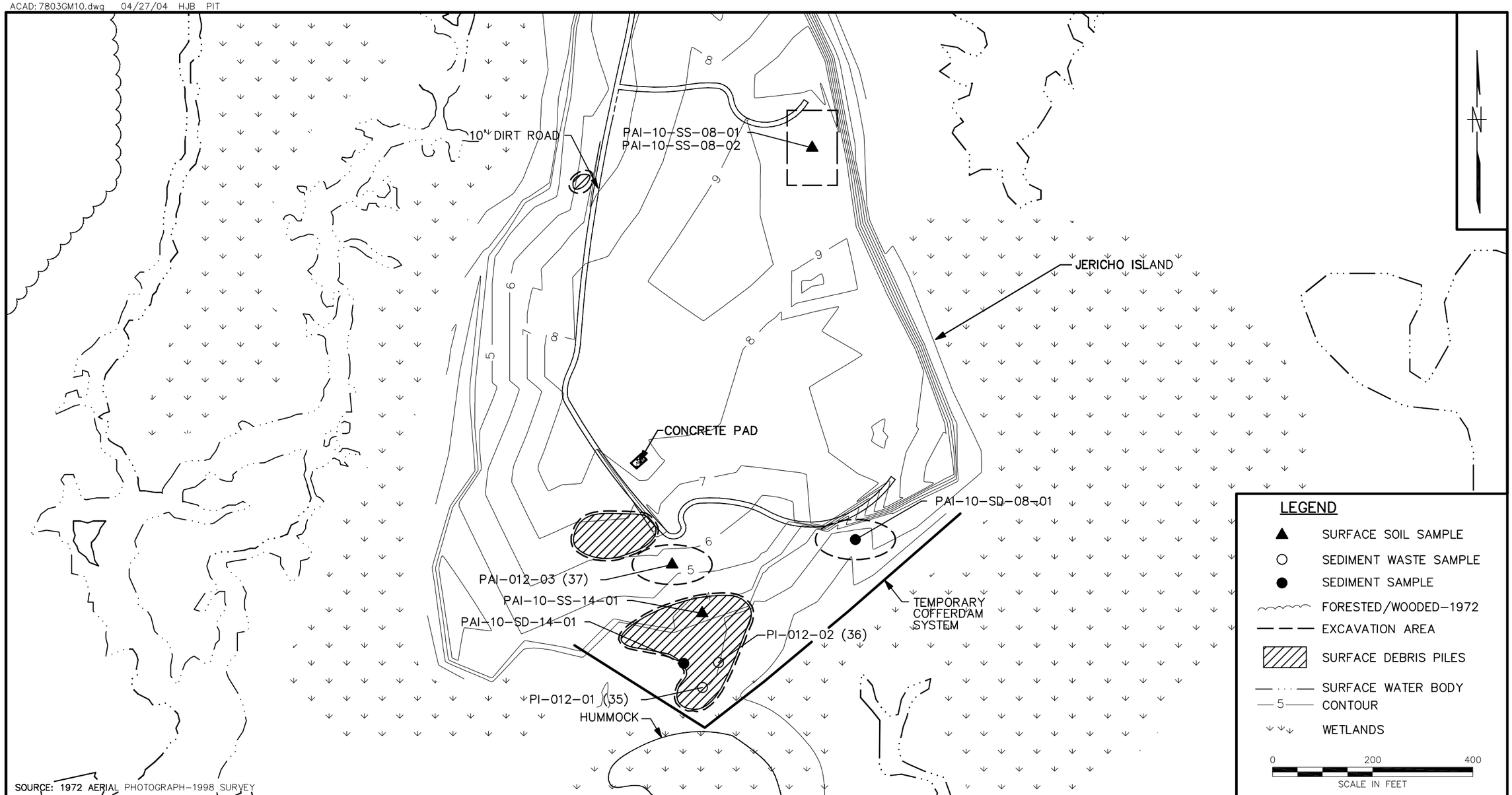
DRAWN BY HJB DATE 11/28/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

ALTERNATIVE 3 – EXCAVATION/CONSOLIDATION/ CAPPING OF ALL CONTAMINATED MATERIAL
SITE 12/SWMU 10
JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7803
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 5-4
REV. 1

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: 7803GM10.dwg 04/27/04 HJB PIT



SOURCE: 1972 AERIAL PHOTOGRAPH-1998 SURVEY

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 11/16/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

ALTERNATIVE 4 – EXCAVATION AND OFF-SITE DISPOSAL OF WASTE MATERIALS, SOIL AND SEDIMENT
SITE 12/SWMU 10
JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7803
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 5-5
REV. 1

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

6.0 COMPARATIVE ANALYSIS OF REMEDIAL ACTION/CORRECTIVE MEASURES ALTERNATIVES

6.1 INTRODUCTION

This section presents a comparison of the remedial action/corrective measures alternatives to each evaluation criterion. The criteria used for comparison are identical to those used for the detailed analysis of individual alternatives.

The following alternatives are compared in this section:

- Alternative 1 - No Action: This alternative is developed per the NCP to provide a baseline for comparison to other alternatives.

- Alternative 2a – Monitored Natural Recovery for PAH-contaminated Soil and Excavation/ Consolidation/Capping of Contaminated Sediment and Waste Material/Land-use Controls and Monitoring.

- Alternative 2b – Enhanced Biodegradation of PAH-contaminated Soil and Excavation/Consolidation/ Capping of Contaminated Sediment and Waste Material/Land-use Controls and Monitoring.

- Alternative 3 – Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials/Land-use Controls and Monitoring.

- Alternative 4 – Excavation and Off-Site Disposal of Waste Materials, Soil, and Sediment (follows unrestricted land use evaluation).

6.2 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents a comparative discussion of the alternatives versus the evaluation criteria presented in Section 5.0. A summary of this comparative analysis is presented in Table 6-1.

6.2.1 Overall Protection of Human Health and the Environment

Alternative 4 would provide the most overall protection compared to Alternatives 1, 2a, 2b, and 3. The removal of all contaminated soil, sediment, sediment/waste, and waste materials from the site and their disposal at an appropriate off-site facility would be effective and permanent. Alternative 3 would be more

protective than 2a and 2b since all contaminated soil and sediment and waste materials would be contained under a cap system. Alternatives 2b would be more protective than 2a because of the questionable effectiveness of monitored natural recovery. Both of these containment options rely on the placement of the most contaminated material within a cap and constructing and maintaining the integrity of the cap system and long-term O&M. Alternative 2a is less protective in the short term than Alternative 2b because PAHs in soil would undergo monitored natural recovery compared to enhanced biodegradation. Natural attenuation factors, such as biodegradation and dispersion, may require 10 to more than 30 years to be fully protective, and enhanced biodegradation may require approximately 1 to 5 years. Appendix C contains calculations of the approximate time required for PAHs at sample location PAI-SS-08-02 to attain RGOs based on monitored natural recovery and enhanced biodegradation. Based on these calculations, it would take approximately 6 to 30 times longer with monitored natural recovery than enhanced biodegradation. Alternative 3 would be more protective than 2a and 2b since all contaminated soil and sediment and waste materials would be contained under a cap system. Alternative 1 is not protective of human health and the environment. In addition, site risks may increase as waste material continues to erode.

6.2.2 Compliance with ARARs/Media Cleanup Standards

Alternative 1 would not meet Federal and State regulations regarding the final cover requirements of landfills. These ARARs consist of final cover regulations under RCRA Subtitle C and D and South Carolina Regulations regarding Solid Waste Management: Construction, Demolition, and Land Clearing Debris Landfills (R.61-107.11); Solid Waste Management: Municipal Solid Waste Landfills (R.61-107.258); and Sanitary Landfill Design, Construction, and Operation (R.61-70). Alternatives 2a, 2b, 3, and 4 would attain all action-specific ARARs.

Alternative 1 would not attain AWQCs promulgated under the CWA and Surface Water Standards contained in the South Carolina Regulation 61-68 in the short term. The MCLs for cadmium and thallium would not be attained in groundwater under Alternative 1. With Alternative 1, no action would be taken to reduce the release of the waste material into groundwater and surrounding sediment and surface water; consequently, this alternative may not attain AWQCs or MCLs in the long term. With Alternatives 2a, 2b, and 3; however, actions would be included to eliminate the release of the waste materials into the groundwater and surrounding sediment and surface water through containment measures. Alternative 4 would include actions to eliminate the release of waste materials through excavation and off-site disposal.

Alternative 2a includes monitored natural recovery of PAH-contaminated soil, and Alternative 2b includes enhanced biodegradation of PAH-contaminated soil. Alternative 2a relies on natural attenuation for the reduction of PAHs within soil. Alternative 2b would consist of measures to accelerate the attenuation of

the PAHs. Therefore, Alternative 2b would attain the chemical-specific ARARs in a shorter manner than Alternative 2a. However, a reliable time estimate cannot be determined.

RI data indicate that surface water and groundwater do not pose unacceptable risks to human health or ecological receptors although concentrations of several chemicals would remain above chemical-specific ARARs for surface water and groundwater. However, under Alternatives 3 and 4, the potential transport of waste and incidental concentrations of soil and sediment COCs to groundwater and surface water would be eliminated through containment (Alternative 3) or excavation and off-site disposal (Alternative 4). Both alternatives would meet all soil and sediment chemical-specific ARARs immediately after completion of remediation activities, and groundwater and surface water chemical-specific ARARs would be met in the long term. For both Alternatives 3 and 4, chemical-specific ARARs for groundwater and surface water are expected to be achieved within the same time frame.

Alternatives 1, 2a, 2b, 3, and 4 would attain all location-specific ARARs.

6.2.3 Source Control

Alternative 1 would not include source control measures. Alternatives 2a, 2b, and 3 would provide source control through the containment of the impacted media and waste materials. The containment of the waste material would limit the infiltration of precipitation and would minimize the impact of contaminants on groundwater quality. The complete removal of all waste in Alternative 4 would be the most effective remedy for source control.

6.2.4 Waste Management Standards

Alternative 1 would not include removal of any waste materials; therefore, the management of waste material ARARs would not apply. Final cover requirements of several Federal and state of South Carolina regulations would not be met. Alternatives 2a, 2b, and 3 would comply with ARARs under Federal and South Carolina regulations concerning final covers for landfills. Alternative 4 would also comply with waste management standards in the total removal of waste material from the site.

6.2.5 Long-Term Reliability and Effectiveness

Alternative 1 would not be reliable and effective. Residual risks would remain, attributed to exposure to sediment, sediment/waste, and waste where COCs exceed RGOs for human receptors and ecological receptors. Impacts to groundwater from the landfill source area would continue.

Under Alternatives 2a and 2b, potential short term residual risks would result from ecological (macroinvertebrate) and human exposure to soil where concentrations exceed the RGOs for PAHs. Monitored natural attenuation would reduce the concentrations of these PAHs over the long term under Alternative 2a however, long-term reliability and effectiveness is questionable. Enhanced biodegradation would reduce the concentration of these PAHs over a shorter time period in the long term under Alternative 2b. Under Alternative 3, all risks attributable to human and ecological exposure to soil and sediment containing COCs at concentrations greater than the RGOs would be removed and consolidated in the cap system. Therefore, Alternatives 2a, 2b, and 3 would be equivalent in the long term. All these alternatives rely on the long-term effectiveness of the cap system.

Alternative 4 provides the most effective long-term remediation option. All impacted soil, sediment, and waste would be removed from the site. The complete removal would eliminate monitoring and related long-term issues. Issues related to cap system integrity would not be a concern with this option, as compared to Alternatives 2a, 2b, and 3. The long-term reliability and effectiveness of slope stabilization and erosion control measures are a potential concern for these three alternatives under a severe storm event.

6.2.6 Reduction in the Toxicity, Mobility, or Volume through Treatment

Alternatives 1, 3, and 4 would not include treatment technologies. Alternative 2a would include the use of monitored natural recovery and Alternative 2b would use enhanced biodegradation for the reduction of PAHs in soils. These alternatives would not reduce the toxicity or volume of the waste material or sediment and soil COCs other than that which would result from natural dispersion, dilution, or other attenuating factors. Approximately 2,660 cubic yards of waste material and sediment would be contained within the cap systems in Alternatives 2a and 2b. Approximately 4,325 cubic yards of soil, sediment, and waste materials would be contained within the cap system in Alternative 3. Alternative 4 does not involve any treatment except that which would be required to comply with LDRs. Under Alternative 4, approximately 4,325 cubic yards of waste material, soil, and sediment would be excavated and disposed at an appropriate off-site facility.

6.2.7 Short-Term Effectiveness

This criterion is not applicable to Alternative 1. Under Alternatives 2a, 2b, and 3, there would be short-term effects to the neighboring off-base community traffic conditions because of the 400 truck loads of cap material that would be transported on site. Under Alternative 4, there would be short-term impacts to traffic conditions because of the 608 truck loads of waste material that would be transported off site. The time required to complete remedial actions under these alternatives is anticipated to be less than 1 year. Health and safety training and proper PPE usage would minimize any effects to site workers during implementation of these alternatives.

Under Alternatives 2a, 2b, 3, and 4, vegetation within the debris pile areas and sample locations designated for excavation would be removed. Measures would be conducted to minimize the impact of excavation on the salt marsh. No endangered species are known to live within the boundaries of Site 12.

Under Alternatives 2a, 2b, 3, and 4, aquatic receptors that inhabit the area of impacted sediment would be subject to short-term effects resulting from excavation or covering; however, these areas would be expected to re-establish to natural conditions after implementation.

6.2.8 Implementability

This criterion is not applicable to Alternative 1. The implementation of Alternatives 2a, 2b, 3, and 4 would be technically feasible and relatively simple. Contractors, equipment, and materials are readily available for conducting soil-moving and excavation activities and installing slope stabilization and erosion control measures. Existing exposure pathways of residual risks can be monitored easily.

The implementation of Alternatives 2a, 2b, 3, and 4 is administratively feasible. The MCRD Parris Island Partnering Team consists of representatives of the U.S. EPA, SCDHEC, SCDNR, NOAA, and USFWS, and the U.S. Navy and Marine Corps. Regulatory approval and permitting requirements could be coordinated via this partnering mechanism.

6.2.9 Cost

A cost estimate of each alternative includes both capital and O&M costs. Capital costs include both direct and indirect costs. O&M costs are post-construction activities that are necessary to ensure the continued effectiveness of the alternative.

	Capital Costs ($)	O&M Costs		30-Year Present Worth ($)
		Min ($)	Max ($)	
Alternative 1	--	--	--	--
Alternative 2a				
RCRA C Cap	$1,286,000	$45,500	$92,900	$1,938,000
Soil Cover	$1,099,000	$45,500	$92,900	$1,752,000
Alternative 2b				
RCRA C Cap	$1,458,000	$45,500	$192,900	$2,203,000
Soil Cover	$1,272,000	$45,500	$192,900	$2,018,000

	Capital Costs ($)	O&M Costs		30-Year Present Worth ($)
		Min ($)	Max ($)	
Alternative 3				
RCRA C Cap	$1,609,000	$45,500	$91,500	$2,255,000
Soil Cover	$1,342,000	$45,500	$91,500	$1,988,000
Alternative 4				
RCRA C Cap	$1,450,000	--	--	$1,450,000

TABLE 6-1

COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

Criterion	Alternative 1	Alternative 2a	Alternative 2b	Alternative 3	Alternative 4
Overall Protection of Human Health and the Environment	Not protective.	Protective.	More protective than Alternative 2a.	More protective than Alternative 2a and 2b.	Most protective of any alternative.
Compliance with ARARs/Media Cleanup Standards	Does not comply.	Compliance with AWQCs and MCLs in the future. Complies with Federal and state solid waste and hazardous waste landfill closure requirements.	Compliance with AWQCs and MCLs in the future. Complies with Federal and state solid waste and hazardous waste landfill closure requirements.	Compliance with AWQCs and MCLs in the future. Complies with Federal and state solid waste and hazardous waste landfill closure requirements.	Compliance with soil and sediment chemical-specific ARARs when remedial action is complete. Compliance with AWQCs and MCLs in the future.
Source Control	No source control.	Source control through presumptive remedy of containment. Sediment excavation and consolidation under the cap system.	Source control through presumptive remedy of containment. Sediment excavation and consolidation under the cap system.	Source control through presumptive remedy of containment. Total sediment and soil excavation and consolidation under the cap system	Source control through excavation and off-site disposal.
Waste Management Standards	Not applicable.	Complies with Federal and state solid waste and hazardous waste landfill closure requirements.	Complies with Federal and state solid waste and hazardous waste landfill closure requirements.	Complies with Federal and state solid waste and hazardous waste landfill closure requirements.	Complies with Federal and state solid waste and hazardous waste handling, transportation and disposal requirements.
Long-term Reliability and Effectiveness	Not effective or permanent.	Effective and permanent with proper O&M and land use controls. Long-term monitoring and 5-year reviews are required.	Effective and permanent with proper O&M and land use controls. Long-term monitoring and 5-year reviews are required.	Effective and permanent with proper O&M and land use controls. Long-term monitoring and 5-year reviews are required.	More effective and permanent than 2a, 2b, and 3. No O&M, land use controls, long-term monitoring, or 5-year reviews are required. Long-term management of waste is handled by others.

TABLE 6-1

COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 12/SWMU 10 – JERICHO ISLAND DISPOSAL AREA
MCRD PARRIS ISLAND, SOUTH CAROLINA

Criterion	Alternative 1	Alternative 2a	Alternative 2b	Alternative 3	Alternative 4
Reduction in toxicity, mobility, or volume through treatment	None.	Reduction in contaminant mobility through excavation, consolidation, and capping. Destruction of PAHs through biodegradation. May take 10 to more than 30 years to attain RGOs.	Reduction in contaminant mobility through excavation, consolidation, and capping. Destruction of PAHs through biodegradation. May take in excess of 1 to 5 years to attain RGOs.	Reduction in contaminant mobility through excavation, consolidation, and capping. No treatment. Estimated to take 7 months to achieve RGOs.	Source removed and disposed off-site. No treatment expected. Estimated to take 5 months to achieve RGOs.
Short-term Effectiveness	Not applicable.	Short-term impacts to ecological habitat. Impacts to local community from transportation of cap material on site. Remedial actions completed in 6 months.	Short-term impacts to ecological habitat. Impacts to local community from transportation of cap material on site. Remedial actions completed in 6 months.	Short-term impacts to ecological habitat. Impacts to local community from transportation of cap material on site. Remedial actions completed in 7 months	Short-term impacts to ecological habitat. Impacts to local community from transportation of waste material off site. Remedial actions completed in 5 months.
Implementability	Not applicable.	Readily implementable	Readily implementable.	Readily implementable.	Readily implementable.
Cost	$0	<u>RCRA C Cap</u> Capital $1,286,000 O&M $45,500 to 92,900 Present Worth $1,938,000 <u>RCRA D Cap</u> Capital $1,099,000 O&M $45,500 to 92,900 Present Worth $1,752,000	<u>RCRA C Cap</u> Capital $1,458,000 O&M $45,500 to 192,900 Present Worth $2,203,000 <u>RCRA D Cap</u> Capital $1,272,000 O&M $45,500 to 192,900 Present Worth $2,018,000	<u>RCRA C Cap</u> Capital $1,609,000 O&M $45,500 to 91,500 Present Worth $2,255,000 <u>RCRA D Cap</u> Capital $1,342,000 O&M $45,500 to 91,500 Present Worth $1,988,000	Capital $ 1,450,000 O&M $ 0 Present Worth $ 1,450,000
State and U.S. EPA Acceptance	To be determined.	To be determined.	To be determined.	To be determined.	To be determined.
Community Acceptance	To be determined.	To be determined.	To be determined.	To be determine.	To be determined.

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APPENDIX A

EXCAVATION VOLUME CALCULATIONS

CLIENT: MCRD PARRIS ISLAND		JOB NUMBER: 7803
SUBJECT: SITE 12 / SWMU 10 EXCAVATION REQUIREMENTS		
BASED ON: FIGURE 3-2		DRAWING NUMBER:
BY: TJR Date: 09-12-01	CHECKED BY: KMS Date: 9-12-01	APPROVED BY: DATE:

OBJECTIVE:

To calculate the excavation volumes of soils and debris as outlined on Figure 3-2.

APPROACH:

1. Measure the surface area with a planimeter at each area.
2. Calculate the excavation volumes of each area. Assume a 1-foot excavation depth for Areas 1, 2, 3, 4, and 6. Assume a 2-foot excavation depth for Area 5.
3. For surface debris piles (Areas 1, 2, and 3) add 20% of volume for material above surface.

REFERENCES:

1) Figure 3-2, Contaminated Sediment Delineation Map, Site 12 / SWMU 10, Jericho Island Disposal Area, MCRD Parris Island, South Carolina, TtNUS, July 26, 2001.

CALCULATIONS:

1. Excavation Areas:

The excavation areas as measured with a planimeter are as follows:

Area	Associated sample/Surface debris	Area (si)	Area (sf)	Area (acres)
1	Northern Debris Area	0.269	1,722	0.04
2	Small Southern Debris	2.116	13,542	0.31
3	Large Southern Debris	5.650	36,160	0.83
4	PAI-10-SD-08	1.570	10,053	0.23
5	PAI-10-SS-08	2.344	15,000	0.34
6	PAI-012-03 (37)	2.344	15,000	0.34

Figure Scale = 1" = 80'; therefore 1 in^2 = 6,400 ft^2

CLIENT: MCRD PARRIS ISLAND		JOB NUMBER: 7803
SUBJECT: SITE 12 / SWMU 10 EXCAVATION REQUIREMENTS		
BASED ON: FIGURE 3-2		DRAWING NUMBER:
BY: TJR Date: 09-12-01	CHECKED BY: KMS Date: 9-12-01	APPROVED BY: DATE:

2. Excavation Volumes:

The excavation volumes of each area are calculated as follows:

Area	Excavation Area (sf)	Excavation Depth (ft)	Excavation Volume (cf)	Excavation Volume (cy)
1	1,722	1	1,722	64
1 Debris		20%	344	13
2	13,542	1	13,542	502
2 Debris		20%	2,708	100
3	36,160	1	36,160	1,339
3 Debris		20%	7,232	268
4	10,053	1	10,053	372
5	15,000	2	30,000	1,111
6	15,000	1	15,000	556

TOTAL EXCAVATION AREA = 91,477 sf
2.10 acres
EXCAVATION VOLUME = 116,762 cf
= 4,325 cy

APPENDIX B

COST ESTIMATES

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2A (RCRA C cap): Monitored Natural Recovery of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials
Capital Cost

4/27/2004 4:06 PM

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	500	hr			$30.00		$0	$0	$15,000	$0	$15,000
1.2 Prepare Property Easement	200	hr			$30.00		$0	$0	$6,000	$0	$6,000
2 MOBILIZATION/DEMOBILIZATION											
2.1 Office Trailer	6	mo	$345.00				$2,070	$0	$0	$0	$2,070
2.2 Field Office Support	6	mo		$136.00			$0	$816	$0	$0	$816
2.3 Storage Trailer (1)	6	mo	$103.00				$618	$0	$0	$0	$618
2.4 Electrical Generator	6	mo		$978.75		$1,005.00	$0	$5,873	$0	$6,030	$11,903
2.5 Construction Survey	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
2.6 Equipment Mobilization/Demobilization	5	ea			$64.00	$264.00	$0	$0	$320	$1,320	$1,640
2.7 Site Utilities (2 Cell Phones)	12	mo	$150.00				$1,800	$0	$0	$0	$1,800
2.8 Field Construction Management (3p * 5 days/week)	30	mwk			$2,400.00		$0	$0	$72,000	$0	$72,000
3 DECONTAMINATION											
3.1 Decontamination Services	6	mo	$3,400.00				$20,400	$0	$0	$0	$20,400
3.2 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150
3.3 Decon Water	6000	gal		$0.20			$0	$1,200	$0	$0	$1,200
3.4 Decon Water Storage, 6,000 gallon	6	mo				$600.00	$0	$0	$0	$3,600	$3,600
3.5 Decon Water Storage, 4,000 gallon	6	mo				$540.00	$0	$0	$0	$3,240	$3,240
3.6 PPE (6 p * 5 days * 13 weeks)	390	day		$30.90			$0	$12,051	$0	$0	$12,051
3.7 Disposal of Decon Waste (liquid and solid)	6	mo	$900.00				$5,400	$0	$0	$0	$5,400
4 SITE PREPARATION											
4.1 Clear & Grub Access Road	0.2	ac			$1,075.00	$2,700.00	$0	$0	$215	$540	$755
4.2 Access Road Geotextile	545	sy		$0.84	$0.06	$0.02	$0	$458	$33	$11	$501
4.3 Road Gravel 8" thick	545	sy		$5.45	$1.89	$1.00	$0	$2,970	$1,030	$545	$4,545
5 EXCAVATION AND RESTORATION OF CONTAMINATED AREAS											
5.1 Clear Trees and Brush	1.7	ac			$1,075.00	$2,700.00	$0	$0	$1,828	$4,590	$6,418
5.2 Cofferdam	500	lf	$39.00	$12.00	$20.00	$15.00	$19,500	$6,000	$10,000	$7,500	$43,000
5.3 Excavate Waste Material (Level C)	2655	cy			$5.96	$6.21	$0	$0	$15,824	$16,488	$32,311
5.4 Dewatering Pump	35	day			$83.00	$23.00	$0	$0	$2,905	$805	$3,710
5.5 Filter Pumped Water	35	day		$240.00	$300.00	$175.00	$0	$8,400	$10,500	$6,125	$25,025
5.6 Verification Sampling and Testing (TCLP)	6	ea	$1,407.00		$50.00	$20.00	$8,442	$0	$300	$120	$8,862
5.7 Verification Sampling and Testing (TCL and TAL)	24	ea	$1,407.00		$50.00	$20.00	$33,768	$0	$1,200	$480	$35,448
5.8 Transport Excavated Material to Cap Area	2655	cy			$2.74	$5.30	$0	$0	$7,275	$14,072	$21,346
5.9 Disposal of Oversized Material Offsite	20	ton	$40.00				$800	$0	$0	$0	$800
5.10 Backfill Excavated Areas (subsoil)	1515	cy		$5.30	$0.90	$1.86	$0	$8,030	$1,364	$2,818	$12,211
5.11 Backfill Excavated Areas (topsoil)	1140	cy		$17.87	$3.63	$3.31	$0	$20,372	$4,138	$3,773	$28,283
5.12 Revegetation	8200	sy		$0.26	$1.16	$0.18	$0	$2,132	$9,512	$1,476	$13,120
5.13 Wetland Restoration	692	csf		$16.39	$8.88		$0	$11,342	$6,145	$0	$17,487
6 LANDFILL CAP											
6.1 Clear Trees and Brush	1.2	ac			$1,075.00	$2,700.00	$0	$0	$1,290	$3,240	$4,530
6.2 Grade and Proof Roll Cap Area	3400	sy			$0.24	$0.26	$0	$0	$816	$884	$1,700
6.3 Place, Grade & Compact Contaminated Material	2655	cy			$0.93	$1.24	$0	$0	$2,469	$3,292	$5,761
6.4 Intermediate Cover/Gas collection Layer (12")	1355	cy		$5.64	$2.53	$1.73	$0	$7,642	$3,428	$2,344	$13,415
6.5 Geosynthetic Clay Layer	3400	sy		$5.85	$0.90	$0.90	$0	$19,890	$3,060	$3,060	$26,010
6.6 Geosynthetic Liner	3400	sy		$3.60	$4.50	$2.25	$0	$12,240	$15,300	$7,650	$35,190
6.7 Geosynthetic Drainage Layer	3400	sy		$4.50	$1.80	$0.90	$0	$15,300	$6,120	$3,060	$24,480
6.8 Cover Soil (18")	1700	cy		$5.30	$0.90	$1.86	$0	$9,010	$1,530	$3,162	$13,702
6.9 Topsoil (6")	570	cy		$17.87	$3.63	$3.31	$0	$10,186	$2,069	$1,887	$14,142
6.10 Revegetation	5625	sy		$0.26	$1.16	$0.18	$0	$1,463	$6,525	$1,013	$9,000
7 SITE RESTORATION/MONITORING WELLS											
7.1 Site Access Road Removal	545	cy			$1.70	$0.72	$0	$0	$927	$392	$1,319
7.2 Access Road Disposal	820	ton	$40.00				$32,800	$0	$0	$0	$32,800
7.3 Access Road Stand	90	cy		$7.89	$0.91	$1.68	$0	$710	$82	$151	$943

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2A (RCRA C cap): Monitored Natural Recovery of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
7.4 Access Road Revegetation (Wetland Restoration)	50	csf		$16.39	$8.88		$0	$820	$444	$0	$1,264
7.5 Abandon Existing Wells	315	lf	$5.25				$1,654	$0	$0	$0	$1,654
7.6 Install Monitoring Wells (4@10' & 4@30')	160	lf	$65.00				$10,400	$0	$0	$0	$10,400
7.7 Well Development (4 hr/well)	32	hr	$35.00				$1,120	$0	$0	$0	$1,120
7.8 Collect/Containerize IDW	16	drum	$55.00				$880	$0	$0	$0	$880
7.9 Transport /Dispose IDW (2 drums/well)	16	drum	$170.00				$2,720	$0	$0	$0	$2,720
7.10 Fencing	700	lf		$9.20	$3.73	$2.16	$0	$6,440	$2,611	$1,512	$10,563
7.11 Gate	1	ea		$520.00	$280.00	$162.00	$0	$520	$280	$162	$962
7.12 Signage	5	ea		$51.50	$12.80	$7.40	$0	$258	$64	$37	$359
Subtotal							$145,372	$169,920	$219,252	$106,078	$640,623
Local Area Adjustments							100.0%	96.2%	82.0%	82.0%	
							$145,372	$163,463	$179,787	$86,984	$575,606
Overhead on Labor Cost @ 30%									$53,936		$53,936
G & A on Labor Cost @ 10%									$17,979		$17,979
G & A on Material Cost @ 10%								$16,346			$16,346
G & A on Subcontract Cost @ 10%							$14,537				$14,537
Total Direct Cost							$159,909	$179,810	$251,702	$86,984	$678,405
Indirects on Total Direct Cost @ 35%		(excluding disposal costs)									$223,666
Profit on Total Direct Cost @ 10%											$67,840
Subtotal											$969,911
Health & Safety Monitoring @ 2%											$19,398
Total Field Cost											$989,309
Contingency on Total Field Costs @ 20%											$197,862
Engineering on Total Field Cost @ 10%											$98,931
TOTAL COST											**$1,286,102**

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2A (RCRA C cap): Monitored Natural Recovery of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Ma
Annual Cost

Item	Item Cost year 1	Item Cost years 2 to 5 per round	Item Cost years 6 to 30 per round	Item Cost Every 5 Years	Notes
Sampling	$20,000	$5,000	$5,000		Labor, Field Supplies, Travel
Analysis/Water (1)	$28,000	$7,000	$7,000		Analyze eight groundwater samples for full TCL/TAL including blanks and duplicates. Monitor for 30 years.
Analysis/Soil	$1,400	$1,400			Analyze nine soil samples for PAH including blanks and duplicates Monitor for 5 years.
Maintenance	$3,500	$3,500	$3,500		Landfill cap maintenance (seed, mowing, cover repair)
Plans	$10,000				Health and Safety Plan and Sampling Plan
Report	$30,000	$30,000	$30,000		Document sampling events and results
Site Review				$18,000	Perform 5-Year Review
TOTALS	$92,900	$46,900	$45,500	$18,000	

(1) Water sampling rounds would occur quarterly the first year and annually for years 2 through 30.

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2A (RCRA C cap): Monitored Natural Recovery of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,286,102		$1,286,102	1.000	$1,286,102
1		$92,900	$92,900	0.935	$86,862
2		$46,900	$46,900	0.873	$40,944
3		$46,900	$46,900	0.816	$38,270
4		$46,900	$46,900	0.763	$35,785
5		$64,900	$64,900	0.713	$46,274
6		$45,500	$45,500	0.666	$30,303
7		$45,500	$45,500	0.623	$28,347
8		$45,500	$45,500	0.582	$26,481
9		$45,500	$45,500	0.544	$24,752
10		$63,500	$63,500	0.508	$32,258
11		$45,500	$45,500	0.475	$21,613
12		$45,500	$45,500	0.444	$20,202
13		$45,500	$45,500	0.415	$18,883
14		$45,500	$45,500	0.388	$17,654
15		$63,500	$63,500	0.362	$22,987
16		$45,500	$45,500	0.339	$15,425
17		$45,500	$45,500	0.317	$14,424
18		$45,500	$45,500	0.296	$13,468
19		$45,500	$45,500	0.277	$12,604
20		$63,500	$63,500	0.258	$16,383
21		$45,500	$45,500	0.242	$11,011
22		$45,500	$45,500	0.226	$10,283
23		$45,500	$45,500	0.211	$9,601
24		$45,500	$45,500	0.197	$8,964
25		$63,500	$63,500	0.184	$11,684
26		$45,500	$45,500	0.172	$7,826
27		$45,500	$45,500	0.161	$7,326
28		$45,500	$45,500	0.15	$6,825
29		$45,500	$45,500	0.141	$6,416
30		$63,500	$63,500	0.131	$8,319
				TOTAL PRESENT WORTH	$1,938,270

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2A (Soil Cover): Monitored Natural Recovery of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials
Capital Cost

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	500	hr			$30.00		$0	$0	$15,000	$0	$15,000
1.2 Prepare Property Easement	200	hr			$30.00		$0	$0	$6,000	$0	$6,000
2 MOBILIZATION/DEMOBILIZATION											
2.1 Office Trailer	6	mo	$345.00				$2,070	$0	$0	$0	$2,070
2.2 Field Office Support	6	mo		$136.00			$0	$816	$0	$0	$816
2.3 Storage Trailer (1)	6	mo	$103.00				$618	$0	$0	$0	$618
2.4 Electrical Generator	6	mo		$978.75		$1,005.00	$0	$5,873	$0	$6,030	$11,903
2.5 Construction Survey	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
2.6 Equipment Mobilization/Demobilization	5	ea			$64.00	$264.00	$0	$0	$320	$1,320	$1,640
2.7 Site Utilities (2 Cell Phones)	12	mo	$150.00				$1,800	$0	$0	$0	$1,800
2.8 Field Construction Management (3p * 5 days/week)	30	mwk			$2,400.00		$0	$0	$72,000	$0	$72,000
3 DECONTAMINATION											
3.1 Decontamination Services	6	mo	$3,400.00				$20,400	$0	$0	$0	$20,400
3.2 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150
3.3 Decon Water	6000	gal		$0.20			$0	$1,200	$0	$0	$1,200
3.4 Decon Water Storage, 6,000 gallon	6	mo				$600.00	$0	$0	$0	$3,600	$3,600
3.5 Decon Water Storage, 4,000 gallon	6	mo				$540.00	$0	$0	$0	$3,240	$3,240
3.6 PPE (6 p * 5 days * 13 weeks)	390	day		$30.90			$0	$12,051	$0	$0	$12,051
3.7 Disposal of Decon Waste (liquid and solid)	6	mo	$900.00				$5,400	$0	$0	$0	$5,400
4 SITE PREPARATION											
4.1 Clear & Grub Access Road	0.2	ac			$1,075.00	$2,700.00	$0	$0	$215	$540	$755
4.2 Access Road Geotextile	545	sy		$0.84	$0.06	$0.02	$0	$458	$33	$11	$501
4.3 Road Gravel 8" thick	545	sy		$5.45	$1.89	$1.00	$0	$2,970	$1,030	$545	$4,545
5 EXCAVATION AND RESTORATION OF CONTAMINATED AREAS											
5.1 Clear Trees and Brush	1.7	ac			$1,075.00	$2,700.00	$0	$0	$1,828	$4,590	$6,418
5.2 Cofferdam	500	lf	$39.00	$12.00	$20.00	$15.00	$19,500	$6,000	$10,000	$7,500	$43,000
5.3 Excavate Waste Material (Level C)	2655	cy			$5.96	$6.21	$0	$0	$15,824	$16,488	$32,311
5.4 Dewatering Pump	35	day			$83.00	$23.00	$0	$0	$2,905	$805	$3,710
5.5 Filter Pumped Water	35	day		$240.00	$300.00	$175.00	$0	$8,400	$10,500	$6,125	$25,025
5.6 Verification Sampling and Testing (TCLP)	6	ea	$1,407.00		$50.00	$20.00	$8,442	$0	$300	$120	$8,862
5.7 Verification Sampling and Testing (TCL and TAL)	24	ea	$1,407.00		$50.00	$20.00	$33,768	$0	$1,200	$480	$35,448
5.8 Transport Excavated Material to Cap Area	2655	cy			$2.74	$5.30	$0	$0	$7,275	$14,072	$21,346
5.9 Disposal of Oversized Material Offsite	20	ton	$40.00				$800	$0	$0	$0	$800
5.10 Backfill Excavated Areas (subsoil)	1515	cy		$5.30	$0.90	$1.86	$0	$8,030	$1,364	$2,818	$12,211
5.11 Backfill Excavated Areas (topsoil)	1140	cy		$17.87	$3.63	$3.31	$0	$20,372	$4,138	$3,773	$28,283
5.12 Revegetation	8200	sy		$0.26	$1.16	$0.18	$0	$2,132	$9,512	$1,476	$13,120
5.13 Wetland Restoration	692	csf		$16.39	$8.88		$0	$11,342	$6,145	$0	$17,487
6 LANDFILL CAP											
6.1 Clear Trees and Brush	1.2	ac			$1,075.00	$2,700.00	$0	$0	$1,290	$3,240	$4,530
6.2 Grade and Proof Roll Cap Area	3400	sy			$0.24	$0.26	$0	$0	$816	$884	$1,700
6.3 Place, Grade & Compact Contaminated Material	2655	cy			$0.93	$1.24	$0	$0	$2,469	$3,292	$5,761
6.4 Biotic Layer, 6" crush gravel	678	cy		$5.64	$2.53	$1.73	$0	$3,821	$1,714	$1,172	$6,707
6.5 Cover Soil (18")	1700	cy		$5.30	$0.90	$1.86	$0	$9,010	$1,530	$3,162	$13,702
6.6 Topsoil (6")	570	cy		$17.87	$3.63	$3.31	$0	$10,186	$2,069	$1,887	$14,142
6.7 Revegetation	5625	sy		$0.26	$1.16	$0.18	$0	$1,463	$6,525	$1,013	$9,000
7 SITE RESTORATION/MONITORING WELLS											
7.1 Site Access Road Removal	545	cy			$1.70	$0.72	$0	$0	$927	$392	$1,319
7.2 Access Road Disposal	820	ton	$40.00				$32,800	$0	$0	$0	$32,800
7.3 Access Road Stand	90	cy		$7.89	$0.91	$1.68	$0	$710	$82	$151	$943
7.4 Access Road Revegetation (Wetland Restoration)	50	csf		$16.39	$8.88		$0	$820	$444	$0	$1,264
7.5 Abandon Existing Wells	315	lf	$5.25				$1,654	$0	$0	$0	$1,654
7.6 Install Monitoring Wells (4@10' & 4@30')	160	lf	$65.00				$10,400	$0	$0	$0	$10,400

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2A (Soil Cover): Monitored Natural Recovery of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
7.7 Well Development (4 hr/well)	32	hr	$35.00				$1,120	$0	$0	$0	$1,120
7.8 Collect/Containerize IDW	16	drum	$55.00				$880	$0	$0	$0	$880
7.9 Transport /Dispose IDW (2 drums/well)	16	drum	$170.00				$2,720	$0	$0	$0	$2,720
7.10 Fencing	700	lf		$9.20	$3.73	$2.16	$0	$6,440	$2,611	$1,512	$10,563
7.11 Gate	1	ea		$520.00	$280.00	$162.00	$0	$520	$280	$162	$962
7.12 Signage	5	ea		$51.50	$12.80	$7.40	$0	$258	$64	$37	$359
Subtotal							$145,372	$118,669	$193,058	$91,136	$548,236
Local Area Adjustments							100.0%	96.2%	82.0%	82.0%	
							$145,372	$114,160	$158,308	$74,732	$492,571
Overhead on Labor Cost @ 30%									$47,492		$47,492
G & A on Labor Cost @ 10%									$15,831		$15,831
G & A on Material Cost @ 10%								$11,416			$11,416
G & A on Subcontract Cost @ 10%							$14,537				$14,537
Total Direct Cost							$159,909	$125,576	$221,631	$74,732	$581,847
Indirects on Total Direct Cost @ 35%		(excluding disposal costs)									$189,045
Profit on Total Direct Cost @ 10%											$58,185
Subtotal											$829,077
Health & Safety Monitoring @ 2%											$16,582
Total Field Cost											$845,658
Contingency on Total Field Costs @ 20%											$169,132
Engineering on Total Field Cost @ 10%											$84,566
TOTAL COST											**$1,099,356**

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2A (Soil Cover): Monitored Natural Recovery of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Mate
Annual Cost

Item	Item Cost year 1	Item Cost years 2 to 5 per round	Item Cost years 6 to 30 per round	Item Cost Every 5 Years	Notes
Sampling	$20,000	$5,000	$5,000		Labor, Field Supplies, Travel
Analysis/Water (1)	$28,000	$7,000	$7,000		Analyze eight groundwater samples for full TCL/TAL including blanks and duplicates. Monitor for 30 years.
Analysis/Soil	$1,400	$1,400			Analyze nine soil samples for PAH including blanks and duplicates Monitor for 5 years.
Maintenance	$3,500	$3,500	$3,500		Landfill cap maintenance (seed, mowing, cover repair)
Plans	$10,000				Health and Safety Plan and Sampling Plan
Report	$30,000	$30,000	$30,000		Document sampling events and results
Site Review				$18,000	Perform 5-Year Review
TOTALS	$92,900	$46,900	$45,500	$18,000	

(1) Water sampling rounds would occur quarterly the first year and annually for years 2 through 30.

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2A (Soil Cover): Monitored Natural Recovery of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,099,356		$1,099,356	1.000	$1,099,356
1		$92,900	$92,900	0.935	$86,862
2		$46,900	$46,900	0.873	$40,944
3		$46,900	$46,900	0.816	$38,270
4		$46,900	$46,900	0.763	$35,785
5		$64,900	$64,900	0.713	$46,274
6		$45,500	$45,500	0.666	$30,303
7		$45,500	$45,500	0.623	$28,347
8		$45,500	$45,500	0.582	$26,481
9		$45,500	$45,500	0.544	$24,752
10		$63,500	$63,500	0.508	$32,258
11		$45,500	$45,500	0.475	$21,613
12		$45,500	$45,500	0.444	$20,202
13		$45,500	$45,500	0.415	$18,883
14		$45,500	$45,500	0.388	$17,654
15		$63,500	$63,500	0.362	$22,987
16		$45,500	$45,500	0.339	$15,425
17		$45,500	$45,500	0.317	$14,424
18		$45,500	$45,500	0.296	$13,468
19		$45,500	$45,500	0.277	$12,604
20		$63,500	$63,500	0.258	$16,383
21		$45,500	$45,500	0.242	$11,011
22		$45,500	$45,500	0.226	$10,283
23		$45,500	$45,500	0.211	$9,601
24		$45,500	$45,500	0.197	$8,964
25		$63,500	$63,500	0.184	$11,684
26		$45,500	$45,500	0.172	$7,826
27		$45,500	$45,500	0.161	$7,326
28		$45,500	$45,500	0.15	$6,825
29		$45,500	$45,500	0.141	$6,416
30		$63,500	$63,500	0.131	$8,319
				TOTAL PRESENT WORTH	$1,751,523

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2B (RCRA C cap): Enhanced Biodegradation of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials
Capital Cost

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	500	hr			$30.00		$0	$0	$15,000	$0	$15,000
1.2 Prepare Property Easement	200	hr			$30.00		$0	$0	$6,000	$0	$6,000
2 MOBILIZATION/DEMOBILIZATION											
2.1 Office Trailer	6	mo	$345.00				$2,070	$0	$0	$0	$2,070
2.2 Field Office Support	6	mo		$136.00			$0	$816	$0	$0	$816
2.3 Storage Trailer (1)	6	mo	$103.00				$618	$0	$0	$0	$618
2.4 Electrical Generator	6	mo		$978.75		$1,005.00	$0	$5,873	$0	$6,030	$11,903
2.5 Construction Survey	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
2.6 Equipment Mobilization/Demobilization	5	ea			$64.00	$264.00	$0	$0	$320	$1,320	$1,640
2.7 Site Utilities (2 Cell Phones)	12	mo	$150.00				$1,800	$0	$0	$0	$1,800
2.8 Field Construction Management (3p * 5 days/week)	30	mwk			$2,400.00		$0	$0	$72,000	$0	$72,000
3 DECONTAMINATION											
3.1 Decontamination Services	6	mo	$3,400.00				$20,400	$0	$0	$0	$20,400
3.2 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150
3.3 Decon Water	6,000	gal		$0.20			$0	$1,200	$0	$0	$1,200
3.4 Decon Water Storage, 6,000 gallon	6	mo				$600.00	$0	$0	$0	$3,600	$3,600
3.5 Decon Water Storage, 4,000 gallon	6	mo				$540.00	$0	$0	$0	$3,240	$3,240
3.6 PPE (6 p * 5 days * 13 weeks)	390	day		$30.90			$0	$12,051	$0	$0	$12,051
3.7 Disposal of Decon Waste (liquid and solid)	6	mo	$900.00				$5,400	$0	$0	$0	$5,400
4 SITE PREPARATION											
4.1 Clear & Grub Access Road	0	ac			$1,075.00	$2,700.00	$0	$0	$215	$540	$755
4.2 Access Road Geotextile	545	sy		$0.84	$0.06	$0.02	$0	$458	$33	$11	$501
4.3 Road Gravel 8" thick	545	sy		$5.45	$1.89	$1.00	$0	$2,970	$1,030	$545	$4,545
5 EXCAVATION AND RESTORATION OF CONTAMINATED AREAS											
5.1 Clear Trees and Brush	2	ac			$1,075.00	$2,700.00	$0	$0	$1,828	$4,590	$6,418
5.2 Cofferdam	500	lf	$39.00	$12.00	$20.00	$15.00	$19,500	$6,000	$10,000	$7,500	$43,000
5.3 Excavate Waste Material (Level C)	2,655	cy			$5.96	$6.21	$0	$0	$15,824	$16,488	$32,311
5.4 Dewatering Pump	35	day			$83.00	$23.00	$0	$0	$2,905	$805	$3,710
5.5 Filter Pumped Water	35	day		$240.00	$300.00	$175.00	$0	$8,400	$10,500	$6,125	$25,025
5.6 Verification Sampling and Testing (TCLP)	6	ea	$1,407.00		$50.00	$20.00	$8,442	$0	$300	$120	$8,862
5.7 Verification Sampling and Testing (TCL and TAL)	24	ea	$1,407.00		$50.00	$20.00	$33,768	$0	$1,200	$480	$35,448
5.8 Transport Excavated Material to Cap Area	2,655	cy			$2.74	$5.30	$0	$0	$7,275	$14,072	$21,346
5.9 Disposal of Oversized Material Offsite	20	ton	$40.00				$800	$0	$0	$0	$800
5.10 Backfill Excavated Areas (subsoil)	1,515	cy		$5.30	$0.90	$1.86	$0	$8,030	$1,364	$2,818	$12,211
5.11 Backfill Excavated Areas (topsoil)	1,140	cy		$17.87	$3.63	$3.31	$0	$20,372	$4,138	$3,773	$28,283
5.12 Revegetation	8,200	sy		$0.26	$1.16	$0.18	$0	$2,132	$9,512	$1,476	$13,120
5.13 Wetland Restoration	692	csf		$16.39	$8.88		$0	$11,342	$6,145	$0	$17,487
6 EXCAVATION AND RESTORATION OF CONTAMINATED AREAS											
6.1 Clear Trees and Brush	1	ac			$1,075.00	$2,700.00	$0	$0	$860	$2,160	$3,020
6.2 Soil Biodegradation with Tilling	1,667	cy		$5.00	$18.00	$27.00	$0	$8,335	$30,006	$45,009	$83,350
6.3 Revegetation	3,950	sy		$0.26	$1.16	$0.18	$0	$1,027	$4,582	$711	$6,320
7 LANDFILL CAP											
7.1 Clear Trees and Brush	1	ac			$1,075.00	$2,700.00	$0	$0	$1,290	$3,240	$4,530
7.2 Grade and Proof Roll Cap Area	3,400	sy			$0.24	$0.26	$0	$0	$816	$884	$1,700
7.3 Place, Grade & Compact Contaminated Material	2,655	cy			$0.93	$1.24	$0	$0	$2,469	$3,292	$5,761
7.4 Intermediate Cover/Gas collection Layer (12")	1,355	cy		$5.64	$2.53	$1.73	$0	$7,642	$3,428	$2,344	$13,415
7.5 Geosynthetic Clay Layer	3,400	sy		$5.85	$0.90	$0.90	$0	$19,890	$3,060	$3,060	$26,010
7.6 Geosynthetic Liner	3,400	sy		$3.60	$4.50	$2.25	$0	$12,240	$15,300	$7,650	$35,190
7.7 Geosynthetic Drainage Layer	3,400	sy		$4.50	$1.80	$0.90	$0	$15,300	$6,120	$3,060	$24,480
7.8 Cover Soil (18")	1,700	cy		$5.30	$0.90	$1.86	$0	$9,010	$1,530	$3,162	$13,702
7.9 Topsoil (6")	570	cy		$17.87	$3.63	$3.31	$0	$10,186	$2,069	$1,887	$14,142
7.10 Revegetation	5,625	sy		$0.26	$1.16	$0.18	$0	$1,463	$6,525	$1,013	$9,000

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2B (RCRA C cap): Enhanced Biodegradation of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials
Capital Cost

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
8 SITE RESTORATION/MONITORING WELLS											
8.1 Site Access Road Removal	545	cy			$1.70	$0.72	$0	$0	$927	$392	$1,319
8.2 Access Road Disposal	820	ton	$40.00				$32,800	$0	$0	$0	$32,800
8.3 Access Road Stand	90	cy		$7.89	$0.91	$1.68	$0	$710	$82	$151	$943
8.4 Access Road Revegetation (Wetland Restoration)	50	csf		$16.39	$8.88		$0	$820	$444	$0	$1,264
8.5 Abandon Existing Wells	315	lf	$5.25				$1,654	$0	$0	$0	$1,654
8.6 Install Monitoring Wells (4 @ 10' & 4 @ 30')	160	lf	$65.00				$10,400	$0	$0	$0	$10,400
8.7 Well Development (4 hr/well)	32	hr	$35.00				$1,120	$0	$0	$0	$1,120
8.8 Collect/Containerize IDW	16	drum	$55.00				$880	$0	$0	$0	$880
8.9 Transport /Dispose IDW (2 drums/well)	16	drum	$170.00				$2,720	$0	$0	$0	$2,720
8.10 Fencing	700	lf		$9.20	$3.73	$2.16	$0	$6,440	$2,611	$1,512	$10,563
8.11 Gate	1	ea		$520.00	$280.00	$162.00	$0	$520	$280	$162	$962
8.12 Signage	5	ea		$51.50	$12.80	$7.40	$0	$258	$64	$37	$359
Subtotal							$145,372	$179,282	$254,700	$153,958	$733,313
Local Area Adjustments							100.0%	96.2%	82.0%	82.0%	
							$145,372	$172,470	$208,854	$126,246	$652,942
Overhead on Labor Cost @ 30%									$62,656		$62,656
G & A on Labor Cost @ 10%									$20,885		$20,885
G & A on Material Cost @ 10%								$17,247			$17,247
G & A on Subcontract Cost @ 10%							$14,537				$14,537
Total Direct Cost							$159,909	$189,717	$292,396	$126,246	$768,267
Indirects on Total Direct Cost @ 35%		(excluding disposal costs)									$254,292
Profit on Total Direct Cost @ 10%											$76,827
Subtotal											$1,099,386
Health & Safety Monitoring @ 2%											$21,988
Total Field Cost											$1,121,373
Contingency on Total Field Costs @ 20%											$224,275
Engineering on Total Field Cost @ 10%											$112,137
TOTAL COST											**$1,457,785**

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2B (RCRA C cap): Enhanced Biodegradation of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Mate
Annual Cost

Item	Item Cost year 1	Item Cost years 2 to 5 per round	Item Cost years 6 to 30 per round	Item Cost Every 5 Years	Notes
Sampling	$20,000	$5,000	$5,000		Labor, Field Supplies, Travel
Analysis/Water (1)	$28,000	$7,000	$7,000		Analyze eight groundwater samples for full TCL/TAL including blanks and duplicates. Monitor for 30 years.
Analysis/Soil	$1,400	$1,400			Analyze nine soil samples for PAH including blanks and duplicates Monitor for 5 years.
Maintenance	$3,500	$3,500	$3,500		Landfill cap maintenance (seed, mowing, cover repair)
Biodegradation	$100,000				Second Application of of Soil Biodegradation with Tilling
Plans	$10,000				Health and Safety Plan and Sampling Plan
Report	$30,000	$30,000	$30,000		Document sampling events and results
Site Review				$18,000	Perform 5-Year Review
TOTALS	$192,900	$46,900	$45,500	$18,000	

(1) Water sampling rounds would occur quarterly the first year and annually for years 2 through 30.

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2B (RCRA C cap): Enhanced Biodegradation of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,457,785		$1,457,785	1.000	$1,457,785
1		$192,900	$192,900	0.935	$180,362
2		$46,900	$46,900	0.873	$40,944
3		$46,900	$46,900	0.816	$38,270
4		$46,900	$46,900	0.763	$35,785
5		$64,900	$64,900	0.713	$46,274
6		$45,500	$45,500	0.666	$30,303
7		$45,500	$45,500	0.623	$28,347
8		$45,500	$45,500	0.582	$26,481
9		$45,500	$45,500	0.544	$24,752
10		$63,500	$63,500	0.508	$32,258
11		$45,500	$45,500	0.475	$21,613
12		$45,500	$45,500	0.444	$20,202
13		$45,500	$45,500	0.415	$18,883
14		$45,500	$45,500	0.388	$17,654
15		$63,500	$63,500	0.362	$22,987
16		$45,500	$45,500	0.339	$15,425
17		$45,500	$45,500	0.317	$14,424
18		$45,500	$45,500	0.296	$13,468
19		$45,500	$45,500	0.277	$12,604
20		$63,500	$63,500	0.258	$16,383
21		$45,500	$45,500	0.242	$11,011
22		$45,500	$45,500	0.226	$10,283
23		$45,500	$45,500	0.211	$9,601
24		$45,500	$45,500	0.197	$8,964
25		$63,500	$63,500	0.184	$11,684
26		$45,500	$45,500	0.172	$7,826
27		$45,500	$45,500	0.161	$7,326
28		$45,500	$45,500	0.15	$6,825
29		$45,500	$45,500	0.141	$6,416
30		$63,500	$63,500	0.131	$8,319
				TOTAL PRESENT WORTH	$2,203,453

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2B (Soil Cover): Enhanced Biodegradation of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials
Capital Cost

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	500	hr			$30.00		$0	$0	$15,000	$0	$15,000
1.2 Prepare Property Easement	200	hr			$30.00		$0	$0	$6,000	$0	$6,000
2 MOBILIZATION/DEMOBILIZATION											
2.1 Office Trailer	6	mo	$345.00				$2,070	$0	$0	$0	$2,070
2.2 Field Office Support	6	mo		$136.00			$0	$816	$0	$0	$816
2.3 Storage Trailer (1)	6	mo	$103.00				$618	$0	$0	$0	$618
2.4 Electrical Generator	6	mo		$978.75		$1,005.00	$0	$5,873	$0	$6,030	$11,903
2.5 Construction Survey	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
2.6 Equipment Mobilization/Demobilization	5	ea			$64.00	$264.00	$0	$0	$320	$1,320	$1,640
2.7 Site Utilities (2 Cell Phones)	12	mo	$150.00				$1,800	$0	$0	$0	$1,800
2.8 Field Construction Management (3p * 5 days/week)	30	mwk			$2,400.00		$0	$0	$72,000	$0	$72,000
3 DECONTAMINATION											
3.1 Decontamination Services	6	mo	$3,400.00				$20,400	$0	$0	$0	$20,400
3.2 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150
3.3 Decon Water	6,000	gal		$0.20			$0	$1,200	$0	$0	$1,200
3.4 Decon Water Storage, 6,000 gallon	6	mo				$600.00	$0	$0	$0	$3,600	$3,600
3.5 Decon Water Storage, 4,000 gallon	6	mo				$540.00	$0	$0	$0	$3,240	$3,240
3.6 PPE (6 p * 5 days * 13 weeks)	390	day		$30.90			$0	$12,051	$0	$0	$12,051
3.7 Disposal of Decon Waste (liquid and solid)	6	mo	$900.00				$5,400	$0	$0	$0	$5,400
4 SITE PREPARATION											
4.1 Clear & Grub Access Road	0	ac			$1,075.00	$2,700.00	$0	$0	$215	$540	$755
4.2 Access Road Geotextile	545	sy		$0.84	$0.06	$0.02	$0	$458	$33	$11	$501
4.3 Road Gravel 8" thick	545	sy		$5.45	$1.89	$1.00	$0	$2,970	$1,030	$545	$4,545
5 EXCAVATION AND RESTORATION OF CONTAMINATED AREAS											
5.1 Clear Trees and Brush	2	ac			$1,075.00	$2,700.00	$0	$0	$1,828	$4,590	$6,418
5.2 Cofferdam	500	lf	$39.00	$12.00	$20.00	$15.00	$19,500	$6,000	$10,000	$7,500	$43,000
5.3 Excavate Waste Material (Level C)	2,655	cy			$5.96	$6.21	$0	$0	$15,824	$16,488	$32,311
5.4 Dewatering Pump	35	day			$83.00	$23.00	$0	$0	$2,905	$805	$3,710
5.5 Filter Pumped Water	35	day		$240.00	$300.00	$175.00	$0	$8,400	$10,500	$6,125	$25,025
5.6 Verification Sampling and Testing (TCLP)	6	ea	$1,407.00		$50.00	$20.00	$8,442	$0	$300	$120	$8,862
5.7 Verification Sampling and Testing (TCL and TAL)	24	ea	$1,407.00		$50.00	$20.00	$33,768	$0	$1,200	$480	$35,448
5.8 Transport Excavated Material to Cap Area	2,655	cy			$2.74	$5.30	$0	$0	$7,275	$14,072	$21,346
5.9 Disposal of Oversized Material Offsite	20	ton	$40.00				$800	$0	$0	$0	$800
5.10 Backfill Excavated Areas (subsoil)	1,515	cy		$5.30	$0.90	$1.86	$0	$8,030	$1,364	$2,818	$12,211
5.11 Backfill Excavated Areas (topsoil)	1,140	cy		$17.87	$3.63	$3.31	$0	$20,372	$4,138	$3,773	$28,283
5.12 Revegetation	8,200	sy		$0.26	$1.16	$0.18	$0	$2,132	$9,512	$1,476	$13,120
5.13 Wetland Restoration	692	csf		$16.39	$8.88		$0	$11,342	$6,145	$0	$17,487
6 EXCAVATION AND RESTORATION OF CONTAMINATED AREAS											
6.1 Clear Trees and Brush	1	ac			$1,075.00	$2,700.00	$0	$0	$860	$2,160	$3,020
6.2 Soil Biodegradation with Tilling	1,667	cy		$5.00	$18.00	$27.00	$0	$8,335	$30,006	$45,009	$83,350
6.3 Revegetation	3,950	sy		$0.26	$1.16	$0.18	$0	$1,027	$4,582	$711	$6,320
7 LANDFILL CAP											
7.1 Clear Trees and Brush	1	ac			$1,075.00	$2,700.00	$0	$0	$1,290	$3,240	$4,530
7.2 Grade and Proof Roll Cap Area	3,400	sy			$0.24	$0.26	$0	$0	$816	$884	$1,700
7.3 Place, Grade & Compact Contaminated Material	2,655	cy			$0.93	$1.24	$0	$0	$2,469	$3,292	$5,761
7.4 Biotic Layer, 6" crush gravel	678	cy		$5.64	$2.53	$1.73	$0	$3,821	$1,714	$1,172	$6,707
7.5 Cover Soil (18")	1,700	cy		$5.30	$0.90	$1.86	$0	$9,010	$1,530	$3,162	$13,702
7.6 Topsoil (6")	570	cy		$17.87	$3.63	$3.31	$0	$10,186	$2,069	$1,887	$14,142
7.7 Revegetation	5,625	sy		$0.26	$1.16	$0.18	$0	$1,463	$6,525	$1,013	$9,000
8 SITE RESTORATION/MONITORING WELLS											
8.1 Site Access Road Removal	545	cy			$1.70	$0.72	$0	$0	$927	$392	$1,319
8.2 Access Road Disposal	820	ton	$40.00				$32,800	$0	$0	$0	$32,800

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2B (Soil Cover): Enhanced Biodegradation of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
8.3 Access Road Stand	90	cy		$7.89	$0.91	$1.68	$0	$710	$82	$151	$943
8.4 Access Road Revegetation (Wetland Restoration)	50	csf		$16.39	$8.88		$0	$820	$444	$0	$1,264
8.5 Abandon Existing Wells	315	lf	$5.25				$1,654	$0	$0	$0	$1,654
8.6 Install Monitoring Wells (4 @ 10' & 4 @ 30')	160	lf	$65.00				$10,400	$0	$0	$0	$10,400
8.7 Well Development (4 hr/well)	32	hr	$35.00				$1,120	$0	$0	$0	$1,120
8.8 Collect/Containerize IDW	16	drum	$55.00				$880	$0	$0	$0	$880
8.9 Transport /Dispose IDW (2 drums/well)	16	drum	$170.00				$2,720	$0	$0	$0	$2,720
8.10 Fencing	700	lf		$9.20	$3.73	$2.16	$0	$6,440	$2,611	$1,512	$10,563
8.11 Gate	1	ea		$520.00	$280.00	$162.00	$0	$520	$280	$162	$962
8.12 Signage	5	ea		$51.50	$12.80	$7.40	$0	$258	$64	$37	$359
Subtotal							$145,372	$128,031	$228,506	$139,016	$640,926
Local Area Adjustments							100.0%	96.2%	82.0%	82.0%	
							$145,372	$123,166	$187,375	$113,993	$569,906
Overhead on Labor Cost @ 30%									$56,213		$56,213
G & A on Labor Cost @ 10%									$18,738		$18,738
G & A on Material Cost @ 10%								$12,317			$12,317
G & A on Subcontract Cost @ 10%							$14,537				$14,537
Total Direct Cost							$159,909	$135,483	$262,325	$113,993	$671,710
Indirects on Total Direct Cost @ 35%		(excluding disposal costs)									$220,497
Profit on Total Direct Cost @ 10%											$67,171
Subtotal											$959,378
Health & Safety Monitoring @ 2%											$19,188
Total Field Cost											$978,565
Contingency on Total Field Costs @ 20%											$195,713
Engineering on Total Field Cost @ 10%											$97,857
TOTAL COST											**$1,272,135**

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2B (Soil Cover): Enhanced Biodegradation of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materi
Annual Cost

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Item	Item Cost year 1	Item Cost years 2 to 5 per round	Item Cost years 6 to 30 per round	Item Cost Every 5 Years	Notes
Sampling	$20,000	$5,000	$5,000		Labor, Field Supplies, Travel
Analysis/Water (1)	$28,000	$7,000	$7,000		Analyze eight groundwater samples for full TCL/TAL including blanks and duplicates. Monitor for 30 years.
Analysis/Soil	$1,400	$1,400			Analyze nine soil samples for PAH including blanks and duplicates Monitor for 5 years.
Maintenance	$3,500	$3,500	$3,500		Landfill cap maintenance (seed, mowing, cover repair)
Biodegradation	$100,000				Second Application of of Soil Biodegradation with Tilling
Plans	$10,000				Health and Safety Plan and Sampling Plan
Report	$30,000	$30,000	$30,000		Document sampling events and results
Site Review				$18,000	Perform 5-Year Review
TOTALS	$192,900	$46,900	$45,500	$18,000	

(1) Water sampling rounds would occur quarterly the first year and annually for years 2 through 30.

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 2B (Soil Cover): Enhanced Biodegradation of PAH Contaminated Soil and Excavation/Consolidation/Capping of Contaminated Sediment and Waste Materials
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,272,135		$1,272,135	1.000	$1,272,135
1		$192,900	$192,900	0.935	$180,362
2		$46,900	$46,900	0.873	$40,944
3		$46,900	$46,900	0.816	$38,270
4		$46,900	$46,900	0.763	$35,785
5		$64,900	$64,900	0.713	$46,274
6		$45,500	$45,500	0.666	$30,303
7		$45,500	$45,500	0.623	$28,347
8		$45,500	$45,500	0.582	$26,481
9		$45,500	$45,500	0.544	$24,752
10		$63,500	$63,500	0.508	$32,258
11		$45,500	$45,500	0.475	$21,613
12		$45,500	$45,500	0.444	$20,202
13		$45,500	$45,500	0.415	$18,883
14		$45,500	$45,500	0.388	$17,654
15		$63,500	$63,500	0.362	$22,987
16		$45,500	$45,500	0.339	$15,425
17		$45,500	$45,500	0.317	$14,424
18		$45,500	$45,500	0.296	$13,468
19		$45,500	$45,500	0.277	$12,604
20		$63,500	$63,500	0.258	$16,383
21		$45,500	$45,500	0.242	$11,011
22		$45,500	$45,500	0.226	$10,283
23		$45,500	$45,500	0.211	$9,601
24		$45,500	$45,500	0.197	$8,964
25		$63,500	$63,500	0.184	$11,684
26		$45,500	$45,500	0.172	$7,826
27		$45,500	$45,500	0.161	$7,326
28		$45,500	$45,500	0.15	$6,825
29		$45,500	$45,500	0.141	$6,416
30		$63,500	$63,500	0.131	$8,319
				TOTAL PRESENT WORTH	$2,017,802

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 3 (RCRA C cap): Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	500	hr			$30.00		$0	$0	$15,000	$0	$15,000
1.2 Prepare Property Easement	200	hr			$30.00		$0	$0	$6,000	$0	$6,000
2 MOBILIZATION/DEMOBILIZATION											
2.1 Office Trailer	7	mo	$345.00				$2,415	$0	$0	$0	$2,415
2.2 Field Office Support	7	mo		$136.00			$0	$952	$0	$0	$952
2.3 Storage Trailer (1)	7	mo	$103.00				$721	$0	$0	$0	$721
2.4 Electrical Generator	7	mo		$978.75		$1,005.00	$0	$6,851	$0	$7,035	$13,886
2.5 Construction Survey	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
2.6 Equipment Mobilization/Demobilization	5	ea			$64.00	$264.00	$0	$0	$320	$1,320	$1,640
2.7 Site Utilities (2 Cell Phones)	14	mo	$150.00				$2,100	$0	$0	$0	$2,100
2.8 Field Construction Management (3p * 5 days/week)	34	mwk			$2,400.00		$0	$0	$81,600	$0	$81,600
3 DECONTAMINATION											
3.1 Decontamination Services	7	mo	$3,400.00				$23,800	$0	$0	$0	$23,800
3.2 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150
3.3 Decon Water	7,000	gal		$0.20			$0	$1,400	$0	$0	$1,400
3.4 Decon Water Storage, 6,000 gallon	7	mo				$600.00	$0	$0	$0	$4,200	$4,200
3.5 Decon Water Storage, 4,000 gallon	7	mo				$540.00	$0	$0	$0	$3,780	$3,780
3.6 PPE (6 p * 5 days * 13 weeks)	510	day		$30.90			$0	$15,759	$0	$0	$15,759
3.7 Disposal of Decon Waste (liquid and solid)	7	mo	$900.00				$6,300	$0	$0	$0	$6,300
4 SITE PREPARATION											
4.1 Clear & Grub Access Road	0	ac			$1,075.00	$2,700.00	$0	$0	$215	$540	$755
4.2 Access Road Geotextile	545	sy		$0.84	$0.06	$0.02	$0	$458	$33	$11	$501
4.3 Road Gravel 8" thick	545	sy		$5.45	$1.89	$1.00	$0	$2,970	$1,030	$545	$4,545
5 EXCAVATION AND RESTORATION OF CONTAMINATED AREAS											
5.1 Clear Trees and Brush	2.5	ac			$1,075.00	$2,700.00	$0	$0	$2,688	$6,750	$9,438
5.2 Cofferdam	500	lf	$39.00	$12.00	$20.00	$15.00	$19,500	$6,000	$10,000	$7,500	$43,000
5.3 Excavate Waste Material (Level C)	4,325	cy			$5.96	$6.21	$0	$0	$25,777	$26,858	$52,635
5.4 Dewatering Pump	45	day			$83.00	$23.00	$0	$0	$3,735	$1,035	$4,770
5.5 Filter Pumped Water	45	day		$240.00	$300.00	$175.00	$0	$10,800	$13,500	$7,875	$32,175
5.6 Verification Sampling and Testing (TCLP)	6	ea	$1,407.00		$50.00	$20.00	$8,442	$0	$300	$120	$8,862
5.7 Verification Sampling and Testing (TCL and TAL)	24	ea	$1,407.00		$50.00	$20.00	$33,768	$0	$1,200	$480	$35,448
5.8 Transport Excavated Material to Cap Area	4,325	cy			$2.74	$5.30	$0	$0	$11,851	$22,923	$34,773
5.9 Disposal of Oversized Material Offsite	20	ton	$40.00				$800	$0	$0	$0	$800
5.10 Backfill Excavated Areas (subsoil)	2,244	cy		$5.30	$0.90	$1.86	$0	$11,893	$2,020	$4,174	$18,087
5.11 Backfill Excavated Areas (topsoil)	1,700	cy		$17.87	$3.63	$3.31	$0	$30,379	$6,171	$5,627	$42,177
5.12 Revegetation	12,200	sy		$0.26	$1.16	$0.18	$0	$3,172	$14,152	$2,196	$19,520
5.13 Wetland Restoration	692	csf		$16.39	$8.88		$0	$11,342	$6,145	$0	$17,487
6 LANDFILL CAP											
6.1 Clear Trees and Brush	2	ac			$1,075.00	$2,700.00	$0	$0	$2,150	$5,400	$7,550
6.2 Grade and Proof Roll Cap Area	4,950	sy			$0.24	$0.26	$0	$0	$1,188	$1,287	$2,475
6.3 Place, Grade & Compact Contaminated Material	4,325	cy			$0.93	$1.24	$0	$0	$4,022	$5,363	$9,385
6.4 Intermediate Cover/Gas collection Layer (12")	1,650	cy		$5.64	$2.53	$1.73	$0	$9,306	$4,175	$2,855	$16,335
6.5 Geosynthetic Clay Layer	4,950	sy		$5.85	$0.90	$0.90	$0	$28,958	$4,455	$4,455	$37,868
6.6 Geosynthetic Liner	4,950	sy		$3.60	$4.50	$2.25	$0	$17,820	$22,275	$11,138	$51,233
6.7 Geosynthetic Drainage Layer	4,950	sy		$4.50	$1.80	$0.90	$0	$22,275	$8,910	$4,455	$35,640
6.8 Cover Soil (18")	2,475	cy		$5.30	$0.90	$1.86	$0	$13,118	$2,228	$4,604	$19,949
6.9 Topsoil (6")	825	cy		$17.87	$3.63	$3.31	$0	$14,743	$2,995	$2,731	$20,468
6.10 Revegetation	10,000	sy		$0.26	$1.16	$0.18	$0	$2,600	$11,600	$1,800	$16,000
7 SITE RESTORATION/MONITORING WELLS											
7.1 Site Access Road Removal	545	cy			$1.70	$0.72	$0	$0	$927	$392	$1,319
7.2 Access Road Disposal	820	ton	$40.00				$32,800	$0	$0	$0	$32,800
7.3 Access Road Stand	90	cy		$7.89	$0.91	$1.68	$0	$710	$82	$151	$943

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 3 (RCRA C cap): Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
7.4 Access Road Revegetation (Wetland Restoration)	50	csf		$16.39	$8.88		$0	$820	$444	$0	$1,264
7.5 Abandon Existing Wells	315	lf	$5.25				$1,654	$0	$0	$0	$1,654
7.6 Install Monitoring Wells (4 @ 10' & 4 @ 30')	160	lf	$65.00				$10,400	$0	$0	$0	$10,400
7.7 Well Development (4 hr/well)	32	hr	$35.00				$1,120	$0	$0	$0	$1,120
7.8 Collect/Containerize IDW	16	drum	$55.00				$880	$0	$0	$0	$880
7.9 Transport /Dispose IDW (2 drums/well)	16	drum	$170.00				$2,720	$0	$0	$0	$2,720
7.10 Fencing	844	lf		$9.20	$3.73	$2.16	$0	$7,765	$3,148	$1,823	$12,736
7.11 Gate	1	ea		$520.00	$280.00	$162.00	$0	$520	$280	$162	$962
7.12 Signage	5	ea		$51.50	$12.80	$7.40	$0	$258	$64	$37	$359
Subtotal							$150,420	$226,667	$277,327	$150,320	$804,734
Local Area Adjustments							100.0%	96.2%	82.0%	82.0%	
							$150,420	$218,054	$227,408	$123,263	$719,144
Overhead on Labor Cost @ 30%									$68,222		$68,222
G & A on Labor Cost @ 10%									$22,741		$22,741
G & A on Material Cost @ 10%								$21,805			$21,805
G & A on Subcontract Cost @ 10%							$15,042				$15,042
Total Direct Cost							$165,462	$239,859	$318,371	$123,263	$846,955
Indirects on Total Direct Cost @ 35%		(excluding disposal costs)									$281,517
Profit on Total Direct Cost @ 10%											$84,695
Subtotal											$1,213,167
Health & Safety Monitoring @ 2%											$24,263
Total Field Cost											$1,237,431
Contingency on Total Field Costs @ 20%											$247,486
Engineering on Total Field Cost @ 10%											$123,743
TOTAL COST											**$1,608,660**

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 3 (RCRA C cap): Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials
Annual Cost

Item	Item Cost year 1	Item Cost years 2 to 5 per round	Item Cost years 6 to 30 per round	Item Cost Every 5 Years	Notes
Sampling	$20,000	$5,000	$5,000		Labor, Field Supplies, Travel
Analysis/Water (1)	$28,000	$7,000	$7,000		Analyze eight groundwater samples for full TCL/TAL including blanks and duplicates. Monitor for 30 years.
Maintenance	$3,500	$3,500	$3,500		Landfill cap maintenance (seed, mowing, cover repair)
Plans	$10,000				Health and Safety Plan and Sampling Plan
Report	$30,000	$30,000	$30,000		Document sampling events and results
Site Review				$18,000	Perform 5-Year Review
TOTALS	$91,500	$45,500	$45,500	$18,000	

(1) Sampling rounds would occur quarterly the first year and annually for years 2 through 30.

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 3 (RCRA C cap): Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,608,660		$1,608,660	1.000	$1,608,660
1		$91,500	$91,500	0.935	$85,553
2		$45,500	$45,500	0.873	$39,722
3		$45,500	$45,500	0.816	$37,128
4		$45,500	$45,500	0.763	$34,717
5		$63,500	$63,500	0.713	$45,276
6		$45,500	$45,500	0.666	$30,303
7		$45,500	$45,500	0.623	$28,347
8		$45,500	$45,500	0.582	$26,481
9		$45,500	$45,500	0.544	$24,752
10		$63,500	$63,500	0.508	$32,258
11		$45,500	$45,500	0.475	$21,613
12		$45,500	$45,500	0.444	$20,202
13		$45,500	$45,500	0.415	$18,883
14		$45,500	$45,500	0.388	$17,654
15		$63,500	$63,500	0.362	$22,987
16		$45,500	$45,500	0.339	$15,425
17		$45,500	$45,500	0.317	$14,424
18		$45,500	$45,500	0.296	$13,468
19		$45,500	$45,500	0.277	$12,604
20		$63,500	$63,500	0.258	$16,383
21		$45,500	$45,500	0.242	$11,011
22		$45,500	$45,500	0.226	$10,283
23		$45,500	$45,500	0.211	$9,601
24		$45,500	$45,500	0.197	$8,964
25		$63,500	$63,500	0.184	$11,684
26		$45,500	$45,500	0.172	$7,826
27		$45,500	$45,500	0.161	$7,326
28		$45,500	$45,500	0.15	$6,825
29		$45,500	$45,500	0.141	$6,416
30		$63,500	$63,500	0.131	$8,319
				TOTAL PRESENT WORTH	$2,255,088

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 3 (Soil Cover): Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials
Capital Cost

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	500	hr			$30.00		$0	$0	$15,000	$0	$15,000
1.2 Prepare Property Easement	200	hr			$30.00		$0	$0	$6,000	$0	$6,000
2 MOBILIZATION/DEMOBILIZATION											
2.1 Office Trailer	7	mo	$345.00				$2,415	$0	$0	$0	$2,415
2.2 Field Office Support	7	mo		$136.00			$0	$952	$0	$0	$952
2.3 Storage Trailer (1)	7	mo	$103.00				$721	$0	$0	$0	$721
2.4 Electrical Generator	7	mo		$978.75		$1,005.00	$0	$6,851	$0	$7,035	$13,886
2.5 Construction Survey	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
2.6 Equipment Mobilization/Demobilization	5	ea			$64.00	$264.00	$0	$0	$320	$1,320	$1,640
2.7 Site Utilities (2 Cell Phones)	14	mo	$150.00				$2,100	$0	$0	$0	$2,100
2.8 Field Construction Management (3p * 5 days/week)	34	mwk			$2,400.00		$0	$0	$81,600	$0	$81,600
3 DECONTAMINATION											
3.1 Decontamination Services	7	mo	$3,400.00				$23,800	$0	$0	$0	$23,800
3.2 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150
3.3 Decon Water	7,000	gal		$0.20			$0	$1,400	$0	$0	$1,400
3.4 Decon Water Storage, 6,000 gallon	7	mo				$600.00	$0	$0	$0	$4,200	$4,200
3.5 Decon Water Storage, 4,000 gallon	7	mo				$540.00	$0	$0	$0	$3,780	$3,780
3.6 PPE (6 p * 5 days * 13 weeks)	510	day		$30.90			$0	$15,759	$0	$0	$15,759
3.7 Disposal of Decon Waste (liquid and solid)	7	mo	$900.00				$6,300	$0	$0	$0	$6,300
4 SITE PREPARATION											
4.1 Clear & Grub Access Road	0	ac			$1,075.00	$2,700.00	$0	$0	$215	$540	$755
4.2 Access Road Geotextile	545	sy		$0.84	$0.06	$0.02	$0	$458	$33	$11	$501
4.3 Road Gravel 8" thick	545	sy		$5.45	$1.89	$1.00	$0	$2,970	$1,030	$545	$4,545
5 EXCAVATION AND RESTORATION OF CONTAMINATED AREAS											
5.1 Clear Trees and Brush	2.5	ac			$1,075.00	$2,700.00	$0	$0	$2,688	$6,750	$9,438
5.2 Cofferdam	500	lf	$39.00	$12.00	$20.00	$15.00	$19,500	$6,000	$10,000	$7,500	$43,000
5.3 Excavate Waste Material (Level C)	4,325	cy			$5.96	$6.21	$0	$0	$25,777	$26,858	$52,635
5.4 Dewatering Pump	45	day			$83.00	$23.00	$0	$0	$3,735	$1,035	$4,770
5.5 Filter Pumped Water	45	day		$240.00	$300.00	$175.00	$0	$10,800	$13,500	$7,875	$32,175
5.6 Verification Sampling and Testing (TCLP)	6	ea	$1,407.00		$50.00	$20.00	$8,442	$0	$300	$120	$8,862
5.7 Verification Sampling and Testing (TCL and TAL)	24	ea	$1,407.00		$50.00	$20.00	$33,768	$0	$1,200	$480	$35,448
5.8 Transport Excavated Material to Cap Area	4,325	cy			$2.74	$5.30	$0	$0	$11,851	$22,923	$34,773
5.9 Disposal of Oversized Material Offsite	20	ton	$40.00				$800	$0	$0	$0	$800
5.10 Backfill Excavated Areas (subsoil)	2,244	cy		$5.30	$0.90	$1.86	$0	$11,893	$2,020	$4,174	$18,087
5.11 Backfill Excavated Areas (topsoil)	1,700	cy		$17.87	$3.63	$3.31	$0	$30,379	$6,171	$5,627	$42,177
5.12 Revegetation	12,200	sy		$0.26	$1.16	$0.18	$0	$3,172	$14,152	$2,196	$19,520
5.13 Wetland Restoration	692	csf		$16.39	$8.88		$0	$11,342	$6,145	$0	$17,487
6 LANDFILL CAP											
6.1 Clear Trees and Brush	2	ac			$1,075.00	$2,700.00	$0	$0	$2,150	$5,400	$7,550
6.2 Grade and Proof Roll Cap Area	4,950	sy			$0.24	$0.26	$0	$0	$1,188	$1,287	$2,475
6.3 Place, Grade & Compact Contaminated Material	4,325	cy			$0.93	$1.24	$0	$0	$4,022	$5,363	$9,385
6.4 Biotic Layer, 6" crush gravel	825	cy		$5.64	$2.53	$1.73	$0	$4,653	$2,087	$1,427	$8,168
6.5 Cover Soil (18")	2,475	cy		$5.30	$0.90	$1.86	$0	$13,118	$2,228	$4,604	$19,949
6.6 Topsoil (6")	825	cy		$17.87	$3.63	$3.31	$0	$14,743	$2,995	$2,731	$20,468
6.7 Revegetation	10,000	sy		$0.26	$1.16	$0.18	$0	$2,600	$11,600	$1,800	$16,000
7 SITE RESTORATION/MONITORING WELLS											
7.1 Site Access Road Removal	545	cy			$1.70	$0.72	$0	$0	$927	$392	$1,319
7.2 Access Road Disposal	820	ton	$40.00				$32,800	$0	$0	$0	$32,800
7.3 Access Road Stand	90	cy		$7.89	$0.91	$1.68	$0	$710	$82	$151	$943
7.4 Access Road Revegetation (Wetland Restoration)	50	csf		$16.39	$8.88		$0	$820	$444	$0	$1,264
7.5 Abandon Existing Wells	315	lf	$5.25				$1,654	$0	$0	$0	$1,654
7.6 Install Monitoring Wells (4 @ 10' & 4 @ 30')	160	lf	$65.00				$10,400	$0	$0	$0	$10,400

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 3 (Soil Cover): Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
7.7 Well Development (4 hr/well)	32	hr	$35.00				$1,120	$0	$0	$0	$1,120
7.8 Collect/Containerize IDW	16	drum	$55.00				$880	$0	$0	$0	$880
7.9 Transport /Dispose IDW (2 drums/well)	16	drum	$170.00				$2,720	$0	$0	$0	$2,720
7.10 Fencing	844	lf		$9.20	$3.73	$2.16	$0	$7,765	$3,148	$1,823	$12,736
7.11 Gate	1	ea		$520.00	$280.00	$162.00	$0	$520	$280	$162	$962
7.12 Signage	5	ea		$51.50	$12.80	$7.40	$0	$258	$64	$37	$359
Subtotal							$150,420	$152,962	$239,600	$128,846	$671,826
Local Area Adjustments							100.0%	96.2%	82.0%	82.0%	
							$150,420	$147,149	$196,472	$105,653	$599,694
Overhead on Labor Cost @ 30%									$58,941		$58,941
G & A on Labor Cost @ 10%									$19,647		$19,647
G & A on Material Cost @ 10%								$14,715			$14,715
G & A on Subcontract Cost @ 10%							$15,042				$15,042
Total Direct Cost							$165,462	$161,864	$275,060	$105,653	$708,039
Indirects on Total Direct Cost @ 35%		(excluding disposal costs)									$232,897
Profit on Total Direct Cost @ 10%											$70,804
Subtotal											$1,011,740
Health & Safety Monitoring @ 2%											$20,235
Total Field Cost											$1,031,975
Contingency on Total Field Costs @ 20%											$206,395
Engineering on Total Field Cost @ 10%											$103,197
TOTAL COST											**$1,341,567**

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 3 (Soil Cover): Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials
Annual Cost

Item	Item Cost year 1	Item Cost years 2 to 5 per round	Item Cost years 6 to 30 per round	Item Cost Every 5 Years	Notes
Sampling	$20,000	$5,000	$5,000		Labor, Field Supplies, Travel
Analysis/Water (1)	$28,000	$7,000	$7,000		Analyze eight groundwater samples for full TCL/TAL including blanks and duplicates. Monitor for 30 years.
Maintenance	$3,500	$3,500	$3,500		Landfill cap maintenance (seed, mowing, cover repair)
Plans	$10,000				Health and Safety Plan and Sampling Plan
Report	$30,000	$30,000	$30,000		Document sampling events and results
Site Review				$18,000	Perform 5-Year Review
TOTALS	$91,500	$45,500	$45,500	$18,000	

(1) Sampling rounds would occur quarterly the first year and annually for years 2 through 30.

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12/ Swmu 10 - Jericho Island Disposal Area
Alternative 3 (Soil Cover): Excavation/Consolidation/Capping of All Contaminated Sediment, Soil, and Waste Materials
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,341,567		$1,341,567	1.000	$1,341,567
1		$91,500	$91,500	0.935	$85,553
2		$45,500	$45,500	0.873	$39,722
3		$45,500	$45,500	0.816	$37,128
4		$45,500	$45,500	0.763	$34,717
5		$63,500	$63,500	0.713	$45,276
6		$45,500	$45,500	0.666	$30,303
7		$45,500	$45,500	0.623	$28,347
8		$45,500	$45,500	0.582	$26,481
9		$45,500	$45,500	0.544	$24,752
10		$63,500	$63,500	0.508	$32,258
11		$45,500	$45,500	0.475	$21,613
12		$45,500	$45,500	0.444	$20,202
13		$45,500	$45,500	0.415	$18,883
14		$45,500	$45,500	0.388	$17,654
15		$63,500	$63,500	0.362	$22,987
16		$45,500	$45,500	0.339	$15,425
17		$45,500	$45,500	0.317	$14,424
18		$45,500	$45,500	0.296	$13,468
19		$45,500	$45,500	0.277	$12,604
20		$63,500	$63,500	0.258	$16,383
21		$45,500	$45,500	0.242	$11,011
22		$45,500	$45,500	0.226	$10,283
23		$45,500	$45,500	0.211	$9,601
24		$45,500	$45,500	0.197	$8,964
25		$63,500	$63,500	0.184	$11,684
26		$45,500	$45,500	0.172	$7,826
27		$45,500	$45,500	0.161	$7,326
28		$45,500	$45,500	0.15	$6,825
29		$45,500	$45,500	0.141	$6,416
30		$63,500	$63,500	0.131	$8,319
				TOTAL PRESENT WORTH	$1,987,995

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12 / Swmu 10 - Jericho Island Disposal Area
Alternative 4: Excavation and Off-Site Disposal of Waste Materials, Soils and Sediment
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	500	hr			$30.00		$0	$0	$15,000	$0	$15,000
1.2 Prepare Property Easemen	200	hr			$30.00		$0	$0	$6,000	$0	$6,000
2 MOBILIZATION/DEMOBILIZATION											
2.1 Office Trailer	5	mo	$345.00				$1,725	$0	$0	$0	$1,725
2.2 Field Office Support	5	mo		$136.00			$0	$680	$0	$0	$680
2.3 Storage Trailer (1)	5	mo	$103.00				$515	$0	$0	$0	$515
2.4 Electrical Generator	5	mo		$978.75		$1,005.00	$0	$4,894	$0	$5,025	$9,919
2.5 Construction Survey	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
2.6 Equipment Mobilization/Demobilization	5	ea			$64.00	$264.00	$0	$0	$320	$1,320	$1,640
2.7 Site Utilities (2 Cell Phones)	10	mo	$150.00				$1,500	$0	$0	$0	$1,500
2.8 Field Construction Mgt. (3p * 5 days/week)	22	mwk			$2,400.00		$0	$0	$52,800	$0	$52,800
3 DECONTAMINATION											
3.1 Decontamination Services	5	mo	$3,400.00				$17,000	$0	$0	$0	$17,000
3.2 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150
3.3 Decon Water	5,000	gal		$0.20			$0	$1,000	$0	$0	$1,000
3.4 Decon Water Storage Tank, 6,000 gallon	5	mo				$600.00	$0	$0	$0	$3,000	$3,000
3.5 Clean Water Storage Tank, 4,000 gallon	5	mo				$540.00	$0	$0	$0	$2,700	$2,700
3.6 PPE (6 p * 5 days * 22 weeks)	660	day		$30.90			$0	$20,394	$0	$0	$20,394
3.7 Disposal of Decon Waste (liquid & solid)	5	mo	$900.00				$4,500	$0	$0	$0	$4,500
4 SITE PREPARATION											
4.1 Clear & Grub Access Road	0.2	ac			$1,075.00	$2,700.00	$0	$0	$215	$540	$755
4.2 Access Road Geotextile	545	sy		0.84	$0.06	$0.02	$0	$458	$33	$11	$501
4.3 Road Gravel, 8" thick	545	sy		5.45	$1.89	$1.00	$0	$2,970	$1,030	$545	$4,545
5 EXCAVATION AND RESTORATION OF CONTAMINATED AREAS											
5.1 Clear Trees and Brush	2.5	ac			$1,075.00	$2,700.00	$0	$0	$2,688	$6,750	$9,438
5.2 Cofferdam	500	lf	$39.00	$12.00	$20.00	$15.00	$19,500	$6,000	$10,000	$7,500	$43,000
5.3 Excavate Waste Material (Level C)	4,325	cy			$5.96	$6.21	$0	$0	$25,777	$26,858	$52,635
5.4 Dewatering Pump	45	day			$83.00	$23.00	$0	$0	$3,735	$1,035	$4,770
5.5 Filter Pumped Water	45	day		$240.00	$300.00	$175.00	$0	$10,800	$13,500	$7,875	$32,175
5.6 Verification Sampling & Testing (TCLP)	6	ea	$1,407.00		$50.00	$20.00	$8,442	$0	$300	$120	$8,862
5.7 Verification Sampling & Testing (TCL & TAL)	24	ea	$1,407.00		$50.00	$20.00	$33,768	$0	$1,200	$480	$35,448
5.8 Disposal of Non-Hazardous Materials	5,450	ton	$40.00				$218,000	$0	$0	$0	$218,000
5.9 Disposal of Oversized Material Offsite	20	ton	$40.00				$800	$0	$0	$0	$800
5.10 Disposal of Hazardous Materials	605	ton	$120.00				$72,600	$0	$0	$0	$72,600
5.11 Backfill Excavated Areas (subsoil)	2,244	cy		$5.30	$0.90	$1.86	$0	$11,893	$2,020	$4,174	$18,087
5.12 Backfill Excavated Areas (topsoil)	1,700	cy		$17.87	$3.63	$3.31	$0	$30,379	$6,171	$5,627	$42,177
5.13 Revegetation	12,200	sy		$0.26	$1.16	$0.18	$0	$3,172	$14,152	$2,196	$19,520
5.14 Wetland Restoration	692	csf		$16.39	$8.88		$0	$11,342	$6,145	$0	$17,487
6 SITE RESTORATION/MONITORING WELLS											
6.1 Access Road Removal	545	cy			$1.70	$0.72	$0	$0	$927	$392	$1,319
6.2 Access Road Disposal	820	ton	$40.00				$32,800	$0	$0	$0	$32,800
6.3 Access Road Sand	90	cy		$7.89	$0.91	$1.68	$0	$710	$82	$151	$943
6.4 Access Road Revegetation (Wetland Restoration)	50	csf		$16.39	$8.88		$0	$820	$444	$0	$1,264
6.5 Abandon Existing Wells	315	lf	$5.25				$1,654	$0	$0	$0	$1,654
Subtotal							$415,804	$111,311	$169,187	$77,000	$773,302
Local Area Adjustments							100.0%	96.2%	82.0%	82.0%	

MARINE CORPS RECRUIT DEPOT
Parris Island, South Carolina
Site 12 / Swmu 10 - Jericho Island Disposal Area
Alternative 4: Excavation and Off-Site Disposal of Waste Materials, Soils and Sediment
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
							$415,804	$107,082	$138,734	$63,140	$724,759
Overhead on Labor Cost @ 30%									$41,620		$41,620
G & A on Labor Cost @ 10%									$13,873		$13,873
G & A on Material Cost @ 10%								$10,708			$10,708
G & A on Subcontract Cost @ 10%							$41,580				$41,580
Total Direct Cost							$457,384	$117,790	$194,227	$63,140	$832,541
Indirects on Total Direct Cost @ 35%		(excluding disposal cost)									$176,344
Profit on Total Direct Cost @ 10%											$83,254
Subtotal											$1,092,139
Health & Safety Monitoring @ 2%											$21,843
Total Field Cost											$1,113,982
Contingency on Total Field Costs @ 20%											$222,796
Engineering on Total Field Cost @ 10%											$111,398
TOTAL COST											**$1,448,176**

APPENDIX C

DEGRADATION TIMES FOR PAHS IN SOIL

Calculation of Degradation Times for PAHs in Soil

Degradation Rates	Monitored Natural Recovery (a)	Average Value (days)	Enhanced Biodegradation (b)	Average Value (days)
Benzo(a)anthracene	4 - 6,250 days	3,127	100 - 120 days	110
Chrysene	371 - 1,000 days	871	100 - 125 days	112.5
Benzo(a)pyrene	2 - 693 days	349	30 - 80 days	55
Benzo(b)fluoranthene	360 - 610 days	485	130 - 150 days	140
Benzo(k)fluoranthene	910 - 2,140 days	1,525	110 - 130 days	120

Concentration (ug/kg)	PAI-SS-08-02	Human Health PRG	Ecological PRG
Benzo(a)anthracene	3,100	870	100
Chrysene	1,800	87,000	100
Benzo(a)pyrene	1,700	87	100
Benzo(b)fluoranthene	2,900	870	100
Benzo(k)fluoranthene	1,400	8,700	100

Contaminant	Half-lives to reach PRG	Monitored Natural Recovery (days)	Monitored Natural Recovery (years)	Enhanced Biodegradation (days)	Enhanced Biodegradation (years)
Benzo(a)anthracene	5	15,635	42	550	1.5
Chrysene	5	4,355	12	562.5	1.5
Benzo(a)pyrene	5	1,745	4.8	275	0.75
Benzo(b)fluoranthene	5	2,425	6.6	700	1.9
Benzo(k)fluoranthene	4	6,100	16.7	480	1.3

a) Source: Mackay, D., Shiu, W.Y., & Ma, K.C. Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals - PAHs, Polychlorinated Dioxins, and Dibenzofurans. 1992.

b) Source: Cookson Joh T., Jr. Bioremediation Engineering Design and Application. 1995.

APPENDIX D

CALCULATION OF TOTAL PAHS AND BAP EQUIVALENTS

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
SUBJECT:	SITE 12/SWMU10 - JERICHO ISLAND DISPOSAL AREA		
BASED ON:	PAH Data for Surface Soil and Sediment Samples from Site 12/SWMU 10 RI/RFI	DRAWING NUMBER:	
BY: JJB Date: 09/17/01	CHECKED BY: Date:	APPROVED BY:	DATE:

Objective:

Using PAH data for surface soil and sediment samples collected during the Site 12/SWMU 10 RFI/RI, calculate Total PAH and BAP Equivalent concentrations.

Assumptions:

(1) Total PAH concentrations will be used to compare against ecological RGOs to determine the extent of impacted sediment.

(2) BAP Equivalent concentrations will be used to compare against the human health RGO to determine the extent of impacted sediment.

(3) Total PAH #1 uses 1/2 the method detection limit (MDL) for nondetects. Laboratory-provided, sample-specific MDLs are used. If an MDL is not available, 1/2 the detection limit is used.

(4) Total PAH #2 assumes a value of zero for nondetects.

(5) For Total PAHs #1 and #2 = Low Molecular Weight PAHs + High Molecular Weight PAHs.

(6) Low Molecular Weight PAHs = 2-methylnaphthalene + acenaphthene + acenaphthylene + anthracene + fluorene + naphthalene + phenanthrene.

(7) High Molecular Weight PAHs = benzo(a)anthracene + benzo(a)pyrene + chyrsene + dibenzo(a,h)anthracene + fluoranthene + pyrene.

(8) Reference for Total PAHs: MacDonald, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. FDEP.

(9) BAP equivalents = benzo(a)anthracene(0.1) + benzo(a)pyrene(1.0) + benzo(b)fluoranthene(0.1) + benzo(k)fluoranthene(0.01) + chyrsene(0.001) + dibenzo(a,h)anthracene(1.0) + indeno(1,2,3-cd)pyrene (0.1)
For nondetects, 1/2 the method detection limit (MDL) is used.

(10) Bolded cells indicate that an RGO has been exceeded. The following RGOs are used
Human health (soil and sediment) - B(a)P equivalent concentration of 434 ug/kg (MCRD Parris Island derived RGO)
Ecological (soil) - Total PAH concentration of 1000 ug/kg (U.S. EPA Region 4 Screening Value)
Ecological (sediment) - Total PAH concentration of 1684 ug/kg (U.S. EPA Region 4 Screening Value)

Calculations:

PAH Chemicals	Sample PAI-10-SS-01-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	460 U	160	80	0	
Acenaphthene	460 U	170	85	0	
Acenaphthylene	460 U	150	75	0	
Anthracene	460 U	160	80	0	
Benzo(a)anthracene	460 U	160	80	0	8
Benzo(a)pyrene	460 U	210	105	0	105
Benzo(b)fluoranthene	460 U	190	0	0	9.5
Benzo(k)fluoranthene	460 U	170	0	0	0.85
Chrysene	460 U	170	85	0	0.085
Dibenzo(a,h)anthracene	460 U	150	75	0	75
Fluoranthene	460 U	200	100	0	
Fluorene	460 U	150	75	0	
Indeno(1,2,3-cd)pyrene	460 U	190	0	0	9.5
Naphthalene	460 U	150	75	0	
Phenanthrene	460 U	22	11	0	
Pyrene	460 U	190	95	0	
	SUM		1021	0	208

PAH Chemicals	Sample PAI-10-SS-02-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	390 U	130	65	0	
Acenaphthene	390 U	140	70	0	
Acenaphthylene	390 U	130	65	0	
Anthracene	390 U	140	70	0	
Benzo(a)anthracene	390 U	140	70	0	7
Benzo(a)pyrene	390 U	180	90	0	90
Benzo(b)fluoranthene	390 U	170	0	0	8.5
Benzo(k)fluoranthene	390 U	140	0	0	0.7
Chrysene	390 U	150	75	0	0.075
Dibenzo(a,h)anthracene	390 U	130	65	0	65
Fluoranthene	390 U	170	85	0	
Fluorene	390 U	130	65	0	
Indeno(1,2,3-cd)pyrene	390 U	160	0	0	8
Naphthalene	390 U	130	65	0	
Phenanthrene	390 U	19	10	0	
Pyrene	390 U	160	80	0	
	SUM		875	0	179

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
SUBJECT:	SITE 12/SWMU10 - JERICHO ISLAND DISPOSAL AREA		
BASED ON:	PAH Data for Surface Soil and Sediment Samples from Site 12/SWMU 10 RI/RFI	DRAWING NUMBER:	
BY: JJB Date: 09/17/01	CHECKED BY: Date:	APPROVED BY:	DATE:

PAH Chemicals	Sample PAI-10-SS-03-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	410 U	140	70	0	
Acenaphthene	410 U	150	75	0	
Acenaphthylene	410 U	140	70	0	
Anthracene	410 U	150	75	0	
Benzo(a)anthracene	410 U	150	75	0	7.5
Benzo(a)pyrene	410 U	190	95	0	95
Benzo(b)fluoranthene	410 U	180	0	0	9
Benzo(k)fluoranthene	410 U	150	0	0	0.75
Chrysene	410 U	160	80	0	0.08
Dibenzo(a,h)anthracene	410 U	140	70	0	70
Fluoranthene	410 U	180	90	0	
Fluorene	410 U	140	70	0	
Indeno(1,2,3-cd)pyrene	410 U	170	0	0	8.5
Naphthalene	410 U	140	70	0	
Phenanthrene	410 U	20	10	0	
Pyrene	410 U	170	85	0	
	SUM		935	0	191

PAH Chemicals	Sample PAI-10-SS-04-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	370 U	130	65	0	
Acenaphthene	370 U	130	65	0	
Acenaphthylene	370 U	130	65	0	
Anthracene	370 U	130	65	0	
Benzo(a)anthracene	370 U	130	65	0	18.5
Benzo(a)pyrene	370 U	170	85	0	185
Benzo(b)fluoranthene	370 U	160	0	0	18.5
Benzo(k)fluoranthene	370 U	130	0	0	1.85
Chrysene	370 U	140	70	0	0.185
Dibenzo(a,h)anthracene	370 U	130	65	0	185
Fluoranthene	370 U	170	85	0	
Fluorene	370 U	130	65	0	
Indeno(1,2,3-cd)pyrene	370 U	160	0	0	18.5
Naphthalene	370 U	120	60	0	
Phenanthrene	370 U	18	9	0	
Pyrene	24 J	160	24	24	
	SUM		788	24	428

PAH Chemicals	Sample PAI-10-SS-05-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	380 U	130	65	0	
Acenaphthene	380 U	140	70	0	
Acenaphthylene	380 U	130	65	0	
Anthracene	380 U	140	70	0	
Benzo(a)anthracene	380 U	140	70	0	7
Benzo(a)pyrene	380 U	180	90	0	90
Benzo(b)fluoranthene	380 U	160	0	0	8
Benzo(k)fluoranthene	380 U	140	0	0	0.7
Chrysene	380 U	150	75	0	0.075
Dibenzo(a,h)anthracene	380 U	130	65	0	65
Fluoranthene	380 U	170	85	0	
Fluorene	380 U	130	65	0	
Indeno(1,2,3-cd)pyrene	380 U	160	0	0	8
Naphthalene	380 U	130	65	0	
Phenanthrene	380 U	19	10	0	
Pyrene	380 U	160	80	0	
	SUM		875	0	179

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
SUBJECT:	SITE 12/SWMU10 - JERICHO ISLAND DISPOSAL AREA		
BASED ON:	PAH Data for Surface Soil and Sediment Samples from Site 12/SWMU 10 RI/RFI	DRAWING NUMBER:	
BY: JJB Date: 09/17/01	CHECKED BY: Date:	APPROVED BY:	DATE:

PAH Chemicals	Sample PAI-10-SS-06-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	350 U	120	60	0	
Acenaphthene	350 U	130	65	0	
Acenaphthylene	350 U	120	60	0	
Anthracene	350 U	120	60	0	
Benzo(a)anthracene	49 J	120	49	49	4.9
Benzo(a)pyrene	32 J	160	32	32	32
Benzo(b)fluoranthene	33 J	150	0	0	3.3
Benzo(k)fluoranthene	34 J	130	0	0	0.34
Chrysene	47 J	130	47	47	0.047
Dibenzo(a,h)anthracene	350 U	120	60	0	60
Fluoranthene	89 J	160	89	89	
Fluorene	350 U	120	60	0	
Indeno(1,2,3-cd)pyrene	350 U	150	0	0	7.5
Naphthalene	350 U	120	60	0	
Phenanthrene	69 J	17	69	69	
Pyrene	71 J	150	71	71	
	SUM		782	357	108

PAH Chemicals	Sample PAI-10-SS-07-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	370 U	130	65	0	
Acenaphthene	370 U	140	70	0	
Acenaphthylene	370 U	130	65	0	
Anthracene	370 U	130	65	0	
Benzo(a)anthracene	370 U	130	65	0	6.5
Benzo(a)pyrene	370 U	170	85	0	85
Benzo(b)fluoranthene	370 U	160	0	0	8
Benzo(k)fluoranthene	370 U	140	0	0	0.7
Chrysene	370 U	140	70	0	0.07
Dibenzo(a,h)anthracene	370 U	130	65	0	65
Fluoranthene	370 U	170	85	0	
Fluorene	370 U	130	65	0	
Indeno(1,2,3-cd)pyrene	370 U	160	0	0	8
Naphthalene	370 U	120	60	0	
Phenanthrene	370 U	18	9	0	
Pyrene	370 U	160	80	0	
	SUM		849	0	173

PAH Chemicals	Sample PAI-10-SS-08-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	360 U	130	65	0	
Acenaphthene	360 U	130	65	0	
Acenaphthylene	360 U	120	60	0	
Anthracene	24 J	130	24	24	
Benzo(a)anthracene	140 J	130	140	140	14
Benzo(a)pyrene	120 J	170	120	120	120
Benzo(b)fluoranthene	120 J	160	0	0	12
Benzo(k)fluoranthene	110 J	130	0	0	1.1
Chrysene	160 J	140	160	160	0.16
Dibenzo(a,h)anthracene	360 U	120	60	0	60
Fluoranthene	280 J	160	280	280	
Fluorene	360 U	120	60	0	
Indeno(1,2,3-cd)pyrene	69 J	150	0	0	6.9
Naphthalene	360 U	120	60	0	
Phenanthrene	140 J	18	140	140	
Pyrene	230 J	150	230	230	
	SUM		1464	1094	214

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
SUBJECT:	SITE 12/SWMU10 - JERICHO ISLAND DISPOSAL AREA		
BASED ON:	PAH Data for Surface Soil and Sediment Samples from Site 12/SWMU 10 RI/RFI	DRAWING NUMBER:	
BY: JJB Date: 09/17/01	CHECKED BY: Date:	APPROVED BY:	DATE:

PAH Chemicals	Sample PAI-10-SS-08-02 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	9 J	2.51	9	9	
Acenaphthene	30	5.35	30	30	
Acenaphthylene	32	4.13	32	32	
Anthracene	350	5.05	350	350	
Benzo(a)anthracene	3100	3.8	3100	3100	310
Benzo(a)pyrene	1700	6.41	1700	1700	1700
Benzo(b)fluoranthene	2900	4.38	0	0	290
Benzo(k)fluoranthene	1400	4.44	0	0	14
Chrysene	1800	3.59	1800	1800	1.8
Dibenzo(a,h)anthracene	840 J	5.82	840	840	840
Fluoranthene	4000	4.3	4000	4000	
Fluorene	17 J	3.26	17	17	
Indeno(1,2,3-cd)pyrene	1300	7.43	0	0	130
Naphthalene	10 J	3.75	10	10	
Phenanthrene	1600	4.04	1600	1600	
Pyrene	3400	2.97	3400	3400	
	SUM		16888	16888	3286

PAH Chemicals	Sample PAI-10-SS-09-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	360 U	130	65	0	
Acenaphthene	360 U	130	65	0	
Acenaphthylene	360 U	120	60	0	
Anthracene	360 U	130	65	0	
Benzo(a)anthracene	360 U	130	65	0	6.5
Benzo(a)pyrene	360 U	170	85	0	85
Benzo(b)fluoranthene	360 U	160	0	0	8
Benzo(k)fluoranthene	360 U	130	0	0	0.65
Chrysene	360 U	140	70	0	0.07
Dibenzo(a,h)anthracene	360 U	120	60	0	60
Fluoranthene	360 U	160	80	0	
Fluorene	360 U	120	60	0	
Indeno(1,2,3-cd)pyrene	360 U	150	0	0	7.5
Naphthalene	360 U	120	60	0	
Phenanthrene	360 U	18	9	0	
Pyrene	360 U	150	75	0	
	SUM		819	0	168

PAH Chemicals	Sample PAI-10-SS-10-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	360 U	130	65	0	
Acenaphthene	360 U	130	65	0	
Acenaphthylene	360 U	120	60	0	
Anthracene	360 U	130	65	0	
Benzo(a)anthracene	360 U	130	65	0	6.5
Benzo(a)pyrene	360 U	170	85	0	85
Benzo(b)fluoranthene	360 U	160	0	0	8
Benzo(k)fluoranthene	360 U	130	0	0	0.65
Chrysene	360 U	140	70	0	0.07
Dibenzo(a,h)anthracene	360 U	120	60	0	60
Fluoranthene	360 U	160	80	0	
Fluorene	360 U	120	60	0	
Indeno(1,2,3-cd)pyrene	360 U	150	0	0	7.5
Naphthalene	360 U	120	60	0	
Phenanthrene	360 U	18	9	0	
Pyrene	360 U	150	75	0	
	SUM		819	0	168

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
SUBJECT:	SITE 12/SWMU10 - JERICHO ISLAND DISPOSAL AREA		
BASED ON:	PAH Data for Surface Soil and Sediment Samples from Site 12/SWMU 10 RI/RFI	DRAWING NUMBER:	
BY: JJB	CHECKED BY:	APPROVED BY:	DATE:
Date: 09/17/01	Date:		

PAH Chemicals	Sample PAI-10-SS-11-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	350 U	120	60	0	
Acenaphthene	350 U	130	65	0	
Acenaphthylene	350 U	120	60	0	
Anthracene	350 U	130	65	0	
Benzo(a)anthracene	350 U	130	65	0	6.5
Benzo(a)pyrene	350 U	170	85	0	85
Benzo(b)fluoranthene	350 U	150	0	0	7.5
Benzo(k)fluoranthene	350 U	130	0	0	0.65
Chrysene	350 U	130	65	0	0.065
Dibenzo(a,h)anthracene	350 U	120	60	0	60
Fluoranthene	350 U	160	80	0	
Fluorene	350 U	120	60	0	
Indeno(1,2,3-cd)pyrene					
Naphthalene	350 U	17	9	0	
Phenanthrene	350 U	150	75	0	
Pyrene	350 U	24	12	0	
	SUM		761	0	160

PAH Chemicals	Sample PAI-10-SS-12-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	340 U	120	60	0	
Acenaphthene	340 U	130	65	0	
Acenaphthylene	340 U	120	60	0	
Anthracene	340 U	120	60	0	
Benzo(a)anthracene	340 U	120	60	0	6
Benzo(a)pyrene	340 U	160	80	0	80
Benzo(b)fluoranthene	340 U	150	0	0	7.5
Benzo(k)fluoranthene	340 U	130	0	0	0.65
Chrysene	340 U	130	65	0	0.065
Dibenzo(a,h)anthracene	340 U	120	60	0	60
Fluoranthene	340 U	160	80	0	
Fluorene	340 U	120	60	0	
Indeno(1,2,3-cd)pyrene					
Naphthalene	340 U	120	60	0	
Phenanthrene	340 U	17	9	0	
Pyrene	340 U	150	75	0	
	SUM		794	0	154

PAH Chemicals	Sample PAI-10-SS-12-01-D Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	600	120	600	600	
Acenaphthene	440	130	440	440	
Acenaphthylene	580	120	580	580	
Anthracene	340 U	120	60	0	
Benzo(a)anthracene	340 U	120	60	0	6
Benzo(a)pyrene	340 U	160	80	0	80
Benzo(b)fluoranthene	340 U	150	0	0	7.5
Benzo(k)fluoranthene	340 U	130	0	0	0.65
Chrysene	340 U	130	65	0	0.065
Dibenzo(a,h)anthracene	340 U	120	60	0	60
Fluoranthene	340 U	160	80	0	
Fluorene	220 J	120	220	220	
Indeno(1,2,3-cd)pyrene					
Naphthalene	2700	120	2700	2700	
Phenanthrene	340 U	17	9	0	
Pyrene	340 U	150	75	0	
	SUM		5029	4540	154

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BY: JJB Date: 09/17/01	CHECKED BY: Date:	APPROVED BY:	DATE:

PAH Chemicals	Sample PAI-10-SS-12-02 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	20 U	2.51	1	0	
Acenaphthene	20 U	5.35	3	0	
Acenaphthylene	20 U	4.13	2	0	
Anthracene	20 U	5.05	3	0	
Benzo(a)anthracene	33	3.8	33	33	3.3
Benzo(a)pyrene	33	6.41	33	33	33
Benzo(b)fluoranthene	53	4.38	0	0	5.3
Benzo(k)fluoranthene	15 J	4.44	0	0	0.15
Chrysene	27	3.59	27	27	0.027
Dibenzo(a,h)anthracene	20 U	5.82	3	0	2.91
Fluoranthene	39	4.3	39	39	
Fluorene	20 U	3.26	2	0	
Indeno(1,2,3-cd)pyrene	22	7.43	0	0	2.2
Naphthalene	20 U	3.75	2	0	
Phenanthrene	16 J	4.04	16	16	
Pyrene	40	2.97	40	40	
	SUM		203	188	47

PAH Chemicals	Sample PAI-10-SS-13-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	350 U	120	60	0	
Acenaphthene	350 U	130	65	0	
Acenaphthylene	350 U	120	60	0	
Anthracene	350 U	120	60	0	
Benzo(a)anthracene	350 U	120	60	0	6
Benzo(a)pyrene	350 U	160	80	0	80
Benzo(b)fluoranthene	350 U	150	0	0	7.5
Benzo(k)fluoranthene	350 U	130	0	0	0.65
Chrysene	350 U	130	65	0	0.065
Dibenzo(a,h)anthracene	350 U	120	60	0	60
Fluoranthene	350 U	160	80	0	
Fluorene	350 U	120	60	0	
Indeno(1,2,3-cd)pyrene					
Naphthalene	350 U	120	60	0	
Phenanthrene	350 U	17	9	0	
Pyrene	350 U	150	75	0	
	SUM		794	0	154

PAH Chemicals	Sample PAI-10-SS-14-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	440 U	160	80	0	
Acenaphthene	440 U	160	80	0	
Acenaphthylene	440 U	150	75	0	
Anthracene	440 U	160	80	0	
Benzo(a)anthracene	440 U	160	80	0	8
Benzo(a)pyrene	440 U	210	105	0	105
Benzo(b)fluoranthene	440 U	190	0	0	9.5
Benzo(k)fluoranthene	440 U	160	0	0	0.8
Chrysene	440 U	170	85	0	0.085
Dibenzo(a,h)anthracene	440 U	150	75	0	75
Fluoranthene	440 U	200	100	0	
Fluorene	440 U	150	75	0	
Indeno(1,2,3-cd)pyrene					
Naphthalene	440 U	150	75	0	
Phenanthrene	440 U	22	11	0	
Pyrene	440 U	190	95	0	
	SUM		1016	0	198

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
SUBJECT:	SITE 12/SWMU10 - JERICHO ISLAND DISPOSAL AREA		
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PAH Chemicals	Sample PAI-10-SS-15-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	370 U	130	65	0	
Acenaphthene	370 U	130	65	0	
Acenaphthylene	370 U	120	60	0	
Anthracene	370 U	130	65	0	
Benzo(a)anthracene	370 U	130	65	0	6.5
Benzo(a)pyrene	370 U	170	85	0	85
Benzo(b)fluoranthene	370 U	160	0	0	8
Benzo(k)fluoranthene	370 U	130	0	0	0.65
Chrysene	370 U	140	70	0	0.07
Dibenzo(a,h)anthracene	370 U	120	60	0	60
Fluoranthene	370 U	160	80	0	
Fluorene	370 U	120	60	0	
Indeno(1,2,3-cd)pyrene	370 U	150	0	0	7.5
Naphthalene	370 U	120	60	0	
Phenanthrene	370 U	18	9	0	
Pyrene	370 U	150	75	0	
	SUM		819	0	168

PAH Chemicals	Sample PAI-10-SS-15-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	350 U	120	60	0	
Acenaphthene	350 U	130	65	0	
Acenaphthylene	350 U	120	60	0	
Anthracene	350 U	130	65	0	
Benzo(a)anthracene	350 U	130	65	0	6.5
Benzo(a)pyrene	350 U	170	85	0	85
Benzo(b)fluoranthene	350 U	150	0	0	7.5
Benzo(k)fluoranthene	350 U	130	0	0	0.65
Chrysene	350 U	130	65	0	0.065
Dibenzo(a,h)anthracene	350 U	120	60	0	60
Fluoranthene	350 U	160	80	0	
Fluorene	350 U	120	60	0	
Indeno(1,2,3-cd)pyrene					
Naphthalene	350 U	120	60	0	
Phenanthrene	350 U	17	9	0	
Pyrene	350 U	150	75	0	
	SUM		809	0	160

PAH Chemicals	Sample PAI-10-SS-16-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	360 U	130	65	0	
Acenaphthene	360 U	130	65	0	
Acenaphthylene	360 U	120	60	0	
Anthracene	360 U	130	65	0	
Benzo(a)anthracene	360 U	130	65	0	6.5
Benzo(a)pyrene	360 U	170	85	0	85
Benzo(b)fluoranthene	360 U	160	0	0	8
Benzo(k)fluoranthene	360 U	130	0	0	0.65
Chrysene	360 U	140	70	0	0.07
Dibenzo(a,h)anthracene	360 U	120	60	0	60
Fluoranthene	360 U	160	80	0	
Fluorene	360 U	120	60	0	
Indeno(1,2,3-cd)pyrene	360 U	150	0	0	7.5
Naphthalene	360 U	120	60	0	
Phenanthrene	360 U	18	9	0	
Pyrene	360 U	150	75	0	
	SUM		819	0	168

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
SUBJECT:	SITE 12/SWMU10 - JERICHO ISLAND DISPOSAL AREA		
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PAH Chemicals	Sample PAI-10-SS-17-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	360 U	130	65	0	
Acenaphthene	360 U	130	65	0	
Acenaphthylene	360 U	120	60	0	
Anthracene	360 U	130	65	0	
Benzo(a)anthracene	360 U	130	65	0	6.5
Benzo(a)pyrene	360 U	170	85	0	85
Benzo(b)fluoranthene	360 U	160	0	0	8
Benzo(k)fluoranthene	360 U	130	0	0	0.65
Chrysene	360 U	140	70	0	0.07
Dibenzo(a,h)anthracene	360 U	120	60	0	60
Fluoranthene	360 U	160	80	0	
Fluorene	360 U	120	60	0	
Indeno(1,2,3-cd)pyrene	360 U	150	0	0	7.5
Naphthalene	360 U	120	60	0	
Phenanthrene	360 U	18	9	0	
Pyrene	360 U	150	75	0	
	SUM		819	0	168

PAH Chemicals	Sample PI-012-03(37) Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	440 U	NA	220	0	
Acenaphthene	440 U	NA	220	0	
Acenaphthylene	440 U	NA	220	0	
Anthracene	440 U	NA	220	0	
Benzo(a)anthracene	41 J	NA	41	41	4.1
Benzo(a)pyrene	53 J	NA	53	53	53
Benzo(b)fluoranthene	130 J	NA	0	0	13
Benzo(k)fluoranthene	440 U	NA	0	0	2.2
Chrysene	62 J	NA	62	62	0.062
Dibenzo(a,h)anthracene	34 J	NA	34	34	34
Fluoranthene	41 J	NA	41	41	
Fluorene	440 U	NA	220	0	
Indeno(1,2,3-cd)pyrene	64 J	NA	64	64	6.4
Naphthalene	440 U	NA	220	0	
Phenanthrene	440 U	NA	220	0	
Pyrene	43 J	NA	43	43	
	SUM		1878	338	113

PAH Chemicals	Sample PAI-10-SD-01-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	520 U	NA	260	0	
Acenaphthene	120 U	18	9	0	
Acenaphthylene	240 U	9	4.5	0	
Anthracene	12 U	0.56	0.28	0	
Benzo(a)anthracene	12 U	0.99	0.495	0	0.0495
Benzo(a)pyrene	12 U	0.9	0.45	0	0.45
Benzo(b)fluoranthene	24 U	1.6	0	0	0.08
Benzo(k)fluoranthene	12 U	1.5	0	0	0.0075
Chrysene	12 U	1.1	0.55	0	0.00055
Dibenzo(a,h)anthracene	24 U	4.2	2.1	0	2.1
Fluoranthene	24 U	6.3	3.15	0	
Fluorene	24 U	1.6	0.8	0	
Indeno(1,2,3-cd)pyrene	12 U	0.97	0	0	0.0485
Naphthalene	120 U	8.3	4.15	0	
Phenanthrene	12 U	1.9	0.95	0	
Pyrene	12 U	12	6	0	
	SUM		292	0	2.7

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
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PAH Chemicals	Sample PAI-10-SD-02-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	510 U	NA	255	0	
Acenaphthene	200 U	28	14	0	
Acenaphthylene	380 U	15	7.5	0	
Anthracene	20 U	0.9	0.45	0	
Benzo(a)anthracene	20 U	1.6	0.8	0	0.08
Benzo(a)pyrene	20 UJ	1.5	20	20	20
Benzo(b)fluoranthene	38 U	2.6	0	0	0.13
Benzo(k)fluoranthene	20 U	2.5	0	0	0.0125
Chrysene	20 U	1.8	0.9	0	0.0009
Dibenzo(a,h)anthracene	38 U	6.8	3.4	0	3.4
Fluoranthene	38 U	10	5	0	
Fluorene	38 U	2.7	1.35	0	
Indeno(1,2,3-cd)pyrene	20 U	1.6	0	0	0.08
Naphthalene	200 U	13	6.5	0	
Phenanthrene	20 U	3.1	1.55	0	
Pyrene	20 U	19	9.5	0	
	SUM		326	20	23.7

PAH Chemicals	Sample PAI-10-SD-02-01A-D Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	500 U	NA	250	0	
Acenaphthene	200 U	29	14.5	0	
Acenaphthylene	390 U	15	7.5	0	
Anthracene	20 U	0.91	0.455	0	
Benzo(a)anthracene	20 U	1.6	0.8	0	0.08
Benzo(a)pyrene	26 J	1.5	26	26	26
Benzo(b)fluoranthene	39 U	2.7	0	0	0.135
Benzo(k)fluoranthene	20 U	2.5	0	0	0.0125
Chrysene	20 U	1.9	0.95	0	0.00095
Dibenzo(a,h)anthracene	39 U	6.9	3.45	0	3.45
Fluoranthene	39 U	10	5	0	
Fluorene	39 U	2.7	1.35	0	
Indeno(1,2,3-cd)pyrene	20 U	1.6	0	0	0.08
Naphthalene	200 U	14	7	0	
Phenanthrene	20 U	3.2	1.6	0	
Pyrene	20 U	20	10	0	
	SUM		329	26	29.8

PAH Chemicals	Sample PAI-10-SD-03-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	460 U	NA	230	0	
Acenaphthene	96 U	14	7	0	
Acenaphthylene	190 U	7	3.5	0	
Anthracene	9.6 U	0.43	0.215	0	
Benzo(a)anthracene	9.6 U	0.77	0.385	0	0.0385
Benzo(a)pyrene	9.6 U	0.7	0.35	0	0.35
Benzo(b)fluoranthene	19 U	1.3	0	0	0.065
Benzo(k)fluoranthene	9.6 U	1.2	0	0	0.006
Chrysene	9.6 U	0.88	0.44	0	0.00044
Dibenzo(a,h)anthracene	19 U	3.3	1.65	0	1.65
Fluoranthene	19 U	4.9	2.45	0	
Fluorene	19 U	1.3	0.65	0	
Indeno(1,2,3-cd)pyrene	9.6 U	0.75	0	0	0.0375
Naphthalene	96 U	6.4	3.2	0	
Phenanthrene	9.6 U	1.5	0.75	0	
Pyrene	9.6 U	9.4	4.7	0	
	SUM		255	0	2.1

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
SUBJECT:	SITE 12/SWMU10 - JERICHO ISLAND DISPOSAL AREA		
BASED ON:	PAH Data for Surface Soil and Sediment Samples from Site 12/SWMU 10 RI/RFI	DRAWING NUMBER:	
BY: JJB	CHECKED BY:	APPROVED BY:	DATE:
Date: 09/17/01	Date:		

PAH Chemicals	Sample PAI-10-SD-04-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	600 U	NA	300	0	
Acenaphthene	100 U	14	7	0	
Acenaphthylene	200 U	7.4	3.7	0	
Anthracene	10 U	0.45	0.225	0	
Benzo(a)anthracene	10 U	0.81	0.405	0	0.0405
Benzo(a)pyrene	10 U	0.74	0.37	0	0.37
Benzo(b)fluoranthene	20 U	1.3	0	0	0.065
Benzo(k)fluoranthene	10 U	1.3	0	0	0.0065
Chrysene	10 U	0.92	0.46	0	0.00046
Dibenzo(a,h)anthracene	20 U	3.5	1.75	0	1.75
Fluoranthene	20 U	5.2	2.6	0	
Fluorene	20 U	1.3	0.65	0	
Indeno(1,2,3-cd)pyrene	10 U	0.79	0	0	0.0395
Naphthalene	100 U	6.8	3.4	0	
Phenanthrene	10 U	1.6	0.8	0	
Pyrene	10 U	9.9	4.95	0	
	SUM		326	0	2.3

PAH Chemicals	Sample PAI-10-SD-05-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	500 U	NA	250	0	
Acenaphthene	97 U	14	7	0	
Acenaphthylene	190 U	7.1	3.55	0	
Anthracene	9.7 U	0.44	0.22	0	
Benzo(a)anthracene	9.7 U	0.78	0.39	0	0.039
Benzo(a)pyrene	9.7 U	0.71	0.355	0	0.355
Benzo(b)fluoranthene	19 U	1.3	0	0	0.065
Benzo(k)fluoranthene	9.7 U	1.2	0	0	0.006
Chrysene	9.7 U	0.89	0.445	0	0.000445
Dibenzo(a,h)anthracene	19 U	3.3	1.65	0	1.65
Fluoranthene	19 U	5	2.5	0	
Fluorene	19 U	1.3	0.65	0	
Indeno(1,2,3-cd)pyrene	9.7 U	0.77	0	0	0 0385
Naphthalene	97 U	6.5	3.25	0	
Phenanthrene	9.7 U	1.5	0.75	0	
Pyrene	9.7 U	9.5	4.75	0	
	SUM		276	0	2.2

PAH Chemicals	Sample PAI-10-SD-06-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	460 U	NA	230	0	
Acenaphthene	93 U	13	6.5	0	
Acenaphthylene	180.0 U	6.8	3.4	0	
Anthracene	9.3 U	0.42	0.21	0	
Benzo(a)anthracene	9.3 U	0.75	0.375	0	0.0375
Benzo(a)pyrene	9.3 U	0.69	0.345	0	0.345
Benzo(b)fluoranthene	18 U	1.2	0	0	0.06
Benzo(k)fluoranthene	9.3 U	1.2	0	0	0.006
Chrysene	9.3 U	0.86	0.43	0	0.00043
Dibenzo(a,h)anthracene	18.0 U	3.2	1.6	0	1.6
Fluoranthene	18 U	4.8	2.4	0	
Fluorene	18.0 U	1.2	0.6	0	
Indeno(1,2,3-cd)pyrene	9.3 U	0.74	0	0	0.037
Naphthalene	93.0 U	6.3	3.15	0	
Phenanthrene	9.3 U	1.5	0.75	0	
Pyrene	9.3 U	9.1	4.55	0	
	SUM		254	0	2.1

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
SUBJECT:	SITE 12/SWMU10 - JERICHO ISLAND DISPOSAL AREA		
BASED ON:	PAH Data for Surface Soil and Sediment Samples from Site 12/SWMU 10 RI/RFI	DRAWING NUMBER:	
BY: JJB Date: 09/17/01	CHECKED BY: Date:	APPROVED BY:	DATE:

PAH Chemicals	Sample PAI-10-SD-07-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	530 U	NA	265	0	
Acenaphthene	100 U	15	7.5	0	
Acenaphthylene	200.0 U	7.6	3.8	0	
Anthracene	10.0 U	0.46	0.23	0	
Benzo(a)anthracene	10 U	0.82	0.41	0	0.041
Benzo(a)pyrene	11	0.76	11	11	11
Benzo(b)fluoranthene	20 U	1.4	0	0	0.07
Benzo(k)fluoranthene	10 U	1.3	0	0	0.0065
Chrysene	10 U	0.95	0.475	0	0.000475
Dibenzo(a,h)anthracene	20 U	3.5	1.75	0	1.75
Fluoranthene	20 U	5.3	2.65	0	
Fluorene	20 U	1.4	0.7	0	
Indeno(1,2,3-cd)pyrene	10 U	0.81	0	0	0.0405
Naphthalene	100 U	6.9	3.45	0	
Phenanthrene	10 U	1.6	0.8	0	
Pyrene	10 U	10	5	0	
	SUM		303	11	12.9

PAH Chemicals	Sample PAI-10-SD-08-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	2600 U	NA	1300	0	
Acenaphthene	270 U	38	19	0	
Acenaphthylene	520 U	19	9.5	0	
Anthracene	27 U	1.2	0.6	0	
Benzo(a)anthracene	27 U	2.1	1.05	0	0.105
Benzo(a)pyrene	38	1.9	38	38	38
Benzo(b)fluoranthene	120	3.5	0	0	12
Benzo(k)fluoranthene	27 U	3.3	0	0	0.0165
Chrysene	27 U	2.4	1.2	0	0.0012
Dibenzo(a,h)anthracene	52 U	9.1	4.55	0	4.55
Fluoranthene	52 U	14	7	0	
Fluorene	52 U	3.5	1.75	0	
Indeno(1,2,3-cd)pyrene	27 U	2.1	0	0	0.105
Naphthalene	270 U	18	9	0	
Phenanthrene	27 U	4.2	2.1	0	
Pyrene	27 U	26	13	0	
	SUM		1407	38	54.8

PAH Chemicals	Sample PAI-10-SD-09-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	1100 U	NA	550	0	
Acenaphthene	220 U	31	15.5	0	
Acenaphthylene	420 U	16	8	0	
Anthracene	22 U	0.98	0.49	0	
Benzo(a)anthracene	22 U	1.7	0.85	0	0.085
Benzo(a)pyrene	29 J	1.6	29	29	29
Benzo(b)fluoranthene	42 U	2.9	0	0	0.145
Benzo(k)fluoranthene	22 U	2.7	0	0	0.0135
Chrysene	22 U	2	1	0	0.001
Dibenzo(a,h)anthracene	42 U	7.5	3.75	0	3.75
Fluoranthene	42 U	11	5.5	0	
Fluorene	42 U	2.9	1.45	0	
Indeno(1,2,3-cd)pyrene	22 U	1.7	0	0	0.085
Naphthalene	220 U	15	7.5	0	
Phenanthrene	22 U	3.4	1.7	0	
Pyrene	22 U	21	10.5	0	
	SUM		635	29	33

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
SUBJECT:	SITE 12/SWMU10 - JERICHO ISLAND DISPOSAL AREA		
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BY: JJB Date: 09/17/01	CHECKED BY: Date:	APPROVED BY:	DATE:

PAH Chemicals	Sample PAI-10-SD-10-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	480 U	NA	240	0	
Acenaphthene	110 U	15	7.5	0	
Acenaphthylene	210 U	7.8	3.9	0	
Anthracene	11 U	0.48	0.24	0	
Benzo(a)anthracene	11 U	0.85	0.425	0	0.0425
Benzo(a)pyrene	11 U	0.78	0.39	0	0.39
Benzo(b)fluoranthene	21 U	1.4	0	0	0.07
Benzo(k)fluoranthene	11 U	1.3	0	0	0.0065
Chrysene	11 U	0.97	0.485	0	0.000485
Dibenzo(a,h)anthracene	21 U	3.6	1.8	0	1.8
Fluoranthene	21 U	5.4	2.7	0	
Fluorene	21 U	1.4	0.7	0	
Indeno(1,2,3-cd)pyrene	11 U	0.83	0	0	0.0415
Naphthalene	110 U	7.1	3.55	0	
Phenanthrene	11 U	1.7	0.85	0	
Pyrene	11 U	10	5	0	
	SUM		268	0	2.4

PAH Chemicals	Sample PAI-10-SD-11-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	510 U	NA	255	0	
Acenaphthene	110 U	16	8	0	
Acenaphthylene	210 U	8.1	4.05	0	
Anthracene	11 U	0.5	0.25	0	
Benzo(a)anthracene	11 U	0.88	0.44	0	0.044
Benzo(a)pyrene	11 U	0.81	0.405	0	0.405
Benzo(b)fluoranthene	21 U	1.5	0	0	0.075
Benzo(k)fluoranthene	29 R	1.4	0	0	0.29
Chrysene	11 U	1	0.5	0	0.0005
Dibenzo(a,h)anthracene	21 U	3.8	1.9	0	1.9
Fluoranthene	21 U	5.7	2.85	0	
Fluorene	21 U	1.5	0.75	0	
Indeno(1,2,3-cd)pyrene	11 U	0.87	0	0	0.0435
Naphthalene	110 U	7.4	3.7	0	
Phenanthrene	11 U	1.7	0.85	0	
Pyrene	11 U	11	5.5	0	
	SUM		284	0	2.8

PAH Chemicals	Sample PAI-10-SD-12-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	530 U	NA	265	0	
Acenaphthene	110 U	16	8	0	
Acenaphthylene	220.0 U	8.2	4.1	0	
Anthracene	11.0 U	0.51	0.255	0	
Benzo(a)anthracene	11 U	0.9	0.45	0	0.045
Benzo(a)pyrene	11 U	0.82	0.41	0	0.41
Benzo(b)fluoranthene	22 U	1.5	0	0	0.075
Benzo(k)fluoranthene	11 U	1.4	0	0	0.007
Chrysene	11 U	1	0.5	0	0.0005
Dibenzo(a,h)anthracene	22 U	3.8	1.9	0	1.9
Fluoranthene	22 U	5.7	2.85	0	
Fluorene	22 U	1.5	0.75	0	
Indeno(1,2,3-cd)pyrene	11 U	0.88	0	0	0.044
Naphthalene	110 U	7.5	3.75	0	
Phenanthrene	11 U	1.8	0.9	0	
Pyrene	11 U	11	5.5	0	
	SUM		294	0	2.5

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
SUBJECT:	SITE 12/SWMU10 - JERICHO ISLAND DISPOSAL AREA		
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BY: JJB	CHECKED BY:	APPROVED BY:	DATE:
Date: 09/17/01	Date:		

PAH Chemicals	Sample PAI-10-SD-13-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	610 U	NA	305	0	
Acenaphthene	110 U	16	8	0	
Acenaphthylene	220.0 U	8.3	4.15	0	
Anthracene	11.0 U	0.51	0.255	0	
Benzo(a)anthracene	18 J	0.91	18	18	1.8
Benzo(a)pyrene	30	0.83	30	30	30
Benzo(b)fluoranthene	25 J	1.5	0	0	2.5
Benzo(k)fluoranthene	18	1.4	0	0	0.18
Chrysene	44 J	1	44	44	0.044
Dibenzo(a,h)anthracene	22 U	3.9	1.95	0	1.95
Fluoranthene	92	5.8	92	92	
Fluorene	22 U	1.5	0.75	0	
Indeno(1,2,3-cd)pyrene	11 U	0.9	0	0	0.045
Naphthalene	110 U	7.6	3.8	0	
Phenanthrene	11 U	1.8	0.9	0	
Pyrene	89	11	89	89	
	SUM		598	273	37

PAH Chemicals	Sample PAI-10-SD-14-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	880 U	NA	440	0	
Acenaphthene	160 U	23	11.5	0	
Acenaphthylene	310.0 U	12	6	0	
Anthracene	16.0 U	0.72	0.36	0	
Benzo(a)anthracene	16 U	1.3	0.65	0	0.065
Benzo(a)pyrene	31	1.2	31	31	31
Benzo(b)fluoranthene	31 U	2.1	0	0	0.105
Benzo(k)fluoranthene	16 U	2	0	0	0.01
Chrysene	16 U	1.5	0.75	0	0.00075
Dibenzo(a,h)anthracene	31 U	5.5	2.75	0	2.75
Fluoranthene	31 U	8.1	4.05	0	
Fluorene	31 U	2.1	1.05	0	
Indeno(1,2,3-cd)pyrene	26	1.3	0	0	2.6
Naphthalene	160 U	11	5.5	0	
Phenanthrene	16 U	2.5	1.25	0	
Pyrene	16 U	16	8	0	
	SUM		513	31	37

PAH Chemicals	Sample PAI-10-SD-14-02A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	580 U	NA	290	0	
Acenaphthene	160 U	23	11.5	0	
Acenaphthylene	310.0 U	12	6	0	
Anthracene	16.0 U	0.72	0.36	0	
Benzo(a)anthracene	16 U	1.3	0.65	0	0.065
Benzo(a)pyrene	21	1.2	21	21	21
Benzo(b)fluoranthene	31 U	2.1	0	0	0.105
Benzo(k)fluoranthene	16 U	2	0	0	0.01
Chrysene	16 U	1.5	0.75	0	0.00075
Dibenzo(a,h)anthracene	31 U	5.5	2.75	0	2.75
Fluoranthene	31 U	8.2	4.1	0	
Fluorene	31 U	2.1	1.05	0	
Indeno(1,2,3-cd)pyrene	16 U	1.3	0	0	0.065
Naphthalene	160 U	11	5.5	0	
Phenanthrene	16 U	2.5	1.25	0	
Pyrene	16 U	16	8	0	
	SUM		353	21	24

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
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BY: JJB Date: 09/17/01	CHECKED BY: Date:	APPROVED BY:	DATE:

PAH Chemicals	Sample PAI-10-SD-15-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	570 U	NA	285	0	
Acenaphthene	130 U	18	9	0	
Acenaphthylene	250.0 U	9.2	4.6	0	
Anthracene	13.0 U	0.57	0.285	0	
Benzo(a)anthracene	13 U	1	0.5	0	0.05
Benzo(a)pyrene	13 U	0.92	0.46	0	0.46
Benzo(b)fluoranthene	25 U	1.7	0	0	0.085
Benzo(k)fluoranthene	13 U	1.6	0	0	0.008
Chrysene	13 U	1.2	0.6	0	0.0006
Dibenzo(a,h)anthracene	25 U	4.3	2.15	0	2.15
Fluoranthene	25 U	6.4	3.2	0	
Fluorene	25 U	1.7	0.85	0	
Indeno(1,2,3-cd)pyrene	13 U	0.99	0	0	0.0495
Naphthalene	130 U	8.4	4.2	0	
Phenanthrene	13 U	2	1	0	
Pyrene	13 U	12	6	0	
	SUM		318	0	2.8

PAH Chemicals	Sample PAI-10-SD-16-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	810 U	NA	405	0	
Acenaphthene	170 U	24	12	0	
Acenaphthylene	330.0 U	13	6.5	0	
Anthracene	17.0 U	0.77	0.385	0	
Benzo(a)anthracene	17 U	1.4	0.7	0	0.07
Benzo(a)pyrene	22 J	1.3	22	22	22
Benzo(b)fluoranthene	33 U	2.3	0	0	0.115
Benzo(k)fluoranthene	17 U	2.1	0	0	0.0105
Chrysene	17 U	1.6	0.8	0	0.0008
Dibenzo(a,h)anthracene	33 U	5.9	2.95	0	2.95
Fluoranthene	33 U	8.8	4.4	0	
Fluorene	33 U	2.3	1.15	0	
Indeno(1,2,3-cd)pyrene	17 U	1.3	0	0	0.065
Naphthalene	170 U	11	5.5	0	
Phenanthrene	17 U	2.7	1.35	0	
Pyrene	17 U	17	8.5	0	
	SUM		471	22	25

PAH Chemicals	Sample PAI-10-SD-17-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	1200 U	NA	600	0	
Acenaphthene	110 U	16	8	0	
Acenaphthylene	210.0 U	8	4	0	
Anthracene	11.0 U	0.49	0.245	0	
Benzo(a)anthracene	11 U	0.87	0.435	0	0.0435
Benzo(a)pyrene	12	0.8	12	12	12
Benzo(b)fluoranthene	21 U	1.4	0	0	0.07
Benzo(k)fluoranthene	11 U	1.4	0	0	0.007
Chrysene	11 U	1	0.5	0	0.0005
Dibenzo(a,h)anthracene	21 U	3.7	1.85	0	1.85
Fluoranthene	21 U	5.6	2.8	0	
Fluorene	21 U	1.5	0.75	0	
Indeno(1,2,3-cd)pyrene	11 U	0.86	0	0	0.043
Naphthalene	110 U	7.3	3.65	0	
Phenanthrene	11 U	1.7	0.85	0	
Pyrene	11 U	11	5.5	0	
	SUM		641	12	14

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
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PAH Chemicals	Sample PAI-10-SD-18-01A Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	1000 U	NA	500	0	
Acenaphthene	200 U	29	14.5	0	
Acenaphthylene	390.0 U	15	7.5	0	
Anthracene	20.0 U	0.93	0.465	0	
Benzo(a)anthracene	20 U	1.6	0.8	0	0.08
Benzo(a)pyrene	38	1.5	38	38	38
Benzo(b)fluoranthene	39 U	2.7	0	0	0.135
Benzo(k)fluoranthene	20 U	2.6	0	0	0.013
Chrysene	20 U	1.9	0.95	0	0.00095
Dibenzo(a,h)anthracene	39 U	7	3.5	0	3.5
Fluoranthene	39 U	11	5.5	0	
Fluorene	39 U	2.7	1.35	0	
Indeno(1,2,3-cd)pyrene	20 U	1.6	0	0	0.08
Naphthalene	200 U	14	7	0	
Phenanthrene	20 U	3.2	1.6	0	
Pyrene	20 U	20	10	0	
	SUM		591	38	42

PAH Chemicals	Sample PAI-10-SD-19-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	570 U	240	120	0	
Acenaphthene	140 U	16	8	0	
Acenaphthylene	69 U	33	16.5	0	
Anthracene	2.8 U	1.2	0.6	0	
Benzo(a)anthracene	6.9 U	0.97	0.485	0	0.0485
Benzo(a)pyrene	6.9 U	1	0.5	0	0.5
Benzo(b)fluoranthene	2.8 U	1.8	0	0	0.09
Benzo(k)fluoranthene	2.8 U	0.97	0	0	0.00485
Chrysene	6.9 U	2.8	1.4	0	0.0014
Dibenzo(a,h)anthracene	11 U	3.6	1.8	0	1.8
Fluoranthene	6.9 U	6.3	3.15	0	
Fluorene	14 U	7.3	3.65	0	
Indeno(1,2,3-cd)pyrene	6.9 U	0.84	0	0	0.042
Naphthalene	69 U	21	10.5	0	
Phenanthrene	5.5 U	2	1	0	
Pyrene	14 U	7.1	3.55	0	
	SUM		171	0	2

PAH Chemicals	Sample PAI-10-SD-20-01 Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	830 U	350	175	0	
Acenaphthene	120 U	24	12	0	
Acenaphthylene	100 U	49	24.5	0	
Anthracene	4.1 U	1.8	0.9	0	
Benzo(a)anthracene	10 U	1.4	0.7	0	0.07
Benzo(a)pyrene	10 U	1.5	0.75	0	0.75
Benzo(b)fluoranthene	4.1 U	2.7	0	0	0.135
Benzo(k)fluoranthene	4.1 U	1.4	0	0	0.007
Chrysene	10 U	4.2	2.1	0	0.0021
Dibenzo(a,h)anthracene	16 U	5.4	2.7	0	2.7
Fluoranthene	10	9.3	10	10	
Fluorene	20 U	11	5.5	0	
Indeno(1,2,3-cd)pyrene	10 U	1.2	0	0	0.06
Naphthalene	100 U	31	15.5	0	
Phenanthrene	8.2 U	2.9	1.45	0	
Pyrene	20 U	10	5	0	
	SUM		246	0	4

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7803 - DRAFT RI
SUBJECT:	SITE 12/SWMU10 - JERICHO ISLAND DISPOSAL AREA		
BASED ON:	PAH Data for Surface Soil and Sediment Samples from Site 12/SWMU 10 RI/RFI	DRAWING NUMBER:	
BY: JJB Date: 09/17/01	CHECKED BY: Date:	APPROVED BY:	DATE:

PAH Chemicals	Sample PI-012-01 (35) Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	2000 U	NA	1000	0	
Acenaphthene	2000 U	NA	1000	0	
Acenaphthylene	2000 U	NA	1000	0	
Anthracene	2000 U	NA	1000	0	
Benzo(a)anthracene	2000 U	NA	1000	0	100
Benzo(a)pyrene	2000 U	NA	1000	0	1000
Benzo(b)fluoranthene	2000 U	NA	0	0	100
Benzo(k)fluoranthene	2000 U	NA	0	0	10
Chrysene	2000 U	NA	1000	0	1
Dibenzo(a,h)anthracene	2000 U	NA	1000	0	1000
Fluoranthene	2000 U	NA	1000	0	
Fluorene	2000 U	NA	1000	0	
Indeno(1,2,3-cd)pyrene	2000 U	NA	0	0	100
Naphthalene	2000 U	NA	1000	0	
Phenanthrene	2000 U	NA	1000	0	
Pyrene	2000 U	NA	1000	0	
	SUM		13000	0	2311

PAH Chemicals	Sample PI-012-02 (36) Concentration	MDL	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	620 U	NA	310	0	
Acenaphthene	620 U	NA	310	0	
Acenaphthylene	620 U	NA	310	0	
Anthracene	620 U	NA	310	0	
Benzo(a)anthracene	620 U	NA	310	0	31
Benzo(a)pyrene	620 U	NA	310	0	310
Benzo(b)fluoranthene	620 U	NA	0	0	31
Benzo(k)fluoranthene	620 U	NA	0	0	3.1
Chrysene	620 U	NA	310	0	0.31
Dibenzo(a,h)anthracene	620 U	NA	310	0	310
Fluoranthene	620 U	NA	310	0	
Fluorene	620 U	NA	310	0	
Indeno(1,2,3-cd)pyrene	620 U	NA	0	0	31
Naphthalene	620 U	NA	310	0	
Phenanthrene	620 U	NA	310	0	
Pyrene	620 U	NA	310	0	
	SUM		4030	0	716

Conclusions

The following samples exceeded ecological screening criterion

Sample ID	Matrix	Total PAH Conc.	Criterion	Notes
PAI-10-SS-01-01	Soil	1021	1000	PAHs were not detected in sample. Exceedance due to elevated detection limits.
PAI-10-SS-08-01	Soil	1464	1000	
PAI-10-SS-08-02	Soil	16888	1000	2001 sample reconfirms 1998 result.
PAI-10-SS-12-01-D	Soil	5029	1000	2001 resample does not exceed criteria.
PAI-10-SS-14-01	Soil	1016	1000	PAHs were not detected in sample. Exceedance due to elevated detection limits.
PI-012-03(37)	Soil	1878	1000	
PI-012-01 (35)	Sediment	13000	1684	PAHs were not detected in sample. Exceedance due to elevated detection limits.
PI-012-02 (36)	Sediment	4030	1684	PAHs were not detected in sample. Exceedance due to elevated detection limits.

The following samples exceeded human health screening criterion

Sample ID	Matrix	B(a)P Eq. Conc.	Criterion	Notes
PAI-10-SS-08-02	Soil	3286	434	
PI-012-01 (35)	Sediment	2311	434	PAHs were not detected in sample. Exceedance due to elevated detection limits.
PI-012-02 (36)	Sediment	716	434	PAHs were not detected in sample. Exceedance due to elevated detection limits.