tyco Healthcare

Mallinckrodt

September 19, 2003

Mr. Scott Whittier
Division of Oil and Hazardous Waste Facilities Regulation
Bureau of Remediation and Waste Management
State of Maine Department of Environmental Protection
17 State House Station
Augusta, Maine 04333-0017

Mr. Ernest R.P. Waterman
United States Environmental Protection Agency – Region I
RCRA Corrective Action Section
One Congress Street
Boston, Massachusetts 02140-2023

Subject: HoltraChem Manufacturing Site, Orrington, Maine
Revised Corrective Measures Study Report

Dear Mr. Whittier and Mr. Waterman:

Enclosed are four copies of the Corrective Measures Study (CMS) Report, dated September 2003 as well as a comment response prepared by Camp, Dresser & McKee (CDM) responding in detail to the comments contained in the Maine Department of Environmental Protection's (MEDEP's) letter dated July 23, 2003. Mallinckrodt has spent considerable time reviewing the comments and preparing this response and believes that the CMS Report as revised addresses most of the comments. Mallinckrodt is firmly committed to the remediation of the HoltraChem Manufacturing Site in a manner that is protective of the environment. As we have discussed at multiple meetings, Mallinckrodt has unilaterally continued with the RCRA Corrective Action process as the most expeditious way to address contaminants at the Site.

Furthermore, Mallinckrodt believes that the proposed groundwater containment system is the quickest and most effective way to limit the offsite migration of contaminants. This corrective measure along with source removal activities under the cell building footprint and other identified locations will control and mitigate offsite migration of contaminants. As we have struggled to define the PMPSs and performance standards, it is clear that there may be issues that arise during the implementation of the remedy at this site that will possibly require a reevaluation of various corrective measures. Yet, Mallinckrodt firmly believes that the CMS Report as proposed provides a framework for implementation of a protective remedy at this

Site. Because of that, we hope that MEDEP and USEPA approve the CMS Report as written so that we can proceed to the next steps in the RCRA Corrective Action process.

After your review of this revised CMS Report, Mallinckrodt and its consultants would like to meet with you to discuss any remaining questions that you might have regarding the CMS Report or any other activities continuing at the Site to further expedite the process.

Thank you for your continued time and attention to this project. Please call me at 314-654-6314 to schedule any meeting. If you have technical questions, please contact Ernest Ashley at CDM at 617-452-6416.

Very truly yours,

Patricia Hitt Duft
Mallinckrodt Inc. / Tyco Healthcare

Enclosures

CC: James Grant

Walter Chaffee

J. Andrew Schlickman

Dennis Harnish

Amelia W. Katzen

Mallinckrodt Inc.

HoltraChem Manufacturing Site
Orrington, Maine
Corrective Measures Study

September 19, 2003

Report

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Section 1
Introduction

1.1 Intent of Document

CDM has prepared this Corrective Measures Study (CMS) Report on behalf of Mallinckrodt Inc. (Mallinckrodt) for the HoltraChem Manufacturing Site in Orrington, Maine pursuant to the RCRA Corrective Action Program and conditions set forth in the Consent Decree in Civil Action No. 91-0188-B (District of Maine), United States of America v. Hanlin Group, Inc. This CMS has been prepared as outlined in the Corrective Measures Study Work Plan, June 17, 2002 and MEDEP's comments dated January 21, 2003.

The purpose of this report is to identify and delineate areas of corrective action at the site, and to develop and evaluate corrective measure alternatives for those areas. Recommendations for final corrective measures to be implemented are presented based on the results of the evaluation of these alternatives.

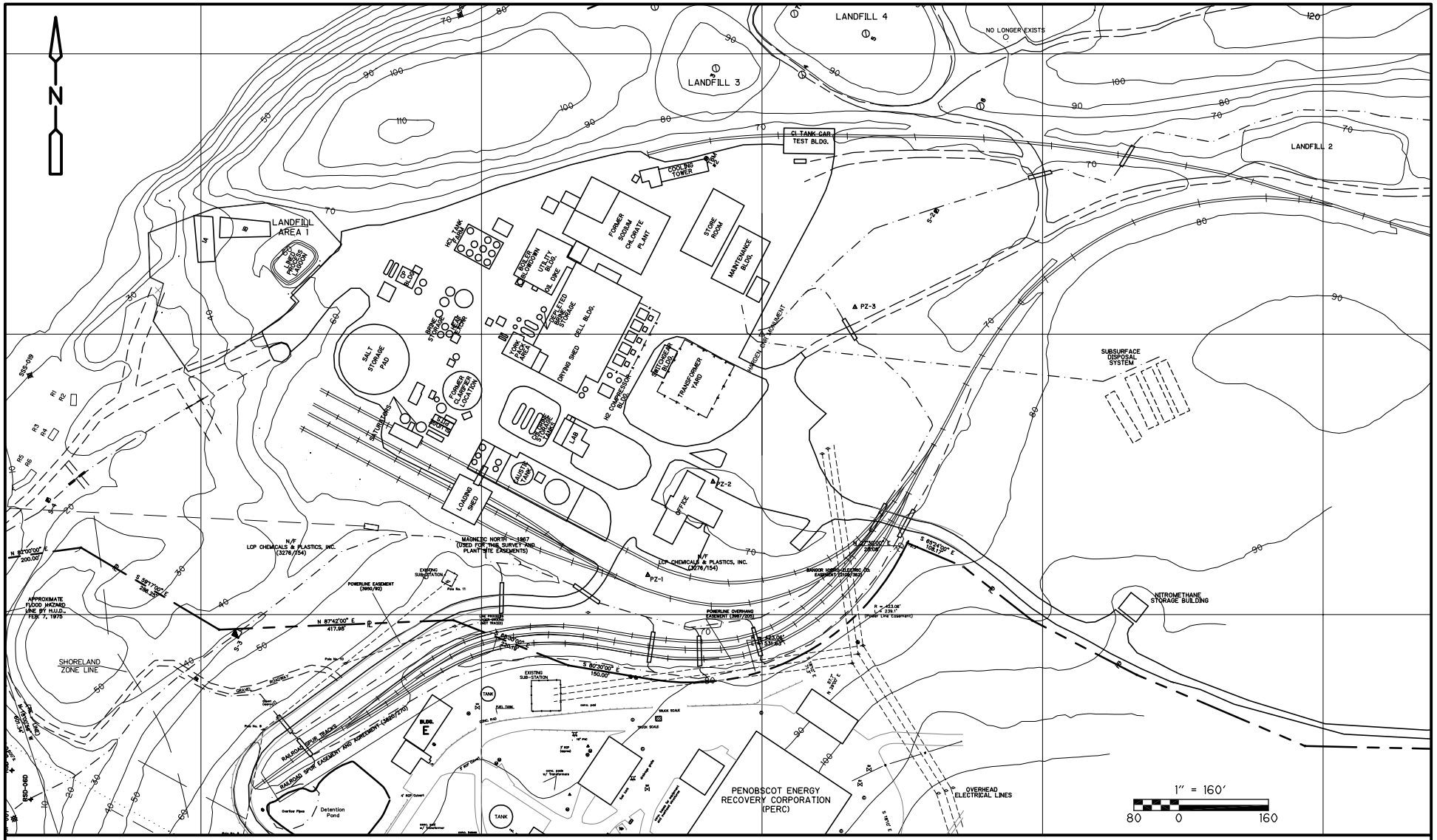
1.2 Background Information

1.2.1 Site History

The plant at the site was constructed in 1967 by International Minerals and Chemical Corporation (IMC), a predecessor to Mallinckrodt to produce chlorine and related products by the mercury half-cell, chlor-alkali process. The only known use of the site prior to its development in 1967 was for mining of sand and gravel. The chlor-alkali plant was sold to Sobin Chemical in 1974. At that time, IMC owned 80% of Sobin Chemical. In March 1975, IMC acquired the remaining interest in Sobin Chemical and sold the plant to LCP Chemicals, Inc. (LCP) a division of Hanlin Group, Inc. on April 30, 1982. HoltraChem Group, Inc. purchased the site from Hanlin Group, Inc. on April 7, 1994. The plant ceased operations in September 2000.

1.2.2 Site Description

The HoltraChem Manufacturing Site is located at 99 Industrial Way in Orrington, Maine approximately 6 miles south of Bangor, Maine on the east side of the Penobscot River. A plan of the site is presented in **Figure 1-1**. The plant site is bordered to the north and west by the Penobscot River; to the south and east by the Penobscot Energy Recovery Company (PERC), a resource recovery facility that generates electricity by burning of municipal refuse; and to the northeast by undeveloped woodland. Residential and commercial properties are located along Route 15 east of the site and residential properties are located along the banks of the Penobscot River north and south of the site.



MALLINCKRODT INC.
HOLTRACHEM MANUFACTURING SITE
CORRECTIVE MEASURES STUDY

SITE PLAN

CDM

FIGURE 1-1

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The site encompasses approximately 235 acres, with the former manufacturing plant located on 12 acres. The plant is located on a relatively flat plateau and is composed of 24 buildings. The plant site is located at an elevation of approximately 65 feet above mean sea level. Five landfills are also located on-site. Landfill 1 is located west of the plant, landfill 2 is located east of the plant and landfills 3, 4 and 5 are located along the northern boundary of the plant.

A railroad spur enters the property from the east and then splits where it enters the northeast corner of the plant. Railroad tracks border the north and south edges of the plant. The former main chemical loading area is located along the southern plant boundary.

Runoff from the main production buildings and the eastern portion of the plant flows to a series of catch basins and finally to the Southerly Stream. The Southerly Stream, flows from the east towards the southern edge of the plant, and enters the Penobscot River at the Southern Cove.

Stormwater from the western and northern portion of the plant flows overland to catch basins, which discharge to the North Ditch, which flows southwesterly into the Penobscot River. The North Ditch is a permitted outfall (No.003) under the plant's general stormwater discharge permit.

The Southern Cove is the portion of the Penobscot River, which lies to the south of the plant area. It is tidal in nature and is composed of a gravel bank region and a mud-flat portion. The North Ditch, the Southerly Stream and the plant outfall all discharge to the Southern Cove.

1.2.3 Site Investigations

Several investigations have been conducted at the site for geotechnical as well as environmental purposes. Investigations characterizing the geology/hydrology, surface and subsurface water, soil and sediment have been performed at the site from 1966 to November 2001. Additionally, due to MEDEP requirements, including the Consent Agreement between Hanlin and MEDEP, several other investigations have been conducted at the HoltraChem site. These contemporaneous investigations were carried out to characterize air mercury emissions and ambient air quality, soil conditions, and surface and groundwater discharges from specific areas on site. CDM performed a Site Investigation and a Supplemental Site Investigation at the site between June 1994 and October 1998 to characterize the nature and extent of contamination at the site. A detailed discussion of previous site investigations is presented in the HoltraChem Manufacturing Site, Orrington, Maine – Site Investigation Report dated December 22, 1998.

In addition to the investigations discussed in the Site Investigation Report the following investigations have been performed at the site after 1998:

Landfill #2 Investigation

The Landfill #2 investigation was conducted by CDM in August 2000 to assess groundwater conditions in the vicinity of the landfill. It was performed in response to MEDEP's request to determine if Landfill 2 was located within the groundwater table, and to assess the integrity of the cap. A total of 14 well points and two piezometers were installed and sampled as part of the investigation. Two rounds of water quality samples were collected. More information is contained in CDM's Landfill 2 Investigation Report, dated October 31, 2000.

Investigation of Chloropicrin in Soils

The Chloropicrin in Soils investigation was conducted by CDM in August 2000 to evaluate the extent of chloropicrin contamination in soils surrounding the former underground chloropicrin pipeline and tank car loading area. Five Geoprobe borings were advanced in the area of the former underground pipeline and another eight around the tank car loading area. Soil samples were collected from the borings and analyzed. Existing monitoring wells in the vicinity and down gradient were evaluated for the presence of free-product. More information is contained in CDM's Chloropicrin Investigation in Soils at the HoltraChem Manufacturing Company, December 28, 2000.

Penobscot River Study

CDM and Menzie-Cura & Associates, Inc. performed an assessment of the lower Penobscot River and a reference river, the Kennebec, in the spring and summer of 2000. Sediment, water quality, fish tissue and benthic toxicity sampling was performed to evaluate the distribution of mercury and the ecological health of the lower Penobscot River environment. A natural resources inventory was also performed. More information is contained in MCA's report Evaluation of Ecological health of the Lower Penobscot River, dated January 19, 2001.

Site Inspection (SI) and Expanded Site Inspection (ESI)

Weston Solutions conducted a Site Inspection under CERCLA at the request of EPA in September 2000. Due to the extensive fieldwork involved the project was reassigned as an Expanded Site Inspection in October 2001. Weston Solutions Superfund Technical Assessment & Response Team 2000 (START) collected 18 surface soil, 16 subsurface soil, 22 sediment and 16 groundwater samples. No air samples were collected during this investigation. A Final Expanded Site Inspection Report was submitted to the EPA (Region I) in October 2002.

Corrective Measures Study Field Investigation

A Corrective Measures Study Field Investigation (CMSFI) was conducted by CDM in November 2001 and November 2002. The purpose of the field investigation was to delineate the horizontal and vertical extent of soil and sediment contamination at the site, and to characterize groundwater for treatability studies. Soil, surface and

groundwater and sediment samples were collected from 15 areas of concern at the site. Geotechnical evaluations were performed to evaluate construction of potential corrective measures such as a slurry wall and siting of a Corrective Action Management Unit (CAMU) for excavated soil, sediment and demolition debris. The data obtained from this investigation was used to evaluate the proposed soil, sediment and groundwater corrective action measures at the site. In November 2002, test pits were excavated along the older sections of the Industrial Sewer to evaluate the presence or absence of free elemental mercury outside of the sewer pipe.

1.3 Regulatory Status

The Corrective Measures Study of the Holtrachem Manufacturing Site is being performed under the RCRA Corrective Action Program and in accordance with the Consent Decree agreement between MEDEP and Holtrachem Manufacturing Inc. The Decree provides specific guidance on the RCRA Corrective Action program for the Orrington site, including required contents of the Site Investigation Work Plan, Site Investigation Report, Corrective Measures Work Plan and Corrective Measures Study.

The Site Investigation Work Plan submitted by CDM in 1993 provided a preliminary listing of potential corrective measures. The work plan was developed in accordance with the requirements of the Consent Decree and the RCRA Facility Investigation (RFI) Guidance document. A Site Investigation and a Supplemental Site Investigation were performed at the site from June 1994 to November 1998 and a final Site Investigation Report submitted to the U.S. Environmental Protection Agency (EPA) and the Maine Department of Environmental Protection (MEDEP) in December 1998. As part of the Site Investigation, preliminary media protection standards (PMPS) were developed and proposed. EPA and MEDEP conditionally approved the PMPS in a letter dated May 2, 2002. The CMS Work Plan submitted in June 2002 provided a further update of the corrective measures based on the results of the Site Investigation, technological advances and discussions with EPA and MEDEP.

In the basis document dated January 21, 2003, MEDEP and EPA approved (with modifications) the Corrective Measures Study Workplan. Mallinckrodt is submitting this CMS within 120 days of the receipt of the January 2003 letter at the request of MEDEP.

1.4 Organization of Document

This document is organized into six sections. Section 1 is the introductory and background section. Section 2 identifies and delineates the corrective action areas at the site. Section 3 identifies and screens the potential final corrective measures for the various contaminated media. Section 4 discusses in detail the development of the corrective measures being retained for further evaluation. Section 5 evaluates the corrective measure alternatives to be studied while Section 6 presents recommendations for final corrective measures to be implemented.

Section 2
Identification and Delineation of Corrective Action Areas

2.1 Media to be Addressed

The Site Investigation and the Corrective Measures Study Field Investigation completed in 1998 and 2001, respectively, identified river sediment, soil, groundwater and surface water as contaminated media. This section identifies and delineates the various areas requiring corrective action. Corrective measures discussed in this report have been evaluated for the following four contaminated media categories:

- Soils – Surface and subsurface soils at the site, includes landfills, filled land, soil contaminated by historical plant operations, soils around the industrial sewer, and soils excavated during construction of the anticipated slurry wall. Sediments from the Southerly Stream and Northern Ditch are considered as soils for the purpose of the CMS.

- Sediment – Includes sediments from the Southern Cove.

- Groundwater – Includes groundwater from the plant area and Landfill No. 1 area.

- Surface Water – Includes the existing lined process lagoon, surface water within the North Ditch and Southerly Stream, and runoff from the site.

Although a PMPS for air is proposed, air monitoring to date has shown that the PMPS for mercury in air is routinely met, therefore, air is not considered a contaminated medium for this site and no corrective measures for air are identified. However, an air monitoring plan will be included as part of the Corrective Measures Implementation (CMI) Construction Work Plan. The purpose will be to monitor compliance with the $0.03 ug/m^3$ ambient air quality guidelines, and to identify contingency actions to be implemented if the guidelines are approved.

2.2 Preliminary Media Protection Standards

Preliminary Media Protection Standards (PMPS) were developed by CDM during the Site Investigation work performed from 1994 to 1998 and submitted to the MEDEP in December 1998. Media Protection Standards are specific numerical criteria to be achieved by recommended corrective measures that will be implemented at the site as a result of this study. The PMPS were based on applicable guidance, results of the Site Investigation, and Human Health and Ecological Risk Assessments. These proposed media standards were modified and approved by the EPA and MEDEP in a letter dated January 21, 2003. **Table 2-1** lists the modified numeric Preliminary Media Protection Standards and Narrative Standards as approved by MEDEP.

Table 2-1
Numeric Preliminary Media Protection Standards (PMPS) approved by MEDEP

	Media						
Constituent	***Ground water***	***Surface Water (on-site)***	***Surface Water (Penobscot River)***	***Sediment (on-site)***	***Sediment (Penobscot River in Southern Cove)***	***Soil***	***Air***
Acetone	700 µg/l	-	-	-	-	-	-
Carbon-tetrachloride	3.0 µg/l	3.0 µg/l	-	-	-	-	-
Chloroform	57 µg/l	57 µg/l	-	-	-	-	-
Chloropicrin	30 µg/l	-	-	-	-	0.125 mg/kg	-
Hexa-chloroethane	7 µg/l	-	-	-	-	-	-
Manganese	500 µg/l or back ground[2]	-	-	-	-	-	-
m-cresol	35 µg/l	-	-	-	-	-	-
Mercury	2.0[1] µg/l	0.91[3] µg/l	background	2.2 mg/kg	Avg: 2.2 mg/kg Averaged areas: less than 0.25 acre in size	2.2 mg/kg	0.31[4] µg/m^3
p-cresol	3.5 µg/l	-	-	-	-	-	-
PCBs	-	-	-	-	-	1.0 mg/kg	-
Penta-chloroethane	13 µg/l	-	-	-	-	-	-
TCE	5 µg/l	-	-	-	-	-	-

Notes:

1. At achievement of this PMPS it must be demonstrated that surface water PMPS is being attained or that untreated groundwater discharge will not significantly lower the existing water quality. If one or the other of these conditions cannot be demonstrated groundwater capture and treatment will be continued. In addition Maine's fish tissue residue standards need to be assessed for attainment prior to shutting the system down.
2. All background values referenced in this table will be established during the Corrective Measures Study. Background values must also be established and met for conductivity, salinity, alkalinity and pH in surface and ground water.
3. The surface water standards for mercury are for total metal values (particulate plus dissolved), not dissolved metals. Discharge at this level must also be documented to not significantly lower the existing water quality and that fish meet the fish tissue residue value or for on-site fish are not significantly elevated over two other reference sites.

4. The air standard is 24 hour averaged value at the property line and a not to exceed value (i.e. air monitoring readings must remain below 0.31 mg/m3 at points of off-site exposure.

Narrative Standards
In addition to the numerical PMPS narrative standards for Penobscot River Sediment, Soil and Surface Water were also issued by MEDEP.

Sediment (Penobscot River)
The two highly elevated areas of mercury contamination will at a minimum be removed. Sampling numbers (RSC-009, RSD 015H, RSD 015G, RSD 015E, RSD 016A, RSD 016B, RSC 012, RSC 020, RSC 010, RSD 015F, RSD 015F, RSD 015A, and RSD 015C) and (RSC 024, RSD 011C, RSD 010A, RSC 018, RSD 010B, RSD 010C, RSD 011A, RSD 011B, RSD 011G and RSD 011F) represents these areas.

Soil
All soils on-site and adjacent to the site that may contain mercury greater than 2.2 ppm must be vegetated paved or otherwise stabilized to prevent erosion. In addition, an industrial sweeper will be utilized on all parking lots, roadways and other paved areas each spring to collect any potentially contaminated soils. All catch basins shall contain "socks" to filter and collect any potentially contaminated soils or sediments. These socks shall be removed and cleaned or replaced periodically to maintain their effectiveness.

Surface water
Areas of mercury contamination will be collected for treatment and will be prevented from entering the on-site surface water. At such time Mallinckrodt believes that no further treatment is warranted, they will need to make a demonstration that:

1. The resident fish in the on-site stream meet the 0.2 fish tissue residue value or that the level is not significantly elevated over two appropriate reference sites,

2. The 0.91 ug/l level will be achieved in the on-site surface waters.

3. A discharge at the 0.91 ug/l level, or such lower level as may be present, and in the quantity present in the on-site surface water will not significantly lower the Penobscot River water quality, including during storm events.

4. And a discharge at that level and quantity will not adversely affect the fish tissue levels in the Penobscot River.

2.3 PMPS Application and Corrective Action Objectives

This sub-section discusses the application of the PMPS used for each environmental media to delineate and manage contamination for the purpose of the CMS. In addition, Corrective Action Objectives (CAOs) for each media, which were developed during the SI, are also provided to serve as general objectives to be met by the corrective measures. Media-specific CAOs have been developed for groundwater, surface water, soil, sediment, and air.

2.3.1 Soil

2.3.1.1 PMPS

The PMPS for mercury in soil cited in the MEDEP/EPA letter dated January 21, 2003 is 2.2 mg/kg. The Narrative Standard states that "All soils on-site and adjacent to the site that may contain mercury greater than 2.2 ppm must be vegetated, paved or otherwise stabilized to prevent erosion." PMPS for chloropicrin in soil (0.125 mg/kg) and polychlorinated biphenyls (PCBs) (1.0 mg/kg) were also established.

PMPS for soil were the subject of considerable discussion between MEDEP, EPA and Mallinckrodt. The following summary of these discussions provides useful information on the intent of the PMPS for soil. Mallinckrodt's last PMPS submittal to MEDEP and EPA dated February 7, 2002 proposed to "manage soils with > 3.2 mg/kg mercury *(now 2.2 mg/kg)*. Excavate or contain mercury hot spots greater than 10 mg/kg to the extent practical (to 10 feet or 6 inches into undisturbed till, whichever is shallower). The extent of what is practical would be defined in the CMS." The "Indications" section of the table proposing PMPS' included "Indicates plant area to be capped. Mercury hot spots greater than 10 mg/kg will be excavated or contained. Excavated soils containing mercury greater than 10 mg/kg will be placed under the plant area cap or in a designated on-site Corrective Action Management Unit (CAMU) which will meet RCRA Title C specifications".

MEDEP's June 25th, 2001 summation of State of Maine, EPA and Mallinckrodt Preliminary Media Protection Standards (Goals), Numerical and Narrative Current Thinking states "Areas of > 3.2 mg/kg Hg *(now 2.2 mg/kg)* outside the plant area will be evaluated for management controls considering erosion control, soil cover, or removal. The appropriate management control would be evaluated in the CMS."

2.3.1.2 Corrective Action Objectives

Corrective Action Objectives state the purposes of the PMPS and remedial actions to be considered for the site. As such, they are primary measurement criteria against which the effectiveness and appropriateness of proposed remedial actions can be evaluated. The Corrective Action Objectives for soil as presented in the SI report are:

- Protect Human Health and the Environment;
- Protect Surface Water;
- Protect Groundwater; and
- Protect Sediment.

In comments on the SI report provided a letter dated May 2, 2002, MEDEP and EPA state that the following Corrective Action Objectives are added for soil:

- Protect Aquatic Life and wildlife biota

To apply the PMPS and evaluate various corrective measures for soil the established PMPS (January 21, 2003 letter) can be stated in terms of the corrective action objectives.

Manage soil greater than 2.2 mg/kg Hg to protect:

- Human health and the environment;
- Surface Water;
- Groundwater;
- Sediment; and
- Aquatic Life and Wildlife Biota.

To simplify future discussions and evaluations of the Corrective Action Objectives and PMPS, aquatic life and wildlife biota are considered to be part of the environment and, as such, must be addressed in consideration of the first bulleted corrective action objective.

Also, because on-site sediment (upland stream and ditch sediments, above the Southern Cove) is directly related to on-site soil (i.e., is derived from overland runoff) and has the same media protection standard, and remedial action alternatives these sediments will be considered as site soils.

2.3.2 Sediment

2.3.2.1 PMPS

The PMPS for mercury in sediment is an average concentration of 2.2 mg/kg or less. This number was developed based on a site-specific partitioning coefficient (mercury in water related to mercury in sediment). It is related to the MEDEP's target level of a concentration in fish that would not require a fish consumption advisory. In the letter dated January 21, 2003, MEDEP and EPA eliminated the use of an upper "control limit" concentration and imposed a limit of one-quarter acre for the area used to determine "average" contamination levels. In addition, MEDEP and EPA listed specific sample locations in the Southern Cove where sediment would have to be removed.

2.3.2.2 Corrective Action Objectives

The corrective action objectives for sediment are:

- Protect human health and the environment;
- Protect surface water; and
- Protect groundwater.

Protection of groundwater pertains only to upland sediment as the Southern Cove is in an area where groundwater discharges to surface water and therefore would not be affected by the overlying sediment. Protection of human health and the environment and protection of surface water will be addressed by the source removal of dissolved and particulate mercury.

2.3.3 Groundwater

2.3.3.1 PMPS

The PMPS for groundwater are listed in Table 1 attached to the MEDEP/EPA letter dated January 21, 2003. In general, the concentrations listed are either established or calculated (risk based) drinking water standards.

2.3.3.2 Corrective Action Objectives

The corrective action objectives for groundwater are:

- Protect human health and the environment;
- Protect drinking water supplies; and
- Protect surface water.

2.3.4 Surface Water

2.3.4.1 PMPS

The PMPS for mercury in site surface water is the State of Maine ambient water quality acute toxicity standard for freshwater. PMPS for other constituents (i.e., salt, pH, etc.) are essentially un-impacted or background concentrations, which will be determined at the flooded gravel pit.

The PMPS for mercury in the Penobscot River is the State of Maine ambient water quality standard or background, which will be determined by upriver measurements.

2.3.4.2 Corrective Action Objectives

The SI and CMS Work Plan present the following CAOs for surface water:

- Protect Human Health and the Environment;
- Protect Groundwater;
- Protect Sediment; and
- Protect Wildlife and Aquatic Biota.

2.3.5 Air

2.3.5.1 PMPS

The PMPS for mercury in air at the site is 0.31 ug/m3 as cited in the MEDEP/EPA letter dated January 21st, 2003. Air monitoring at the site has shown that the PMPS has never been exceeded and hence air is not considered a contaminated medium. However, mercury levels in the air will be monitored during the implementation of corrective measures. In case mercury levels exceed PMPS limits, measures to mitigate mercury levels will be addressed as specified in the health and safety plan and task-specific work plans.

2.3.5.2 Corrective Action Objectives

The SI presents the following CAOs for air:

- Protect Human Health and the Environment;
- Protect soil; and
- Protect surface water.

2.4 Nature and Extent of Contaminated Media

The delineation of the extent of soil, sediment, ground and surface water contamination for evaluation of proposed corrective measures was based upon the information provided in the Site Investigation Report (1998), the Corrective Measures Study Field Investigation Report (2001) and other investigations conducted at the site previously. The CMS field Investigation Report addresses areas for which the MEDEP had requested additional characterization and areas where delineation of contamination greater than PMPS was required for the CMS. The CMS Field Investigation Report is being submitted in conjunction with this CMS report.

The nature and extent of contamination is discussed below according to media and area of contamination.

2.4.1 Soil

Soil at the HoltraChem site is primarily contaminated with mercury. Mercury in site soil results from spills, land disposal, and air deposition. In addition to mercury, volatile organic compounds (VOCs) and PCBs are present in soil in very limited areas. The VOC chloropicrin is present in a layer of soil at depth below the former chloropicrin tank car loading area. PCBs are present in soil in the immediate vicinity of the electrical transformer/rectifier units on the east side of the cell building. Some elevated concentrations of other metals regulated by RCRA were detected in sandblasting/scrap metal area. However, because these are also areas of elevated mercury concentrations, the presence of other metals is not expected to change remediation decisions.

A list of contaminated soil areas at the site along with estimated volumes and ranges of mercury contamination is presented in **Table 2-2**. These areas include the sediments in the Southerly Stream and North Ditch that are similar in characteristics to soil contamination and will therefore be considered as soil contamination areas in the CMS. A description of each soil and sediment area to be addresses in the CMS is provided below. The location and approximate extent of the areas is presented on **Figure 2-1**.

2.4.1.1 Retort Building

The Retort Building is located at the western edge of the manufacturing plant. It was used to recover elemental mercury from brine purification sludge.

Eighteen soil borings were advanced in the area surrounding the retort building during the CMS Field Investigation in November 2001. Sixty-six soil samples were collected and analyzed for total mercury concentrations. Total mercury was present at detectable concentrations in 57 samples, with thirty-two containing mercury at concentrations above the PMPS of 2.2 mg/kg. Overburden materials encountered during soil boring advancement were sand and silt underlain by till. The samples showed a trend of decreasing mercury concentration with depth. Additionally, samples taken from the underlying till were below the PMPS. Groundwater was not encountered.

One test pit was excavated west of the Retort Building to look for elemental mercury beneath the asphalt and to look for a potential drainpipe. Elemental mercury was not observed and a drainpipe was not located. Undisturbed native soil was encountered. Two soil samples were collected. The mercury content of the soil sample collected of the native undisturbed soil was less than the PMPS. Groundwater was not encountered.

Based on the results of the Field Investigation the area of soil greater than the PMPS to the east of the retort building is approximately 40 feet in length, 20 feet in breadth and is 6 feet deep. The larger area to the west of the building is 75 feet in length, 55 feet in breadth and 7 feet deep. Estimated total volume of soil greater than the PMPS from both the areas is estimated to be approximately 1,210 cy containing an average of 20 mg/kg total mercury.

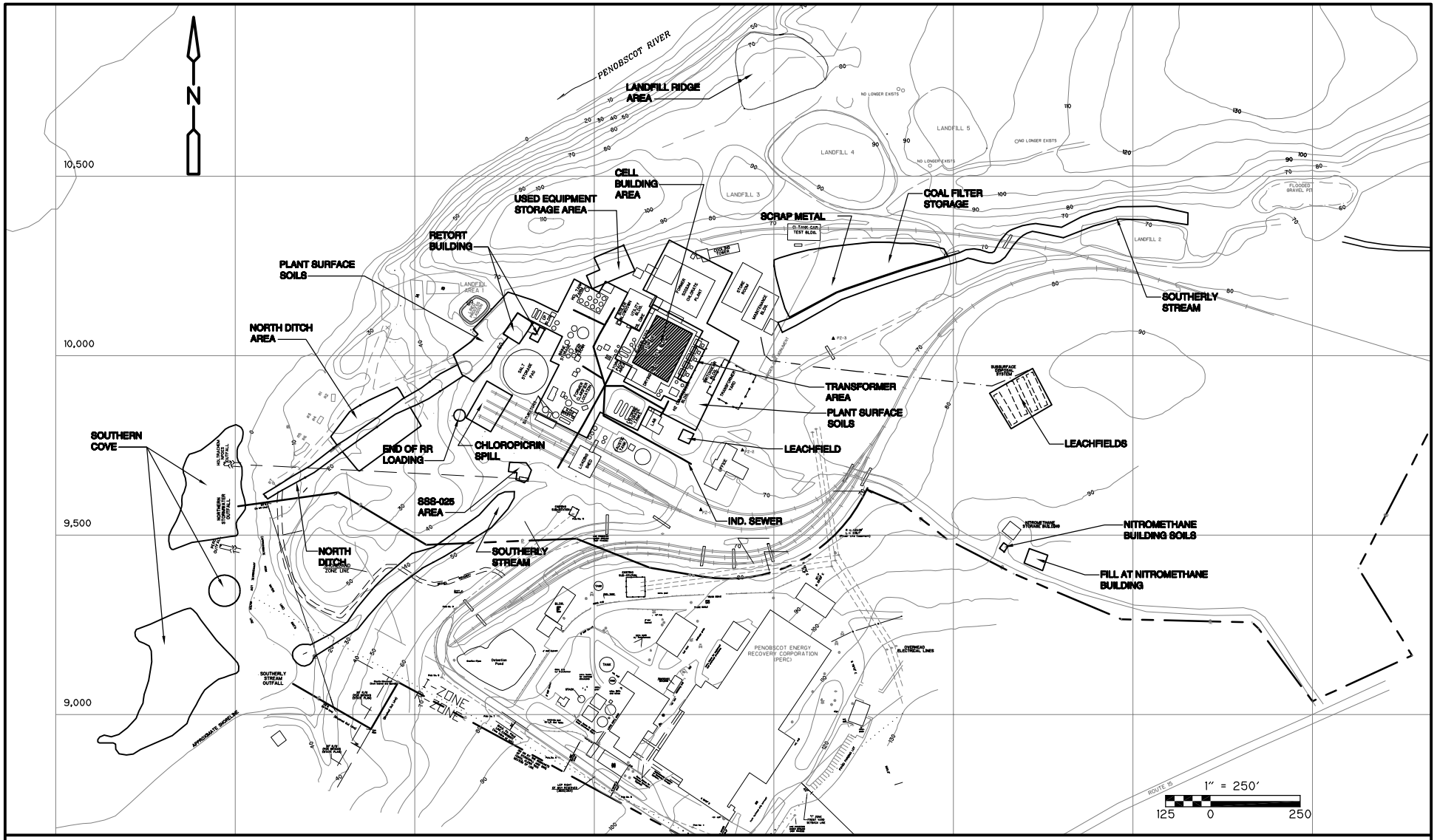
2.4.1.2 Used Equipment Storage Area

The Used Equipment Storage Area is located along the bedrock ridge at the northwestern side of the manufacturing plant. It was used for temporary storage of pipes, tanks and other miscellaneous equipment.

Four test pits were excavated at the used equipment storage area and 10 soil samples collected and analyzed for total mercury during the CMS Field Investigation.

Table 2-2
Estimated Volumes and Contamination Range for Plant Area Soils

Area Name	*Areal Extent (sq. ft.)*	*Volume (cy)*	*Contaminant*	*Conc. (ppm)*
Retort Bldg.	4,758	1210	Mercury	20.33
Used Equipment Area	7,700	285	Mercury	11.4
Landfill Ridge	41,500	22,550	Mercury	33
Scrap Metal & Coal Filter	50,850	11,298	Mercury	25
Fill at Nitromethane	2,365	350	Mercury	30
Transformer Area	600	22	PCBs	3.5
Cell Bldg.	37,500	12,200	Mercury	283
End of RR Loading	1,260	140	Mercury	26
Industrial Sewer	N/A	1,420	Mercury	10
Leach Fields	13,200	200	Mercury	8
Plant Surface Soil	75,185	11,970	Mercury	27.65
N. Ditch Fill Area	14,150	1,240	Mercury	10.73
SSS-025 Area	1,225	50	Mercury	23.15
Chloropicrin Spill Area	8,800	6,520	Chloropicrin	61
South Stream	73,800	5,926	Mercury	18.67
North Ditch	17,150	1,400	Mercury	69.6
Landfill 2	27,080	21,000	Mercury	Unknown



MALLINCKRODT INC.
HOLTRACHEM MANUFACTURING SITE
CORRECTIVE MEASURES STUDY

SOIL AND SEDIMENT AREAS TO BE ADDRESSED

CDM

FIGURE 2-1

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Total mercury was observed at detectable concentrations in two samples at a concentration of 2 mg/kg and 24 mg/kg at 0.5 feet interval. Groundwater was not encountered in the excavations. Two surficial soil samples collected in this area in 1980 by P.E. LaMoreaux & Associates (PELA) contained mercury at 3 and 7.2 mg/kg in the 0-0.5 feet interval.

Three test pits were excavated in this area by CDM to investigate former Leach Field 8. Eight soil samples were collected. Two soil samples contained mercury at concentrations greater than the PMPS (2.216 and 2.501 mg/kg, respectively). Total mercury results for the other samples were less than 1 mg/kg. Groundwater was not encountered in the excavations.

The area with soil mercury concentrations greater than the PMPS is approximately 120 feet in length, 65 feet in breadth and 1 foot deep. The presence of exposed bedrock, limits the extent of contamination to the north. Total volume of contaminated soil in this area is estimated to be approximately 285 cy and the average total mercury concentration of the contaminated area is estimated to be 11.4 mg/kg.

2.4.1.3 Landfill Ridge Area

The Landfill Ridge Area, located between Landfill 4 and the Penobscot River is a former gravel pit in where fill from the plant was reportedly placed.

Two soil borings were advanced and two monitoring wells were installed in this area during the SI. Thirteen soil samples were collected. Mercury concentrations in soil ranged from non-detect to 64 mg/kg and averaged 18.5 mg/kg.

Two soil borings were advanced, three test pits were excavated and seventeen surface soil samples collected during the CMS Field Investigation conducted at the landfill ridge area.

The two soil borings were advanced through the northern side of the fill. Overburden materials encountered during soil boring advancement were silt and sand. A total of 25 samples were collected and analyzed. Total mercury in detectable concentrations was observed in all the samples, of which ten contained mercury above 2.2 mg/kg. Mercury concentrations ranged from 0.88 mg/kg to 72 mg/kg.

Three test pits were excavated on the southern side of the fill to locate vertical and horizontal extents of the fill material. Fill materials encountered during the test pit excavations were sand and silt, some gravel and clay with an underlying native layer of sand and gravel. A total of 8 analytical samples were collected which contained total mercury in concentrations ranging from 0.28 mg/kg to 14 mg/kg. In general, mercury concentrations were highest in the shallow samples and decreased with depth.

Ten surface soil samples were collected from the embankment between the Landfill Ridge Area and the Penobscot River. None of the samples contained mercury greater

than 1 mg/kg. Seven surficial samples were collected after earthwork had been performed to stabilize the slope and consolidate the fill material. Total mercury concentrations in the soil pile sampled ranged from 5 to 70 mg/kg and averaged 33 mg/kg.

The estimated area of fill with mercury concentrations greater than the PMPS at the Landfill Ridge Area is 41,500 sq. ft. The fill depth ranges from 21 feet to 10 feet. The approximate volume of contaminated soil that is present is estimated to be 22,550 cy to 22,000 cy with an estimated average total mercury concentration of 33 mg/kg.

2.4.1.4 Scrap Metal Area and Coal Filter Storage Area

The Scrap Metal and Coal Filter Storage Areas are located northeast of the manufacturing plant adjacent to the Southerly Stream. Based on the surface topography and observed debris at the ground surface, an approximately six foot layer of fill is present. Scrap metal, wood and used equipment has been placed on top of this fill.

Ten test pits were excavated and five soil borings advanced in the Scrap Metal Area as part of the CMS Field Investigation. Overburden materials encountered during the excavation of the pits and the boring advancement were primarily sand and silt with occasional metal, asphalt and concrete. Peat was encountered in several pits and the borings at a depth of 6-7 feet. The peat is interpreted to be a pre-fill soil horizon and it is an approximate elevation of the surface of the nearby southerly stream. Groundwater was typically encountered just above the peat layer.

A total of 36 soil samples were collected from the ten test pits of which 22 soil samples contained total mercury above the PMPS of 2.2 mg/kg. Total mercury concentrations ranged from 0.46 mg/kg to 380 mg/kg, usually decreasing in concentration with increase in depth.

Two soil borings were advanced through the fill and three Geoprobe borings were advanced in area used for sand blasting of equipment adjacent to the Scrap Metal Fill. Seven of the thirteen soil samples collected from the two soil borings advanced through the fill exceeded the PMPS of 2.2 mg/kg for total mercury. The total mercury concentrations ranged from 0.46 mg/kg to 39 mg/kg. None of the soil boring samples in the sand blasting area adjacent to the fill contained mercury above the PMPS. It appears contamination in this area is limited to the surface.

The coal filter storage area was used to store five coal-containing former brine filters. Four samples, one each from each filter were collected. Total mercury was detected above the PMPS of 2.2 mg/kg in all the samples. Total mercury concentrations ranged from 2.4 mg/kg to 68 mg/kg.

The combined footprint of the scrap metal area and the coal storage area is shown on Figure 2-1. It occupies an area of 50,841 sq. ft. and a volume of 11,300 cy. The average total mercury concentration 25 mg/kg.

2.4.1.5 Nitromethane Building

Twelve soil samples were collected from six-hand augered soil borings advanced around the Nitromethane Building. All of the samples were below the PMPS for mercury. One of two surface soil samples collected by Roy F. Weston contained total mercury at a concentration of 28.3 mg/kg. The volume of soil associated with this soil sample is not known but the results of the CDM samples indicate that mercury contamination in soil around the Nitromethane Building is not widespread.

Soil from the former clarifier and brine processing area was moved from the plant and placed east of the Nitromethane Building. Soil was deposited on the ground surface so it is expected that the groundwater table is below the fill. The estimated volume of soil and the mercury content of this fill are based on the notes from soil sampling performed in May 1999. According to the notes, about 29, 10-cy dump truck loads of soil was moved to the Nitromethane Building area. The total volume of soil exceeding the PMPS in this area is approximately 350 cy with an average concentration of 30 mg/kg of mercury.

2.4.1.6 Transformer Area

The Transformer Area is located on the southeast side of the Cell Building associated with the electrical transformer and rectifier equipment (Figure 2-1).

Twelve hand augered borings were advanced in the transformer area. Twenty-three soil samples were collected and analyzed for polychlorinated biphenyls (PCBs). PCB concentrations ranged from 0.51 mg/kg to 14 mg/kg. PCB concentrations above the PMPS of 1 mg/kg were observed in four of the twenty-three samples. These samples were taken from borings located adjacent to transformers along the southeast wall of the cell building. All but one of the samples with PCBs greater than 1 mg/kg was collected from the top 6-inches of soil. One soil sample collected at 1.0 to 1.5 feet contained PCBs at a concentration of 1.41 mg/kg.

Contaminated soil at the transformer area occupies an approximate area of 600 sq. ft. and is present at 1-2 ft depth. The approximate volume of contaminated soil is 22 cy. The average PCB concentration of the soil is approximately 3.5 mg/kg.

2.4.1.7 Cell Building

The Cell Building is located in the center of the manufacturing plant (Figure 2-1). It contained the elemental mercury used in the electrolytic cells. Eight soil borings were advanced around the perimeter of the Cell Building. Forty-one soil analytical samples were collected, of which 35 samples contained total mercury above the PMPS of 2.2 mg/kg. The general overburden materials encountered during excavation were sand and silt underlain by till. Till was encountered in four of eight borings at depths ranging from 4 to 8 feet below grade.

The range of total mercury concentrations observed was from 0.27 mg/kg to 2,500 mg/kg. In general, the highest mercury concentrations were detected in the surficial sands and in a boring located adjacent to a sump near the northeast corner of the

building. Of the eight samples collected from till, only two samples were detected above 10 mg/kg. Groundwater was encountered four to six feet below ground surface. The depth of contamination is estimated to extend down to the till layer which is up to 8 feet deep. Based on these assumptions, the estimated volume of contaminated soil in the Cell Building area is about 12,200 cy containing an average concentration of 283 mg/kg of mercury.

2.4.1.8 End of Railroad Loading Area

Equipment may have been stored at the end of the railroad loading area so this area was investigated for the presence of mercury in soil.

Three test pits were excavated in the area reportedly used for equipment storage. Test pit excavations in this area extended to a depth of 3-5 feet. The surficial soil consists of sand underlain by hard, dense sand, gravel and silt. Seven soil samples were analyzed for total mercury, of which one sample contained more than 2.2 mg/kg of mercury. The estimated volume of contaminated soil present in this area is roughly about 140 cy containing an average concentration of 26 mg/kg of mercury.

2.4.1.9 Industrial Sewer

The industrial sewer at the HoltraChem site is comprised of two separate systems that service the main plant area and the Wastewater Treatment Plant (WWTP), respectively. Portions of the original sewer servicing the manufacturing plant were abandoned and plugged in 1999. The newer portion, which transports the discharge from the WWTP outlet to the discharge weir and onto the river, is still functional.

A study of the original sewer was conducted by CDM in November 2002. Ten test pits were excavated in the soil surrounding the sewer and 22 soil samples taken to determine the mercury concentrations. Excavations extended to the base of the pipe bedding associated with the Industrial Sewer. Samples were collected from beside and/or below the invert of the industrial sewer pipe and visually inspected for the presence or absence of free phase elemental mercury. Headspace and total mercury laboratory analyses were performed on each sample.

Elemental mercury was not observed in any of the 22 soil samples collected adjacent to and/or below the industrial sewer. Soil headspace concentrations ranged from non-detect (Jerome Meter detection limit reported as 0.001 mg/m3) to 0.216 mg/m3. Laboratory analytical results of samples from adjacent to the industrial sewer ranged from 0.11 mg/kg (ISTP-2 at 4') to 31.45 mg/kg (ISTP-8 at 4'). No elemental mercury was observed leaking from or around the sewer pipe.

In 1997 Acheron advance eight Geoprobe borings along the industrial sewer and collected forty-nine samples from varying depths (1-17 ft.). The samples were analyzed for total mercury. Seven samples were found to contain mercury above the PMPS of 2.2 mg/kg. The average of the seven samples was about 7.25 mg/kg.

The volume of soils above the PMPS is estimated to be 1,420 cy containing an average concentration of 10 mg/kg of mercury.

2.4.1.10 Leach Fields

Subsurface disposal systems have been used at the plant since its construction. Those having the of potential to contain mercury were investigated by CDM as part of the SI and by Acheron after it was determined that a lab sink was connected to the plant septic system. The main plant septic system is located in the woods behind the Nitromethane Building. The other two septic systems investigated are Leach Field No. 2 east of the plant lab and change house and Leach Field No. 8 reportedly located along the northwestern edge of the plant adjacent to the bedrock ridge.

CDM investigated Leach Field No. 2 by advancing 4 Geoprobes and collecting 23 soil samples. Mercury concentrations ranged from 0.007 to 17.9 mg/kg. Concentrations exceeding the PMPS were detected in only three samples.

CDM investigated Leach Field No. 8 by excavating three test pits and collecting eight soil samples. Mercury concentrations ranged from 0.4 to 2.5 mg/kg. Concentrations exceeding the PMPS were detected in two samples.

In July 1997, Acheron performed a Leach Field Investigation in response to a MEDEP Notice of Violation and Enforcement Intent. A Summary Report of the Leach Field Investigation consisting of the results of this investigation was submitted to the MEDEP in July 1997. Sixteen soil samples from various depths underneath the disposal beds were collected from four separate leach fields. The leach fields located in the eastern portion of the property are 20 feet x 10 feet in dimensions. Mercury concentrations in soil samples ranged from 0.140 mg/kg to 13.67 mg/kg. The samples obtained from the upgradient ends of the disposal beds showed higher concentrations of mercury as compared to the samples taken from the middle and downgradient end points of each bed. Moreover, the concentration of mercury was observed to decrease with increase in depth. Only two samples exceeded the soil PMPS of 2.2 mg/kg for total mercury. Both samples were from the disposal bed constructed in 1980. Based on this information the estimated volume of soil containing greater than the PMPS is 200 cy volume of all four disposal beds. The average concentration of mercury in the soil from the disposal beds would vary from 8 mg/kg.

2.4.1.11 Plant Surface Soils

Areas of surface soil with mercury concentrations greater than the PMPS in and around the manufacturing plant were determined based on investigations performed by Acheron Inc. in 1980, 1988 and 1990, and CDM in 1995, 1997, 2001 and 2002.

In 1980, PELA collected 31 surficial soil samples from locations along the northern boundary of the plant and between the plant and the Penobscot River. The highest concentrations of mercury were detected in the immediate plant area near the HCl

tanks (57 ppm and 90 ppm) and in soils from the North Ditch running from the paved sump to the Penobscot River (100 ppm).

Surficial soils in the plant area and off-site were sampled by Acheron in 1988. The data indicated that surficial soils across the site contained concentrations of mercury (up to 110 ppm), with the greater concentrations primarily in the top 6 inches of soil within the plant area. The sample locations with the highest concentrations of mercury were located east of the cell building and former sodium chlorate plant, respectively.

On June 20, 1990 Acheron collected soil samples from fifteen locations. Mercury concentrations ranged from 0.17 ppm at the background location to 60 ppm in the North Ditch.

CDM performed soil sampling to characterize the distribution of mercury and, where applicable VOCs, in surficial and near-surface soils, respectively. Soil samples were collected within the site plant operations area, sitewide and in background locations in 1995 and 1997. In 1995, soil samples were collected from twelve areas within the plant (SSS-001 through SSS-012) and from six areas outside of the plant (SSS-013 through SSS-019). Total mercury concentrations ranging from 0.14 to 310 mg/kg were observed in the surficial soil samples. Cyanide was not detected in any of the samples from the six areas outside of the plant. Generally, the soils were described as a light brown, loose coarse, sandy fill with small/medium cobbles. Occasionally till was encountered and an increase of fines was often observed from the surface (0.0-0.5') to the near surface (1.0-1.5') interval.

In 1997, soil samples were collected from 50 locations site wide (SSS-021 through SSS-070). Total mercury concentrations ranged from 0.3 to 310 mg/kg. During the SI, four surface soil samples were collected from a sand blasting area west of and adjacent to the scrap metal fill. The samples were analyzed for eight RCRA regulated metals. Cadmium was detected in all samples but below the corresponding PMPS value of 8 mg/kg. Mercury concentrations in the four samples ranged from 0.64 mg/kg to 310 mg/kg and averaged 86 mg/kg. Eight additional delineation samples were collected in the top two inches of soil from this area. Mercury concentrations ranged from 4.5 mg/kg to 126.9 mg/kg and averaged 24 mg/kg.

Contaminated surface soils within the plant are located mainly near the cell building and brine handling areas, in the sand blasting area near the scrap metal fill. Based on the data the estimated contaminated soil volume occupied by Plant surface soils is about 11,970 cy. On an average, the soils contain approximately 28 mg/kg of mercury.

2.4.1.12 North Ditch Fill Area

Site wide soil sampling performed by CDM in 1997 identified two areas with relatively higher level of mercury: SSS-024-01, southeast of the North Ditch, and SSS-025-01, south of the plant and west of the outfall 001 treatment weir (discussed

below). Fourteen delineation samples collected surrounding SSS-024-01 (North Ditch Area) contained mercury at concentrations ranging from non-detect to 39.2 mg/kg. With one exception, delineation samples collected from the deeper interval (1.0 to 1.5 feet) contained lower mercury concentrations than those collected from ground surface to 0.5 feet. Graphite anodes were also found in the soils at this location, and hence the mercury detected adjacent to the North Ditch is believed to be associated with plant fill.

During CDM Corrective Measures Study Field Investigation conducted in November 2001, seven test pits (TP11-A through TP11-G) were excavated in the vicinity of the North Ditch to evaluate the presence and extent of fill and to collect samples to characterize the mercury content of the fill. Five test pits (TP11-A through TP11-E) were excavated on the east side of the North Ditch and two test pits (TP11-F and TP11-G) were excavated on the western side of the North Ditch. Fill material comprising of three distinct layers was observed in the pits on the eastern side of the ditch. The top material was generally sand with little silt and gravel, underlain by a hard, dry, sand and silt layer and debris fill.

Mercury was detected at 8.4 mg/kg (2.0 feet) in a sample from TP11-C, and at 14.0 mg/kg (4.0 feet) in a sample from TP11-E.

Two test pits were excavated west of the North Ditch. Only surficial samples at these locations contained elevated concentrations of mercury. Two samples were detected above 2.2 mg/kg. Mercury was detected at 17.0 mg/kg (0.5 feet) in the sample collected from TP11-F and at 14.0 mg/kg (1.0 feet) in the sample collected from TP11-G. The estimated contaminated soil in the area is estimated to be 1,240 cy containing an average mercury concentration of 11 mg/kg.

2.4.1.13 SSS-025 Area

Delineation samples associated with SSS-025 contained mercury at concentrations ranging from 0.4 to 52.4 mg/kg. Samples were collected at twelve locations in the vicinity of SSS-025. Mercury at SSS-025 is believed to be associated with overflows of a weir at the pH neutralization tank, or due to the cleaning of sludge from the tank. Samples collected at a depth of 1.0 to 1.5 feet contained lower concentrations of mercury (1.1 mg/kg and 4.8 mg/kg) than those collected at ground surface to 0.5 feet. Six out of twelve samples contained mercury above the 2.2 mg/kg PMPS for mercury in soils. Based on volume calculations about 50 cy of contaminated soil containing 23 mg/kg of average mercury is present in this area.

2.4.1.14 Chloropicrin Spill Area

Chloropicrin contaminated soils are present as a result of spills of the material primarily at or near the chloropicrin tank car loading area. Chloropicrin was manufactured in a building on the western edge of the plant and transferred to the tank car loading area originally by an underground steel pipe, which was later replaced with an overhead steel pipe.

Characterization of chloropicrin in soil was performed in two phases during the SI. Initial near-surface sampling did not identify chloropicrin concentrations greater than the PMPS.

The presence of chloropicrin in the subsurface was investigated in the fall of 2000. Geoprobe borings were used to collect soil samples for headspace screening and laboratory analysis. Chloropicrin was detected in five of 13 soil borings. Detected concentrations ranged from 1.8 mg/kg to 420 mg/kg. The five borings where chloropicrin was detected are all in close proximity to the chloropicrin tank car loading area were a spill reportedly occurred in July of 1985.

Based on the results of SI characterization, the extent of chloropicrin in soil greater that the PMPS is an approximate 10' by 80' area including and surrounding the former chloropicrin tank car loading area. The depth of soil to be evaluated for remediation is approximately 6 to 20 feet below ground surface. This interval is above the groundwater table in this area. An estimated 6,520 cy of contaminated soil containing 61 mg/kg of Chloropicrin is present in this area.

2.4.1.15 Landfills

There are five landfills at the site that hold mercury-containing sludge. The last active landfill, Landfill 5, was closed in 1985. All of the landfills except Landfill 2 are capped with a geomembrane (e.g. Hypalon). Landfill 2 has a clay cap. None of the landfills are lined. Landfill 1 is located between the manufacturing plant and the Penobscot River. Landfill 2 is located in the valley, east of the manufacturing plant. Landfills 3, 4 and 5 are located on a ridge north of the manufacturing plant. Landfill 5 was closed in 1984 in accordance with the RCRA regulations and is considered the only "RCRA Landfill" at the site.

A portion of the fill material in Landfill 2 may be saturated. However, monitoring of well points around this landfill has not shown migration of mercury to the adjacent Southerly Stream. Landfill 2 is estimated to contain about 21,000 cy of mercury contaminated material. CDM performed an investigation at Landfill 2 in October 2000 to assess the groundwater conditions in the vicinity of the landfill. Two rounds of water quality samples were collected and analyzed. Based on the results it was concluded that landfill 2 is not an ongoing source of mercury to the Southerly Stream.

Groundwater associated with the landfills is discussed under the groundwater section below.

2.4.1.16 North Ditch

The North Ditch is a surface water conveyance between the plant and the Southern Cove. Pre-SI samples documented mercury contamination in sediment. SI sampling confirmed the sediment contamination. CMS Field Investigation sampling was used to delineate the extent of sediment and soil contamination in the North Ditch.

A total of 21 hand augered borings were advanced as five transects along the North Ditch during the CMS Field Investigation. Thirty-eight analytical soil samples were tested for total mercury. Concentrations of mercury above the PMPS of 2.2 mg/kg were detected in thirty-two samples. The mercury concentrations in sediment ranged from 1.2 mg/kg to 910 mg/kg and were observed to decrease with increasing depth. However, concentrations less than the PMPS of 2.2 were not documented throughout the length of the North Ditch. As discussed above, fill material is present along and possibly beneath the lower sections of the ditch.

For the purposes of the CMS, mercury greater than the PMPS of 2.2 mg/kg is assumed to be present to a depth of 2 feet along the entire length of the ditch. It is estimated that 1,377 cy of contaminated soil containing on an average 70 mg/kg of mercury, is present in the ditch area.

2.4.1.17 Southerly Stream

The Southerly Stream extends from the flooded gravel pit northeast of the plant, through a culvert at the eastern and southern sides of the plant and then flows to the Southern Cover. CDM advanced sixty hand-augered soil borings in a series of twelve transects across the width of the Southerly Stream during the CMS Field Investigation. From these borings a total of 113 soil samples were collected, of which detectable total mercury concentrations were observed in 107 samples. Sixty-nine samples had mercury in concentrations greater than the PMPS of 2.2 mg/kg. None of the samples collected from Transect A located at the upgradient end of Landfill 2 contained mercury at concentrations greater than 2.2 mg/kg. The range of mercury concentrations observed in the other transects was from 0.10 mg/kg to 250 mg/kg. The estimated volume of contaminated sediment present at the Southerly Stream is approximately 6,000 cy containing about 18.67 mg/kg of average mercury.

2.4.2 Sediment

Sediment present in the on-site ditches and stream and in the Southern Cove at the HoltraChem site contains concentrations of mercury greater than the corresponding PMPS. Because sediments in upland areas are similar to soils and the potential corrective measures applicable to upland sediments are similar to or the same as those for soils, corrective measures for these on-site sediments will be addressed as part of the soil evaluation. Therefore, this discussion will focus on the sediments of the Southern Cove.

The Southern Cove was extensively studied during the SI. Sediment mercury concentrations greater than the PMPS were documented in the vicinity of the North Ditch and Southerly Stream outfalls and in a mudflat is in the center of the cove.

During the CDM Field Investigation, thirty-six sediment samples were collected in three transects extending from the shoreline and sedge beds towards the southern end of the cove. Concentrations ranged from non-detect to 68 mg/kg. Two samples contained concentrations in excess of the 2.2 mg/kg PMPS, while five samples had

mercury concentrations greater than 2.2 mg/kg. Concentrations less than 2.2 mg/kg were observed in the sedge beds closer to the shore.

The combined area of contaminated sediment present in Southern Cove is estimated to be about 114,600 sq. ft. The depth of the mercury-contaminated sediment varies from 0.5 feet to up to 3 feet.

An estimated 7,150 cy of contaminated sediment with an average concentration of about 57 mg/kg of mercury is believed to be present in the gravel bank of the Southern Cove. Another 5,020 cy of organic sediment containing 15 mg/kg of average mercury is present in the mud-flat portion of the Southern Cove. In total approximately 12,170 cy of sediment containing an average concentration 40 mg/kg.

2.4.3 Groundwater

Groundwater at the site is primarily contaminated with mercury, and VOCs. Other contaminants of concern that are present at lower concentrations or that are considered less toxic include brine (NaCl), caustic (NaOH), manganese, and semi-volatile organic compounds. Contaminated groundwater is present beneath the plant area, between the plant and the Penobscot River and on the Landfill Ridge. Groundwater at the site is not currently used for potable or non-potable purposes. Therefore it does not present a current threat to human health via ingestion or dermal contact. All groundwater at the site ultimately discharges to the Penobscot River, some of it via discharge to the Southerly Stream. Of the contaminants of concern present in groundwater, only mercury is considered a persistent and bio-accumulative toxin. Therefore, the primary exposure pathway of concern is through discharge to surface water and bioaccumulation of mercury in aquatic organisms.

The concentrations of mercury in groundwater on the northern side of landfill ridge are typically below drinking water standards and the PMPS. Using data from the Site Investigation, the flux of mercury from this area northward to the Penobscot River was conservatively calculated to be 0.01 lbs/year. Concentrations in many of the wells used to calculate this estimate have since decreased. Therefore, the current flux of mercury from the landfill ridge is expected to be less. Compared to the potential discharge occurring at the base of Landfill Area 1, where groundwater containment is anticipated, the estimated flux of contaminants from the bedrock ridge is more than two orders of magnitude lower. Therefore, this flux is not a significant component of the total flux of mercury from the site, and groundwater on the Landfill ridge that discharges northward to the Penobscot River will not be targeted for remedial measures.

Groundwater beneath Landfill 4 (MW-506-B1) and between Landfill 4 and the plant (MW-410-B1) has concentrations of mercury and VOCs greater than the PMPS. This groundwater flows to the plant area. Groundwater along the southern edge of the plant, which contains mercury and elevated pH, is currently being collected in a groundwater collection trench installed between the plant and the Southerly Stream. The most impacted groundwater at the site is located between the plant and the

Penobscot River in the Landfill 1 area. This is also the area where the flux of mercury and VOCs to the Penobscot River is calculated to be the greatest. Therefore, the remedial alternatives considered in the CMS will focus on the contaminated groundwater located between the plant and the Penobscot River. Furthermore, the existing groundwater collection trench will be integrated into the final corrective measures.

2.4.4 Surface Water

Surface water is present in three distinct environments – a flooded gravel pit, the North Ditch and Southerly Stream surface water conveyances, and the Penobscot River. In addition, there is a lined pond at the western edge of the plant that was formerly used as an overflow basin for stormwater and process brine and currently contains stormwater.

Because it is usually flowing, surface water contaminant concentrations at any point, change with time. Therefore, unlike soil samples and other more fixed media, surface water samples represent the media only at the moment they are sampled. Similarly, surface water concentrations are a reflection of impacts to the water from other contaminated media such as soil, groundwater and/or sediment.

Existing data has shown no indication of contamination of surface water or sediment in the flooded gravel pit where the Southerly Stream originates. Also, contamination was not indicated in samples collected of the unnamed stream that drains undeveloped portions of the site and enters the Penobscot River at the Northern Cove. Concentrations of mercury greater than PMPS were detected in surface water in the Southerly Stream within and below the manufacturing plant in Southerly Stream and the North Ditch during the Site Investigation. Since that time, monitoring of the Southerly Stream and the North Ditch downgradient of the manufacturing plant has been performed weekly. This monitoring has demonstrated decreasing concentrations of mercury in these surface waters since plant shut down. Currently, the Southerly Stream meets the PMPS for mercury and pH. Assuming a non-storm flow rate of approximately 5 gallons per minute and mercury concentrations at the PMPS, the estimated flux of mercury through the Southerly Stream is 0.02 lbs/year.

The Industrial Sewer discharges to surface water through a NPDES permitted outfall to the Penobscot River. Mercury concentrations at the outlet of the wastewater treatment system (Outfall 002) and at the pH adjustment weir (Outfall 001) are monitored before the water is discharged to the Penobscot River. Based on these measurements, it is apparent that additional mercury is getting into the discharge water between the wastewater treatment plant outfall and the pH adjustment weir. Although the HoltraChem NPDES discharge permit limits are not being exceeded, tracking down and eliminating the source of this mercury to surface water will be considered as part of remedial alternatives for surface water.

The source of the mercury contribution is not known but could be discharge of contaminated groundwater to the industrial sewer, mercury present in the industrial sewer or some combination of the two.

Section 3
Threshold Screening of Potential Corrective Measures

3.1 Summary of Potential Corrective Measures

3.1.1 Identification of Applicable Corrective Measures to be Screened

This section presents the complete list of corrective measures that will be considered in the threshold screening process for each media of concern for the HoltraChem Site.

Potential corrective measures were originally proposed in the December 1993 Site Investigation Work Plan. This original list of potential corrective measures were further screened in the Corrective Measures Study Work Plan to eliminate corrective measures considered to be ineffective, not implementable, or that failed to meet the requirements of the Consent Decree. The list of potential corrective measures presented below is based on those proposed in the CMS Work Plan, but is supplemented to include corrective measures stipulated by MEDEP in the "Notice of Preliminary Media Protection Standards Letter" dated January 21, 2003. The list has also been supplemented to include additional potential corrective measures that have been deemed appropriate to address the conditions found during the CMS Site Investigation.

The resulting list of potential corrective measures that will undergo threshold screening is presented below.

3.1.2 Potential Corrective Measures for Soils

The list of potential soil corrective measures to undergo threshold screening is as follows:

- No action
- Vegetated soil cover (in-place)
- Paved cover (in-place)
- Impermeable engineered cap (in-place)
- Consolidate inside groundwater containment area and cap with engineered cap
- Stabilize, consolidate inside the groundwater containment area and cap with engineered cap.
- Excavate and place in on-site management unit

- Excavate and dispose of off-site
- Excavate, treat, and place in an on-site management unit
- Excavate, treat, and dispose of off-site
- In-situ treatment (for chloropicrin spill area)

3.1.3 Potential Corrective Measures for Southern Cove Sediments

- No action
- Dredge and manage on site
- Dredge, stabilize, and manage on site
- Dredge and dispose of off-site
- Dredge, stabilize, and dispose of off-site
- In-Situ treatment using direct current technology

3.1.4 Potential Corrective Measures for Groundwater

- No action
- Cutoff barrier, extraction, and on-site, ex-situ treatment
- Cutoff barrier, extraction, and off-site treatment
- Cutoff barrier, extraction, on-site, ex-situ treatment and reinjection
- Cutoff barrier and in-situ groundwater treatment

3.1.5 Potential Corrective Measures for Surface Water

- No action
- Paving (of surface water conveyances and / or contaminated soils)
- Impermeable engineered cap (of surface water conveyances and / or contaminated soils)
- Groundwater interceptor trench
- Pipe lining to prevent infiltration (for piped portion of southerly stream and industrial sew er)

- Pipe replacement (for piped portion of southerly stream and industrial sewer)
- Pipe cleaning (for industrial sewer)
- Pipe plugging (for industrial sewer)

3.1.6 Potential Corrective Measure for Air

Air Monitoring performed to date indicates that the PMPs for air are routinely met. The presumptive corrective measure for air is therefore "no action", as it is deemed to be protective of human health and the environment. Therefore, no further evaluation of corrective measurer for air is necessary.

3.2 Threshold Screening Process

The requirements for evaluation of corrective measures outlined in the consent decree follow EPA's CMS guidance (OSWER Directive 9902.3-2A). These requirements identify nine evaluation criteria to be considered. Four of these criteria are "threshold criteria" which are criteria that must be met for an alternative to be considered an acceptable corrective measure. The remaining five criteria are "balancing criteria" and are considered in selecting the most appropriate of the corrective measures that meet the threshold criteria. In this section, the potential corrective measures for each contaminated media are evaluated against the threshold criteria, which are explained below.

3.3 Threshold Screening Criteria

3.3.1 Overall Protection of Human Health and the Environment

Protection of human health factors include mitigation of short- and long-term risks to human health created by residual contamination; this includes consideration of overall protection of human health during and after implementation of the corrective measure. Short-term risks are defined as those occurring subsequent to implementation, during operation or post-operation monitoring. Impacts to long-term risks are also considered.

Protection of environmental factors includes the mitigation of short- and long-term environmental effects of implementing each alternative; both beneficial and adverse effects are considered. In addition, overall protection of environmental receptors is considered. The ability of an alternative to reduce exposure and direct contact of environmental receptors with contamination is considered.

3.3.2 Attainment of Media Cleanup Standards

Under this criterion an assessment is made as to whether any PMPS will not be achieved by the corrective measure due to technical infeasibility.

3.3.3 Control of Sources of Releases

Under this criterion the degree to which the sources of releases will be controlled or removed is considered. An evaluation is made of the ability of the alternative to adequately control the sources of releases to reduce or eliminate, to the extent practicable, further releases of hazardous waste or hazardous constituents to the environment.

3.3.4 Compliance with Applicable Waste Management Standards

This criterion considers whether the corrective measure alternative meets the applicable Federal, State and local regulations.

3.4 General Considerations for Threshold Screening

3.4.1 Future Groundwater Controls

As discussed later in this section, the retained corrective action alternatives for addressing groundwater include the capture and treatment of groundwater downgradient of the HoltraChem Plant and Landfill 1. The recommended alternative for groundwater corrective action will therefore include a barrier wall and groundwater pumping and treatment system. As a result, the threshold screening of corrective measures for sediment, soil, and surface water assumes that this groundwater barrier wall, collection, and treatment system will be included in the overall corrective action program.

3.4.2 Feasibility of Soil Flushing

CDM evaluated the feasibility of flushing the soil to potentially reduce the amount of time that active groundwater recovery and treatment would be necessary. The two rate determining factors in the removal of contaminants from soil are the partitioning properties of the contaminant and the number of pore volumes that can be passed through the contaminated zone per unit of time. Flushing occurs naturally but the amount of flushing can be increased through the strategic re-injection of groundwater. The following presents a summary of our feasibility review.

Chloropicrin Flushing

For the chloropicrin spill area, the important limiting factor for flushing is the presence of a relatively low permeability soil layer over the zone of contamination. Residual chloropicrin is present in and immediately below a silt and clay layer present at approximately 8 feet below ground surface and is approximately 10 feet thick at its thickest point. The silt and clay layer appears to be limited in lateral extent, and is well above the local groundwater table. Surplus infiltrated water (rain water or re-injected groundwater in an amount greater than the amount that can pass through the silt and clay) will likely run off the sides of the layer before a sufficient head is developed and maintained to force water through the soil containing chloropicrin. Therefore, it is unlikely that the addition of re-injected groundwater can result in a flushing rate significantly faster than what will occur naturally and will therefore result in no significant remedial benefit.

Mercury Flushing

CDM considered re-injection of groundwater within the groundwater collection area as a means of flushing mercury and thereby shortening the life of active groundwater collection and treatment. However, there are difficulties and concerns inherent with re-injection of groundwater, three of which were noted in comments by the MEDEP and EPA: concern about injection of saline water that could discharge to the Southerly Stream and the potential that elemental mercury, if present after remediation, would render flushing ineffective. CDM has considered re-injection of groundwater and provides the following discussion to document our evaluation of this alternative.

Groundwater could potentially be re-injected in four places: 1) outside, downgradient of the collection system, 2) outside upgradient of the collection system, 3) within the manufacturing plant area, or 4) downgradient of the plant but upgradient of the groundwater collection system. The portion of the site where groundwater re-injection might be most beneficial is beneath the manufacturing plant. However, MEDEP and EPA point out that re-injection of treated groundwater that may be somewhat saline would be undesirable if it were to discharge to the Southerly Stream. Because of the relatively flat topography, shallow depth to till and low hydraulic gradients in the plant area, re-injected groundwater would create a mound and groundwater would likely flow to the Southerly Stream as well as to the present and planned groundwater collection systems.

MEDEP and EPA have indicated the importance of placing consolidated soil above the seasonally high groundwater table. Because it would cause a groundwater mound as discussed above, CDM does not believe that it is practical or desirable to re-inject groundwater into the plant area.

The MEDEP and EPA note that flushing would not significantly speed up remediation if elemental mercury were present because this non-aqueous phase liquid would act as a very slowly releasing continuing source. Although Mallinckrodt has proposed to identify and remove free mercury to the extent practicable, the precise nature, and extent of mercury is difficult to conclusively determine. Therefore, it is not possible for CDM to put an exact timeframe on the amount of time that active groundwater control will be required. Although flushing could theoretically reduce the amount of time the treatment system must operate, CDM cannot quantify the reduction in time that may result from flushing by re-injecting groundwater. Therefore, the benefit of flushing appears limited.

In addition to the above, injection of groundwater is potentially problematic because of changes to the chemistry that occur when the extracted water is exposed to oxygen. Dissolved iron that is present in groundwater will precipitate (as rust). Oxidized iron will often plug up injection wells, trenches and/or the adjacent formation. For these reasons, CDM believes that the best course of action is to excavate source material to the extent practicable, and to limit groundwater infiltration and water levels by passive means. Monitoring of groundwater concentrations will determine the

duration of active groundwater collection and treatment. Soil flushing is therefore not included as one of the corrective measures considered for screening.

3.4.3 Corrective Action for Capped Landfills

There are five landfills at the HoltraChem site, numbered Landfill 1 through Landfill 5. Landfills 1 through 4 were closed in 1980. These were closed using an engineered impermeable geomembrane cap, except for Landfill 2, which has a clay/till cover.

Landfill 5 was closed in 1984 after the Resource Conservation and Recovery Act (RCRA) regulations were in force, and is therefore a RCRA-regulated unit subject to specific monitoring requirements. It has an impermeable geomembrane cap.

In the January 21, 2003 Notice of Preliminary Media Protection Standards, MEDEP stipulated that "The excavation and removal of one or more of the on-site landfills shall be considered as an option for evaluation". CDM evaluated the excavation and removal of Landfill 2, the one landfill that does not have an impermeable geomembrane cap. This landfill also has waste typically in contact with groundwater, while the other landfills do not.

The other landfills have effective caps, will not have waste in contact with groundwater, and will be the subject of long-term groundwater monitoring. Therefore, the PMPSs and corrective action objectives for these landfills are adequately addressed without additional corrective action. The screening and detailed evaluation results are therefore not applicable to Landfills 1, 3, 4, and 5. However, the impacts and costs of removing these landfills are discussed in Section 4 for the purposes of comparison with the other alternatives.

3.4.4 Corrective Action for Transformer Area Soils

As discussed in Section 2, the transformer area consists of a relatively small volume (approximately 22 cy) of PCB-contaminated soil. This is the only known area of PCB contamination on site. Instead of evaluating various corrective action alternatives for this area, it will be addressed using a presumptive corrective action consisting of excavation and off-site disposal. This presumptive measure meets the PMPS for PCBs and achieves the corrective action objectives.

3.4.5 Grouping of Soil Contamination Areas for Screening

For the purposes of screening the corrective measures, the individual contaminated soil areas on site will be grouped into categories consistent with their location, type of contaminant, and physical features. These groups are as follows:

Cell Building and Plant Area Soils, consisting of:

- Cell Building Soils – soils within and adjacent to the cell building footprint with mercury concentrations above the PMPS.

- Plant Area Soils Inside the Groundwater Containment Area – plant area soils other than the cell building soils that lie within the capture zone of the proposed groundwater collection and treatment system, including Landfill 1.
- Plant Area Soils Outside the Groundwater Containment Area – plant area soils that lie outside the capture zone of the proposed groundwater collection and treatment system.

Landfills and Landfill Ridge Area Soils, consisting of:

- Landfill 2.
- Landfills 3, 4, and 5.
- The fill area north of Landfills 3 and 4.

Chloropicrin Spill Area Soils, consisting of:

- Soils in the area of the former chloropicrin spill with concentrations exceeding the PMPS for chloropicrin.

3.5 Cell Building and Plant Area Soils

The results of the threshold screening for the Cell Building and plant area soils are summarized in **Tables 3-1, 3-2 and 3-3**. A discussion of each alternative and the assessment of the threshold criteria significant to the screening results are provided below.

3.5.1 No Action

3.5.1.1 Description of Alternative

Under this alternative the contaminated soil associated with the cell building would be left in place without any treatment, and no active remediation would take place. Institutional controls such as deed restrictions, notifications, or excavation restrictions could be imposed. Ground water monitoring would be performed to determine the rate and extent of natural attenuation.

3.5.1.2 Overall Protection of Human Health and the Environment

This alternative is not protective of human health and the environment because the existing short-term as well as long-term human health risks are not mitigated.

Similarly, the environmental risk posed at the site will remain unchanged as a result of this alternative. These risks consist of potential exposure to mercury by humans, wildlife, and aquatic biota through the existing exposure pathways of direct exposure, erosion to surface water and sediment, and groundwater migration.

Table 3-1
Threshold Screening for Cell Building Soils

Corrective Action Alternative	Assessment of Threshold Criteria				Retained for Detailed Evaluation
	Overall Protection of Human Health and the Environment	Attainment of Media Cleanup Standards	Control of Sources of Releases	Compliance with Applicable Waste Management Standards	
No Action	Not met. Existing risk not controlled.	Not met. Transport via erosion possible.	Not met. Elemental Hg would remain subject to transport via percolation.	Met. Complies with standards.	No
Vegetated Soil Cover (In-Place)	Met. Exposure pathways eliminated.	Met. CAOs met through erosion control and GW protection system.	Not met. Elemental Hg would remain subject to transport via percolation.	Met. Complies with standards.	No
Paved Cover (In-Place)	Met. Exposure pathways eliminated.	Met. CAOs met through erosion control and GW protection system.	Met. Releases controlled by eliminating percolation.	Met. Complies with standards.	**Yes**
Impermeable Engineered Cap (In-Place)	Met. Exposure pathways eliminated.	Met. CAOs met through erosion control and GW protection system.	Met. Releases controlled by eliminating percolation.	Met. Complies with standards.	**Yes**
Consolidate and Cap Inside GW Containment System	Met. Exposure pathways eliminated.	Met. CAOs met through erosion control and GW protection system.	Met. Releases controlled by eliminating percolation.	Met. Complies with standards.	**Yes**
Stabilize, consolidate and cap inside GW contamination system	Met. Exposure pathways eliminated.	Met. CAO's met through stabilization, erosion control and GW protection	Met. Releases controlled by stabilization and eliminating percolation.	Met. Complies with standards.	**Yes**
Excavate/Place in On-Site Management Unit	Met. Exposure pathways eliminated.	Met. Soils exceeding MPS placed in RCRA C management unit	Met. Soils exceeding MPS placed in RCRA C management unit	Not met. Some soils exceed LDRs	**No**
Excavate/Off-Site Disposal	Met. Exposure pathways eliminated.	Met. Soils disposed off site in secure management unit.	Met. Soils disposed off site in secure management unit.	Met. Assumes disposal outside U.S.	**Yes**
Excavate/Treat/Place in On-Site Management Unit	Met. Exposure pathways eliminated.	Met. Soils exceeding MPS placed in Corrective Action Management Unit (CAMU)	Met. Soils exceeding MPS placed in Corrective Action Management Unit (CAMU)	Met. Assumes treatment to UTS.	**Yes**
Excavate/Treat/Off-Site Disposal	Met. Exposure pathways eliminated.	Met. Soils disposed off site in secure management unit.	Met. Soils disposed off site in secure management unit.	Met. Assumes treatment to UTS or disposal outside U.S.	**Yes**

Table 3-2
Threshold Screening for Non-Cell Building Plant Area
Soils Inside GW Containment Area

Corrective Action Alternative	*Assessment of Threshold Criteria*				*Retained for Detailed Evaluation*
	Overall Protection of Human Health and the Environment	*Attainment of Media Cleanup Standards*	*Control of Sources of Releases*	*Compliance with Applicable Waste Management Standards*	
No Action	Not met. Existing risk not controlled.	Not met. Transport via erosion possible.	Not met. Hg would remain subject to transport via percolation.	Met. Complies with standards.	No
Vegetated Soil Cover (In-Place)	Met. Exposure pathways eliminated.	Met. CAOs met through erosion control and GW protection system.	Not met. Hg would remain subject to transport via percolation.	Met. Complies with standards.	No
Paved Cover (In-Place)	Met. Exposure pathways eliminated.	Met. CAOs met through erosion control and GW protection system.	Met. Releases controlled by eliminating percolation.	Met. Complies with standards.	**Yes**
Impermeable Engineered Cap (In-Place)	Met. Exposure pathways eliminated.	Met. CAOs met through erosion control and GW protection system.	Met. Releases controlled by eliminating percolation.	Met. Complies with standards.	**Yes**
Consolidate and Cap Inside GW Containment System	Met. Exposure pathways eliminated.	Met. CAOs met through erosion control and GW protection system.	Met. Releases controlled by eliminating percolation.	Met. Complies with standards.	**Yes**
Stabilize, consolidate and cap inside GW contamination system	Met. Exposure pathways eliminated.	Met. CAO's met through stabilization, erosion control and GW protection	Met. Releases controlled by stabilization and eliminating percolation.	Met. Complies with standards.	**Yes**
Excavate/Place in On-Site Management Unit	Met. Exposure pathways eliminated.	Met. Soils exceeding MPS placed in RCRA C management unit	Met. Soils exceeding MPS placed in RCRA C management unit	Met. Complies with standards (assumes soils do not exceed TCLP).	**Yes**
Excavate/Off-Site Disposal	Met. Exposure pathways eliminated.	Met. Soils disposed off site in secure management unit.	Met. Soils disposed off site in secure management unit.	Met. Complies with standards.	**Yes**
Excavate/Treat/Place in On-Site Management Unit	Met. Exposure pathways eliminated.	Met. Soils exceeding MPS placed in Corrective Action Management Unit (CAMU)	Met. Soils exceeding MPS placed in Corrective Action Management Unit (CAMU)	Met. Assumes treatment to UTS or soils do not exceed TCLP.	**Yes**
Excavate/Treat/Off-Site Disposal	Met. Exposure pathways eliminated.	Met. Soils disposed off site in secure management unit.	Met. Soils disposed off site in secure management unit.	Met. Complies with standards.	**Yes**

Table 3-3
Threshold Screening for Plant Area Soils Outside GW Containment Area

Corrective Action Alternative	*Assessment of Threshold Criteria*				*Retained for Detailed Evaluation*
	Overall Protection of Human Health and the Environment	*Attainment of Media Cleanup Standards*	*Control of Sources of Releases*	*Compliance with Applicable Waste Management Standards*	
No Action	Not met. Existing risk not controlled.	Not met. Transport via erosion and GW possible.	Not met. Contam. subject to transport via percolation and GW.	Met. Complies with standards.	No
Vegetated Soil Cover (In-Place)	Not met. Existing risk not controlled.	Not met. Transport via percolation and GW possible.	Not met. Contam. subject to transport via percolation and GW.	Met. Complies with standards.	No
Paved Cover (In-Place)	Not met. Exposure through GW possible	Not met. Transport via GW possible.	Not met. Contam. subject to transport via GW.	Met. Complies with standards.	No
Impermeable Engineered Cap (In-Place)	Not met. Exposure through GW possible	Not met. Transport via GW possible.	Not met. Contam. subject to transport via GW.	Met. Complies with standards.	No
Consolidate and Cap Inside GW Containment System	Met. Exposure pathways eliminated.	Met. CAOs met through erosion control and GW protection system.	Met. Releases controlled by eliminating percolation.	Met. Complies with standards.	**Yes**
Stabilize, consolidate and cap inside GW contamination system	Met. Exposure pathways eliminated.	Met. CAO's met through stabilization, erosion control and GW protection	Met. Releases controlled by stabilization and eliminating percolation.	Met. Complies with standards.	**Yes**
Excavate/Place in On-Site Management Unit	Met. Exposure pathways eliminated.	Met. Soils exceeding MPS placed in Corrective Action Management Unit (CAMU)	Met. Soils exceeding MPS placed in Corrective Action Management Unit (CAMU)	Met. Complies with standards (assumes soils do not exceed TCLP).	**Yes**
Excavate/Off-Site Disposal	Met. Exposure pathways eliminated.	Met. Soils disposed off site in secure, permitted facility	Met. Soils disposed off site in secure, permitted facility.	Met. Complies with standards.	**Yes**
Excavate/Treat/Place in On-Site Management Unit	Met. Exposure pathways eliminated.	Met. Soils exceeding MPS placed in Corrective Action Management Unit (CAMU)	Met. Soils exceeding MPS placed in Corrective Action Management Unit (CAMU)	Met. Assumes treatment to UTS or soils do not exceed TCLP.	**Yes**
Excavate/Treat/Off-Site Disposal	Met. Exposure pathways eliminated.	Met. Soils disposed off site in secure management unit.	Met. Soils disposed off site in secure management unit.	Met. Complies with standards.	**Yes**

3.5.1.3 Attainment of Media Cleanup Standards

Under this alternative, soils above the PMPS for mercury would remain unmanaged. The potential for direct contact with soils above the PMPS would exist. The potential for erosion of mercury-contaminated soil would remain unchanged, which would likely result in continued contamination of sediments to levels exceeding the PMPS. The potential for the migration of contaminants to groundwater at levels exceeding the PMPS would also remain present. Therefore, this alternative fails to meet this threshold criterion.

3.5.1.4 Controlling the Source of Releases

As no active control or remediation measures are involved, this alternative will not control source releases, or remove any quantity of hazardous constituents from the soils. Mercury will be released to the environment at the present rate and hence, this alternative fails to meet this criterion. Future releases will be reduced only by natural attenuation.

3.5.1.5 Compliance with Applicable Waste Management Standards

This criterion is met, as no remediation waste will be generated by the implementation of this alternative.

3.5.1.6 Conclusion

The no action alternative is not retained for further evaluation.

3.5.2 Vegetated Soil Cover (In-Place)

3.5.2.1 Description of Alternative

This alternative would include the placement of a soil cover consisting of a minimum of 6 inches of topsoil. The covered areas would be seeded with native meadow grass species. The intent of the soil cover is to eliminate direct contact to contaminated soil and also eliminate the transport of contaminants in soil to other uncontaminated areas of the site. The soil cover would not restrict infiltration of rainwater to the groundwater table.

3.5.2.2 Overall Protection of Human Health and the Environment

For the Cell Building soils, and the other plant area soils within the proposed groundwater containment area, this criterion is met. The existing short-term as well as long-term human health risks and environmental risks are mitigated, by the elimination of the pathways of exposure to humans, wildlife, and aquatic biota. The vegetated cover would prevent direct exposure, erosion to surface water and sediment. The migration of contaminants from the soil areas via groundwater to surface water or drinking water supplies would be prevented by the groundwater containment system.

For the plant area soils outside the groundwater containment area, this alternative is only partially protective of human health and the environment because the existing

short-term as well as long-term human and environmental health risks due to potential groundwater migration are not mitigated. The vegetated cover would allow rainfall and snowmelt to percolate through the contaminated soil and potentially carry contaminants into the groundwater table where they could migrate from the area and potentially discharge to surface water.

3.5.2.3 Attainment of Media Cleanup Standards

For the cell building soils, and the other plant area soils within the proposed groundwater containment area, this criterion is met. The soil cover prevents direct contact and transport of contaminants to sediment, while the groundwater containment system prevents migration of contaminants from the soil to surface water or drinking water. As a result, soil above the PMPS is managed such that the corrective action objectives are achieved.

For the plant area soils outside the groundwater containment area, this criterion is not met because the groundwater exposure pathway is not mitigated. As a result contaminants from the soil areas could be carried to the groundwater table via downward percolation of rainfall, and subsequently migrate via groundwater transport to surface water.

3.5.2.4 Controlling the Source of Releases

The soil cover will not prevent percolation of rainfall and snowmelt downward through the contaminated soil. As a result, soil with mercury concentrations above levels that would cause leaching above the PMPS could be a potential source of releases to groundwater. The soil cover alternative would not control this source of releases.

The groundwater containment system would prevent the further migration of contaminants, but the potential continued release of mercury to groundwater from the contaminated soil would potentially increase the amount of time the containment and treatment system would be operated.

3.5.2.5 Compliance with Applicable Waste Management Standards

This criterion is met because no remediation waste will be generated by the implementation of this alternative.

3.5.2.6 Conclusion

This alternative meets the threshold criteria for areas where soil contamination levels do not have the potential to cause leaching above the groundwater PMPS. For other areas, the alternative would not be acceptable, because it does not control the source of releases to groundwater.

3.5.3 Impermeable Cover (Paving or Membrane)

3.5.3.1 Description of Alternatives

The paved cover alternative would consist of installation of a bituminous concrete layer over areas that exceed the PMPS. This would include of clearing and grubbing the area to be capped, grading the surface for proper drainage, and placing a compacted subbase of dense graded crushed stone over the area to be capped. The area would then be paved with two layers of bituminous concrete consisting of a lower binder course and top course. Paved areas would be graded at a minimum slope of 0.5 percent to achieve positive drainage.

The engineered cap alternative would consist of the construction of a soil cover incorporating an impermeable geomembrane over the areas that exceed the PMPS. This would involve clearing and grubbing, grading for proper drainage, and placement of the cap. The cap system would most likely consist of a sand leveling layer, HDPE membrane, granular fill layer, and a vegetation support layer (topsoil). Capped areas would be graded at a minimum slope of 2 percent to achieve positive drainage.

The purpose of the capping systems is to prevent rainfall and snow melt infiltration through the ground surface at contaminated soil areas. These two capping alternatives are considered equivalent in their ability to achieve this objective, although each alternative has different advantages. For example, pavement is slightly less expensive than the soil cover and can tolerate vehicular traffic, but would likely require repair or repaving over the life of the corrective action. The soil cover would require seasonal mowing, but would not require repair or replacement over the life of the corrective action. The soil cover also has an aesthetic advantage because it would blend into the natural landscape better than pavement. These advantages and disadvantages will be considered in the choice of capping system during the design phase. For the purposes of this CMS the capping systems will be considered equivalent, and discussed as a single alternative.

3.5.3.2 Overall Protection of Human Health and the Environment

For the cell building soils, and the other plant area soils within the proposed groundwater containment area, this criterion is met. The existing short-term as well as long-term human health risks and environmental risks are mitigated, by the elimination of the pathways of exposure to humans, wildlife, and aquatic biota. The cap system would prevent direct exposure, erosion to surface water and sediment. The migration of contaminants from the soil areas via groundwater to surface water or drinking water supplies would be prevented by the groundwater containment system.

For the plant area soils outside the groundwater containment area, this alternative is protective of human health and the environment for contaminated soils that are not in contact with groundwater. The prevention of downward infiltration of rainfall by the

cap system would effectively immobilize the contaminants. For areas with contaminated soil within the groundwater table, this alternative is not protective because the migration of contaminants via groundwater and subsequent potential discharge to surface water would not be mitigated.

3.5.3.3 Attainment of Media Cleanup Standards

For the Cell Building soils, and the other plant area soils within the proposed groundwater containment area this criterion is met. The cap prevents direct contact and transport of contaminants to sediment, while the groundwater containment system prevents migration of contaminants from the soil to surface water or drinking water. As a result, soil above the PMPS is managed such that the corrective action objectives are achieved.

For the plant area soils outside the groundwater containment area, this alternative attains the cleanup standards for contaminated soil areas that are not in contact with groundwater. The prevention direct contact and erosion are prevented. The cap also prevents infiltration of rainfall, preventing the downward migration of contaminants to the groundwater table. As a result, soil above the PMPS is managed such that the corrective action objectives are achieved. For soils outside the groundwater containment area that are in contact with groundwater, the cap system does not prevent the migration of contaminants via groundwater. As a result contaminants from the soil areas could migrate via groundwater transport to surface water.

3.5.3.4 Controlling the Source of Releases

For contaminated soils that are above the groundwater table, the cap alternative is effective in controlling the sources of releases, since it prevents direct contact with the contaminant sources, and it prevents contaminants from being transported downward to the groundwater table.

For contaminated soil areas in contact with groundwater, the cap system will not prevent the transport of contaminants via groundwater migration. As a result, soil with mercury concentrations above levels that could result in leaching above the PMPS, could be a potential source of releases to groundwater. The cap alternative would not control this source of releases.

The groundwater containment system would prevent the further migration of contaminants, but the potential continued release of mercury to groundwater from the contaminated soil could increase the amount of time the containment and treatment system must operated to meet the groundwater PMPS.

3.5.3.5 Compliance with Applicable Waste Management Standards

This criterion is met because no remediation waste will be generated by the implementation of this alternative.

3.5.3.6 Conclusion

This alternative meets the threshold criteria for areas inside the proposed groundwater containment system and areas outside the groundwater containment system where the contaminated soil is above the groundwater table. For other areas, the alternative would not be acceptable, because it does not control the source of releases to groundwater.

3.5.4 Consolidation and Capping Inside Groundwater Containment System

3.5.4.1 Description of Alternative

This alternative consists of excavating the various areas of contaminated soil and consolidating them above the groundwater table within the influence of the proposed groundwater containment system. The consolidated soil area would then be capped using an engineered impermeable capping system such as the membrane cap described for the capping alternative above.

3.5.4.2 Conclusion

This alternative is essentially equivalent to the capping alternatives discussed above, but since the soils will all be brought into the groundwater containment system, the concerns regarding transport of contaminants via groundwater are mitigated. This alternative therefore meets the threshold criteria.

3.5.5 Stabilization, Consolidation, and Capping Inside the Groundwater Containment System

3.5.5.1 Description of Alternative

This alternative is identical to the alternative described above, except that excavated soil would be processed to mix in a stabilization additive that would reduce the leaching potential of mercury from the soil. This alternative assumes that an effective additive is available to stabilize the site soils. However, treatability testing would be necessary to determine the type and quantity of additive to use. The stabilized soil would be consolidated and capped as described in the above alternative.

3.5.5.2 Conclusion

This alternative is equivalent to the above alternative in meeting the screening criteria. However, this alternative does not provide an additional benefit because the potential for mercury leaching from the soil is already controlled by elevating the soil above the water table and capping it. For this reason this alternative was not retained for detailed evaluation.

3.5.6 Excavation and Disposal or On-Site Management

3.5.6.1 Description of Alternatives

There are four corrective measures alternatives that include excavation of the contaminated soils. The variations include off-site disposal of the excavated soil or placement of the soil in an on-site management unit, and whether the soils are treated prior to disposal or placement in the on-site management unit. The threshold criteria assessment for the four alternatives is discussed together below, as the considerations and results are essentially the same for each.

Each of the four alternatives would involve excavating the contaminated soil from areas exceeding the PMPS. This would be accomplished using standard construction equipment such as hydraulic excavators, loaders, and dump trucks. The excavated soil would be either disposed of off-site or would be placed in an on-site soil management unit. The on-site management unit would conform to the technical requirements of a RCRA Subtitle C landfill. Off-site disposal would involve trucking the soil from the site to a permitted disposal facility in compliance with applicable regulations.

Treatment for soils to be placed in the on-site management units would consist of on-site processes to remove mercury from highly contaminated soil, or to reduce the volume of soil requiring placement in a management unit. Treatment for soils to be disposed of off-site may consist of on-site processes to reduce the volume of material requiring disposal, or off-site treatment of highly contaminated soil.

3.5.6.2 Overall Protection of Human Health and the Environment

Each of the four alternatives involving excavation of the contaminated soil would meet these threshold criteria. Disposal of the soil off-site or placement in an on-site lined management unit would eliminate the pathways of exposure to humans, wildlife, and aquatic biota, and therefore would meet the corrective action objectives.

3.5.6.3 Attainment of Media Cleanup Standards

Each of the four alternatives attains these criteria because soil exceeding the PMPS would be excavated and placed in a lined and capped on-site or off-site management unit.

3.5.6.4 Controlling the Source of Releases

Each of the four alternatives would be effective in controlling releases to groundwater or surface water because the contaminated soil would be placed in a lined and capped management unit.

3.5.6.5 Compliance with Applicable Waste Management Standards

The alternative consisting of excavation and placement in an on-site management unit would not meet applicable waste management standards for soils that exceed the mercury TCLP criteria of 0.2 mg/l. These soils are defined as hazardous waste by the

RCRA regulations and are prohibited from land disposal in the United States. These soils would require treatment prior to placement.

The remainder of the excavation alternatives would comply with applicable waste management standards, provided that the soils exceeding the hazardous waste criteria are treated to the limits defined in the regulations, or are disposed of outside the United States.

3.5.6.6 Conclusion

The excavation alternatives meet the threshold criteria except for the alternative involving placement in an on-site management unit without treatment. For some soils, this alternative would not comply with RCRA land disposal restrictions.

3.6 Landfills and Landfill Ridge Area Soils

The results of the threshold screening for the landfills and landfill ridge area soils are summarized in **Table 3-4**. A discussion of each alternative and the assessment of the threshold criteria significant to the screening results are provided below.

3.6.1 No Action

3.6.1.1 Description of Alternative

Under this alternative the contaminated soil associated with the landfills and landfill ridge area would be left in place without any treatment, and no active remediation would take place. Institutional controls such as deed restrictions, notifications, or excavation restrictions could be imposed. Ground water monitoring would be performed to determine the rate and extent of natural attenuation.

3.6.1.2 Overall Protection of Human Health and the Environment

This alternative is protective of human health and the environment because the existing soil cover over the areas prevents direct contact with the contaminated soil and prevents erosion of the soil and resulting migration of contamination to surface water and sediment. Groundwater sampling immediately downgradient of these areas shows that groundwater PMPS are not being exceeded. Since the contaminated soil at these locations has been in place for over 20 years, this condition is not expected to change.

3.6.1.3 Attainment of Media Cleanup Standards

This criterion is met. The existing soil covers prevent direct contact and transport of contaminants to sediment. As discussed above, groundwater sampling data indicates that PMPS are not likely to be exceeded downgradient of these areas. As a result, soil above the PMPS is managed such that the corrective action objectives are achieved.

Table 3-4
Threshold Screening for Landfills and Landfill Ridge Area Soils

Corrective Action Alternative	*Assessment of Threshold Criteria*				*Retained for Detailed Evaluation*
	Overall Protection of Human Health and the Environment	*Attainment of Media Cleanup Standards*	*Control of Sources of Releases*	*Compliance with Applicable Waste Management Standards*	
No Action/Monitor	Met. No exposure occuring.	Met. Soil exceeding PMPS managed to prevent exposure.	Met. GW monitoring shows no releases occuring.	Met. Complies with standards.	**Yes**
Impermeable Engineered Cap (In-Place)	Met. Exposure pathways eliminated.	Met. CAOs met through erosion control and GW monitoring.	Met. Releases controlled by eliminating percolation.	Met. Complies with standards.	**Yes**
Consolidate and Cap Inside GW Containment System	Met. Exposure pathways eliminated.	Met. CAOs met through erosion control and GW protection system.	Met. Releases controlled by eliminating percolation.	Met. Complies with standards.	**Yes**
Excavate/Place in On-Site Management Unit	Met. Exposure pathways eliminated.	Met. Soils exceeding MPS placed in Corrective Action Management Unit (CAMU)	Met. Soils exceeding MPS placed in Corrective Action Management Unit (CAMU)	Met. Complies with standards (assumes soils do not exceed TCLP).	**Yes**
Excavate/Off-Site Disposal	Met. Exposure pathways eliminated.	Met. Soils disposed off site in secure management unit.	Met. Soils disposed off site in secure management unit.	Met. Complies with standards.	**Yes**
Stabilize, consolidate and cap inside GW contamination system	Met. Exposure pathways eliminated.	Met. CAO's met through stabilization, erosion control, GW protection system, and stabilization	Met. Releases controlled by stabilization and eliminating percolation.	Met. Complies with standards.	**Yes**

3.6.1.4 Controlling the Source of Releases

This alternative is effective in controlling the source of releases as demonstrated by the fact that dissolved mercury is not present in groundwater immediately downgradient of the contaminated soil areas. The existing soil covers are also effective in preventing the release of contaminants via erosion.

3.6.1.5 Compliance with Applicable Waste Management Standards

This criterion is met as no remediation waste will be generated by the implementation of this alternative.

3.6.1.6 Conclusion

The no action alternative is retained for further evaluation.

3.6.2 Impermeable Cap

3.6.2.1 Description of Alternative

The engineered cap alternative would consist of the construction of a soil cover incorporating an impermeable geomembrane over the areas that exceed the PMPS and that do not already have a geomembrane cap.

This would involve clearing and grubbing, grading for proper drainage, and placement of the cap. The cap system would most likely consist of a sand leveling layer, HDPE membrane, granular fill layer, and a vegetation support layer (topsoil). Capped areas would be graded at a minimum slope of 2 percent to achieve positive drainage.

3.6.2.2 Overall Protection of Human Health and the Environment

This criterion is met. The existing short-term as well as long-term human health risks and environmental risks are mitigated, by the elimination of the pathways of exposure to humans, wildlife, and aquatic biota. The cap system would prevent direct exposure, erosion to surface water and sediment. The migration of contaminants from the soil areas via groundwater to surface water is not likely to occur, as demonstrated by the downgradient sampling data. In addition, the prevention of downward infiltration of rainfall by the cap system would effectively immobilize the contaminants.

3.6.2.3 Attainment of Media Cleanup Standards

The cap prevents direct contact and transport of contaminants to sediment. As discussed above, contaminant migration via groundwater is also controlled. As a result, soil above the PMPS is managed such that the corrective action objectives are achieved.

3.6.2.4 Controlling the Source of Releases

The cap alternative is effective in controlling the sources of releases, since it prevents direct contact with the contaminant sources, and it prevents contaminants from being transported downward to the groundwater table.

3.6.2.5 Compliance with Applicable Waste Management Standards

This criterion is met because no remediation waste will be generated by the implementation of this alternative.

3.6.2.6 Conclusion

The no action alternative is retained for further evaluation.

3.6.3 Consolidation and Capping Inside Groundwater Containment System

3.6.3.1 Description of Alternative

This alternative consists of excavating landfills and the landfill ridge area soils and consolidating them in the plant area within the influence of the proposed groundwater containment system. The consolidated soil area would then be capped using an impermeable capping system such as the membrane cap described for the capping alternative above.

3.6.3.2 Conclusion

This alternative is essentially equivalent to the capping alternative discussed above, with the added level of protection of the groundwater containment system. This alternative therefore meets the threshold criteria.

3.6.4 Stabilization, Consolidation, and Capping Inside the Groundwater Containment System

3.6.4.1 Description of Alternative

This alternative is identical to the alternative described above, except that after excavation, the soil and waste from the landfills and landfill ridge area would be processed to mix in a stabilization additive that would reduce the leaching potential of mercury from the soil. This alternative assumes that an effective additive is available to stabilize the site soils. However, treatability testing would be necessary to determine the type and quantity of additive to use. The stabilized soil would be consolidated and capped as described in the above alternative.

3.6.4.2 Conclusion

This alternative is equivalent to the above alternative in meeting the screening criteria. However, this alternative does not provide an additional benefit over the previous alternative because the potential for mercury leaching from the soil is already controlled by elevating the soil above the water table and capping it. For this reason, this alternative was not retained for detailed evaluation.

3.6.5 Excavation and Disposal or On-Site Management

3.6.5.1 Description of Alternatives

There are two corrective measures alternatives that involve excavation of the contaminated soils from landfills and the landfill ridge area. One includes off-site disposal of the excavated soil and the other includes placement of the soil in an on-site management unit. The threshold criteria assessment for the two excavation alternatives are discussed together below, as the considerations and results are essentially the same for each.

Excavation would be accomplished using standard construction equipment such as hydraulic excavators, loaders, and dump trucks. The excavated soil would be disposed of either off-site or placed in a on-site soil management unit. The on-site management unit would be lined and would conform to the technical requirements of a RCRA Subtitle C landfill. Off-site disposal would involve trucking the soil from the site to a permitted disposal facility in compliance with applicable regulations.

3.6.5.2 Overall Protection of Human Health and the Environment

Each of the alternatives involving excavation would meet these threshold criteria. Disposal of the soil off-site or placement in an on-site lined management unit would eliminate the pathways of exposure to humans, wildlife, and aquatic biota, and therefore would meet the corrective action objectives.

3.6.5.3 Attainment of Media Cleanup Standards

Each of the alternatives attains these criteria because soil exceeding the PMPS would be excavated and placed in a lined and capped on-site or off-site management unit.

3.6.5.4 Controlling the Source of Releases

Each of the alternatives would be effective in controlling releases to groundwater, surface water, or sediment because the contaminated soil would be placed in a lined and capped management unit.

3.6.5.5 Compliance with Applicable Waste Management Standards

The excavation alternatives would comply with applicable waste management standards, provided that the any of the material exceeding the hazardous waste criteria are treated to the limits defined in the regulations, or are disposed of outside the United States.

3.6.5.6 Conclusion

The excavation alternatives meet the threshold criteria and are retained for further evaluation.

3.7 Chloropicrin Spill Area Soil

The results of the threshold screening for the chloropicrin spill area are summarized in **Table 3-5**. A discussion of each alternative and the assessment of the threshold criteria significant to the screening results are provided below.

3.7.1 No Action

3.7.1.1 Description of Alternative

Under this corrective measure the chloropicrin-contaminated soil associated with the spill area would be left in place without any treatment, and no active remediation would take place. Restrictions would be placed on excavation in the vicinity of the spill area. Ground water monitoring will be performed to determine the rate and extent of natural attenuation.

3.7.1.2 Overall Protection of Human Health and the Environment

This criterion is met because the location of the contaminated soil, which is approximately 6 to 8 ft below the ground surface, combined with the fact that the spill area will be within the proposed groundwater collection system eliminates the potential pathways for exposure to the contaminant. Humans and wildlife are protected from exposure to contaminants via direct contact, air emissions, and erosion by the depth of the contaminant. Although groundwater is contaminated downgradient of the spill area, the migration of contaminants to surface water or drinking water sources will be prevented by the groundwater containment system. The potential for exposure to chloropicrin emissions caused excavation in the contaminated area will be controlled by restrictions on future excavation in the area.

3.7.1.3 Attainment of Media Cleanup Standards

As discussed above, exposure from soil exceeding the PMPS to humans and the environment, including aquatic biota, are controlled under this alternative. The potential for transport of contaminants from the area exceeding the PMPS is also controlled. This criterion is therefore met because soil above the PMPS is managed such that the corrective action objectives are achieved.

3.7.1.4 Controlling the Source of Releases

The chloropicrin spill area is a source of release of contaminants to groundwater. This alternative will control the release of chloropicrin to groundwater because the proposed groundwater containment system will capture groundwater from the chloropicrin spill area and treat it. Potential future release of chloropicrin emissions during excavation will be controlled by restrictions on excavation in the area.

Table 3-5
Threshold Screening for Chloropicrin Spill Area

Corrective Action Alternative	*Assessment of Threshold Criteria*				*Retained for Detailed Evaluation*
	Overall Protection of Human Health and the Environment	*Attainment of Media Cleanup Standards*	*Control of Sources of Releases*	*Compliance with Applicable Waste Management Standards*	
No Action/Monitor	Met. Existing risk controlled via active GW containment system.	Met. Contamination above PMPS will be managed but not removed.	Met. Releases from the soil will be controlled by the GW containment system.	Met. Complies with standards.	**Yes**
Impermeable Engineered Cap (In-Place)	Met. Exposure pathways eliminated.	Met. CAOs met through erosion control and GW monitoring.	Met. Releases controlled by eliminating percolation.	Met. Complies with standards.	**Yes**
In-situ Treatment	Met. Long-term exposure pathways eliminated.	Met. CAOs met through removal of contaminant from the soil	Met. Releases controlled by removal of source	Met. Complies with standards.	**Yes**
Excavation /Treatment	Not met. Potential for release of toxic air emissions during construction	Met. Removal of contaminated soils through excavation followed by either treatment on-site or off-site.	Not met. Soils would be likely source of releases to air during construction.	Met. Complies with standards.	No

3.7.1.5 Compliance with Applicable Waste Management Standards

This criterion is met because no remediation waste will be generated by the implementation of this alternative.

3.7.1.6 Conclusion

The no action alternative meets the threshold criteria and is retained for further evaluation.

3.7.2 Impermeable Cap

3.7.2.1 Description of Alternative

The engineered cap alternative would consist of the construction of a soil cover incorporating an impermeable geomembrane over the areas that exceed the PMPS. This would involve clearing and grubbing, grading for proper drainage, and placement of the cap. The cap system would most likely consist of a sand leveling layer, HDPE membrane, granular fill layer, and a vegetation support layer (topsoil). The capped area would be graded at a minimum slope of 2 percent to achieve positive drainage.

3.7.2.2 Conclusion

This alternative is equivalent to the no action alternative in meeting each of the threshold criteria. This alternative is therefore retained for further evaluation.

3.7.3 In-Situ Treatment

3.7.3.1 Description of Alternative

This alternative involves in-situ treatment of the soil comprising the chloropicrin spill area to reduce the contaminant concentrations below the PMPS. Two methods of treatment area potentially applicable: soil vapor extraction, and chemical oxidation. For the purposes of threshold screening the treatment methods are considered equivalent.

3.7.3.2 Overall Protection of Human Health and the Environment

This criterion is met because the treatment process would reduce the concentrations of chloropicrin in the soil to below the PMPS, which represents a level of contaminant that is protective of human health and the environment.

3.7.3.3 Attainment of Media Cleanup Standards

The objective of the in-situ treatment processes would be to reduce the chloropicrin in the soil to below the PMPS. Each of the treatment processes considered is potentially effective in achieving the PMPS. Therefore, this criterion is met.

3.7.3.4 Controlling the Source of Releases

This alternative would control the source of releases by reducing the level of chloropicrin in the soil.

3.7.3.5 Compliance with Applicable Waste Management Standards

This would be in compliance with waste management standards. Contaminated soil would not be removed from the ground. Waste would likely be generated by the treatment process however, if SVE is used. Treatment of the vapor stream from the SVE system would likely employ vapor phase carbon treatment. Permitted facilities for disposal or reprocessing of the spent carbon are readily available however, and would be used. This alternative therefore meets this criterion.

3.7.3.6 Conclusion

The in-situ treatment alternative meets the threshold criteria and is retained for further evaluation.

3.7.4 Excavation and Treatment

3.7.4.1 Description of Alternative

Excavation would entail removal of the chloropicrin impacted soil, and based on the likelihood that the soil would fail the RCRA toxicity characteristic, treatment either on-site or off-site prior to land disposal. The assumed treatment process would be thermal desorption follow by thermal or photolytic destruction of the chloropicrin in the off-gas stream.

3.7.4.2 Overall Protection of Human Health and the Environment

Excavation of soil from this area presents a very high risk of releasing chloropicrin emissions to the air at concentrations that would be dangerous to humans and wildlife. Control of these toxic vapors would be difficult and uncertain in an active excavation. This alternative would therefore not meet this criterion.

3.7.4.3 Attainment of Media Cleanup Standards

This alternative would result in the excavation of soil exceeding the PMPS, and treatment of the soil to below the PMPS. Therefore, this criterion is met.

3.7.4.4 Controlling the Source of Releases

As discussed above, excavation of soil from this area would be very likely to result in the release of chloropicrin to the air. This criterion is therefore not met.

3.7.4.5 Compliance with Applicable Waste Management Standards

This would be in compliance with waste management standards, because excavated soil would be treated on site to meet the chloropicrin PMPS, or treated and disposed of off-site in compliance with hazardous waste regulations.

3.7.4.6 Conclusion

The excavation alternative is not retained for further evaluation because it does not meet the criteria of overall protection of human health and the environment, and the control of sources of releases.

3.8 Southern Cove Sediment

The results of the threshold screening for Southern Cove sediment corrective measures are summarized in **Table 3-6**. A discussion of each alternative and the assessment of the threshold criteria significant to the screening results are provided below.

3.8.1 No Action

3.8.1.1 Description of Alternative

Under this alternative the contaminated sediment within the Southern Cove would be left in place without any treatment, and no active remediation would take place.

3.8.1.2 Overall Protection of Human Health and the Environment

Under this alternative, sediment exceeding the mercury PMPS of 2.2 mg/kg would remain in the cove. This PMPS is a derived value that is deemed to be protective of humans and wildlife considering the bioaccumulative potential of mercury. This criterion is therefore not met by the no action alternative.

3.8.1.3 Attainment of Media Cleanup Standards

This alternative would leave sediment in the cove with mercury concentrations exceeding the PMPS. This criterion is therefore not met.

3.8.1.4 Controlling the Source of Releases

This criterion is not met because the transport of contaminated sediment downstream by river erosion is not prevented.

3.8.1.5 Compliance with Applicable Waste Management Standards

This criterion is met because no remediation waste will be generated by the implementation of this alternative.

3.8.1.6 Conclusion

The no action alternative is not retained for further evaluation because it does not meet the criteria of overall protection of human health and the environment, attainment of media protection standards, and the control of sources of releases.

3.8.2 Dredging and Disposal or On-Site Management

3.8.2.1 Description of Alternatives

There are four corrective measures alternatives that include dredging of the contaminated soils. The variations include off-site disposal of the dredged material or management of the material on-site, and whether the soils are treated prior to disposal or on-site management. The threshold criteria assessment for the four alternatives are discussed together below, as the considerations for each alternative are very similar and results are of the assessment are essentially the same for each.

Table 3-6
Threshold Screening for Southern Cove Sediments

Corrective Action Alternative	*Assessment of Threshold Criteria*				*Retained for Detailed Evaluation*
	Overall Protection of Human Health and the Environment	*Attainment of Media Cleanup Standards*	*Control of Sources of Releases*	*Compliance with Applicable Waste Management Standards*	
No Action	Not met. Existing risk not controlled.	Not met. Transport via erosion possible.	Not met. Hg would remain subject to transport via erosion.	Met. Complies with standards.	No
Dredge/ Manage on site	Met. Exposure pathways eliminated.	Met. Sediments exceeding MPS excavated and placed in either Corrective Action Management Unit (CAMU) or consolidated under an impervious, engineered cap.	Met. Sediments exceeding MPS excavated and placed in either Corrective Action Management Unit (CAMU) or consolidated under an impervious, engineered cap.	Met. Complies with standards.	**Yes**
Dredge/Stabilize/Manageon site	Met. Exposure pathways eliminated.	Met. Sediments stabilized to prevent percolation and disposed in either Corrective Action Management Unit (CAMU) or consolidated with other remediation waste under an impervious, engineered cap.	Met. Sediments stabilized to prevent percolation and disposed in either Corrective Action Management Unit (CAMU) or consolidated with other remediation waste under an impervious, engineered cap.	Met. Complies with standards.	**Yes**
Dredge/Off-site Disposal	Met. Exposure pathways eliminated.	Met. Sediments disposed off-site in secure waste management facility.	Met. Releases controlled by sediment disposal to off-site secure waste management facility.	Met. Complies with standards.	**Yes**
Dredge/Stabilize/Off-site Disposal	Met. Exposure pathways eliminated.	Met. Sediments disposed off-site in a secure waste management facility.	Met. Releases controlled by stabilizing sediments and disposing in off-site, secure waste management facility.	Met. Complies with standards.	**Yes**
In-Situ DCT Treatment	Met. Exposure pathways eliminated.	Met. Intent of treatment is to achieve sediment PMPS in cove.	Met. Hg from the sediments will be collected at the electrodes which may be excavated and disposed either off-site or on-site.	Met. Complies with standards.	**Yes**

The dredging for each of the four alternatives would be accomplished using a combination of equipment, including low ground pressure earthmoving equipment employed at low water, and a floating dredge. The dredge spoils would be disposed of either off-site or managed on site. It is assumed for the purposes of the threshold screening that the on-site management would consist of consolidating and capping the soil with the excavated plant soils inside the proposed groundwater containment area. The cap system would be an engineered impermeable cap. Off-site disposal would involve trucking the soil from the site to a permitted disposal facility in compliance with applicable regulations.

3.8.2.2 Overall Protection of Human Health and the Environment

These alternatives would be protective of human health and the environment by removing the material exceeding the PMPS and therefore interrupting the pathways for exposure to aquatic biota, and subsequent bioaccumulation in the food chain. Dredged material would be consolidated and capped within the influence of the groundwater containment system. This would prevent direct contact with the waste material, erosion, and the transport of contaminants via groundwater.

3.8.2.3 Attainment of Media Cleanup Standards

These alternatives would result in the removal and management of sediment exceeding the PMPS. Therefore, this criterion is met.

3.8.2.4 Controlling the Source of Releases

These alternatives control the source of releases by removing sediment from the cove where it has the potential to be transported via river erosion.

3.8.2.5 Compliance with Applicable Waste Management Standards

These alternatives result in the consolidation of dredged material on site, which is in compliance with waste management standards. RCRA allows for and encourages appropriate used of the "Area of Contamination" approach to support appropriate remedies and expedite remedial actions. This concept provides for the consolidation of material within the area of contamination without that consolidation constituting disposal (Use of the Area of Contamination Concept During RCRA Cleanups, Michael Shapiro, Director, Office of Solid Waste, et al, March 13, 1996). Other waste streams generated during dredging and sediment processing would consist of wastewater generated by dewatering operations. The wastewater would likely be processed on site in the plant wastewater treatment system, which discharges under an NPDES permit.

3.8.2.6 Conclusion

These alternatives all meet the threshold screening criteria and are therefore retained for further evaluation.

3.8.3 In-Situ Treatment Using Direct Current Technology

3.8.3.1 Description of Alternative

This alternative involves the in-situ treatment of the Southern Cove sediments using direct current technology. This technology involves the placement of electrodes within the sediment and the introduction of electrical current to the soil via the electrodes. The process, if successful, mobilizes the mercury within the sediments and collects it at the electrodes. The process is described in more detail in Section 4 of this report.

3.8.3.2 Overall Protection of Human Health and the Environment

If successful, this alternative would result in the removal of mercury from the cove sediments such that the PMPS is achieved. The mercury would be collected by the electrodes, which would then be removed, and the mercury recovered for disposal. This technology has a limited track record of full-scale application. Its effectiveness is therefore considered uncertain. However this alternative, if successful, would be protective of humans and the environment.

3.8.3.3 Attainment of Media Cleanup Standards

The intent of this alternative is to recover mercury from the sediments such that the PMPS are met. As discussed above, the effectiveness of this technology in meeting the PMPs is uncertain. However, if the application of the technology is successful, this criterion would be met.

3.8.3.4 Controlling the Source of Releases

This alternative controls the source of releases by removing sediment from the cove where it has the potential to be transported via river erosion.

3.8.3.5 Compliance with Applicable Waste Management Standards

Waste generated from this process would consist of mercury-contaminated electrodes. These would be disposed of through a permitted retort facility in compliance with applicable regulations.

3.8.3.6 Conclusion

If applied successfully, this alternative would meet the threshold screening criteria and is therefore retained for further evaluation.

3.9 Groundwater

The results of the threshold screening for groundwater corrective measures are summarized in **Table 3-7**. A discussion of each alternative and the assessment of the threshold criteria significant to the screening results are provided below.

Table 3-7
Threshold Screening for Ground Water

Corrective Action Alternative	*Assessment of Threshold Criteria*				*Retained for Detailed Evaluation*
	Overall Protection of Human Health and the Environment	*Attainment of Media Cleanup Standards*	*Control of Sources of Releases*	*Compliance with Applicable Waste Management Standards*	
No Action/Monitor	Not met. Existing risk not controlled.	Not met. Hg contamination not removed from ground water.	Not met. Hg would remain subject to transport via percolation.	Met. Complies with standards.	No
Cutoff barrier/Extraction/ On-Site Ex-Situ Treatment and Discharge to NPDES Outfall	Met. Exposure pathways eliminated.	Met. MPS will be met by on-site, ex-situ treatment of ground water.	Met. Releases from GW controlled by extraction and ex-situ treatment of ground water.	Met. Complies with standards.	**Yes**
Cutoff barrier/Extraction/ Off-Site Treatment	Met. Exposure pathways eliminated.	Met. MPS will be met by off-site, ex-situ treatment of GW.	Met. Releases from GW controlled by extraction and off-site, ex-situ treatment of ground water.	Met. Complies with standards.	**Yes**
Cutoff barrier/Extraction/ On-Site Ex-Situ Treatment and Reinjection	Met. Exposure pathways eliminated.	Met. MPS will be met by on-site, ex-situ treatment of ground water.	Met. Releases from GW controlled by extraction and ex-situ treatment of ground water.	Met. Complies with standards.	**Yes**
Cutoff barrier/In-Situ Treatment	Met. Exposure pathways eliminated.	Met. MPS will be met by in-situ ground water treatment.	Met. Releases from GW controlled by in-situ ground water treatment.	Met. Complies with standards.	**Yes**

3.9.1 No Action

3.9.1.1 Description of Alternative

Under this alternative no treatment or controls would be applied to the site groundwater exceeding the PMPS. Groundwater monitoring would be performed to assess the rate and extent of the natural attenuation of contaminants.

3.9.1.2 Overall Protection of Human Health and the Environment

This alternative is not protective of human health and the environment, because the existing risks to humans, wildlife, and aquatic biota due to the discharge of mercury to the Penobscot River via groundwater are not controlled. Mercury, at concentrations exceeding the PMPS, would continue to migrate in groundwater from the plant area and Landfill 1 into the river.

3.9.1.3 Attainment of Media Cleanup Standards

This alternative would not manage groundwater exceeding the PMPS such that the corrective action objectives are met. Contaminants would not be removed from the groundwater and controls on groundwater exceeding PMPS would not be employed to eliminate the potential exposure pathways.

3.9.1.4 Controlling the Source of Releases

Groundwater contamination on site results from groundwater contacting residual soil contamination and from the past discharge of soluble contaminants directly to groundwater via spills or improper disposal. This alternative does not address the potential for continued release of contamination to groundwater from these residual sources, and therefore does not meet this threshold criterion.

3.9.1.5 Compliance with Applicable Waste Management Standards

This criterion is met because no remediation waste will be generated by the implementation of this alternative.

3.9.1.6 Conclusion

This alternative is not retained for further evaluation.

3.9.2 Containment and Treatment Alternatives

3.9.2.1 Description of Alternatives

The remainder of the groundwater corrective measures involve the construction of a cutoff barrier to collect and treat contaminated groundwater from the plant area. This groundwater containment system would prevent the release of contaminants from the site to surface water or to drinking water supplies.

Four containment and treatment alternatives are considered. One alternative includes on-site treatment of the extracted groundwater and discharge to the river via the existing NPDES outfall. The second groundwater cutoff alternative includes off-site treatment and disposal of the groundwater. The third alternative includes on-site treatment and reinjection of the groundwater. The fourth alternative includes in-situ treatment of the groundwater by means of a "funnel and gate" containment barrier combined with an adsorptive wall. These alternatives are described in more detail in Section 4. The threshold criteria assessment for the four alternatives are discussed together below, as the considerations for each alternative are very similar and results are of the assessment are essentially the same for each.

3.9.2.2 Overall Protection of Human Health and the Environment

This criterion is met for the groundwater containment alternatives because each one eliminates the potential pathways of exposure to humans and wildlife from the groundwater contaminants. These potential pathways consist of groundwater discharge to surface water and contamination of drinking water supplies. The intent of the containment system is to capture and pump contaminated groundwater such that it does not reach these receptors.

3.9.2.3 Attainment of Media Cleanup Standards

This criterion is met by the groundwater containment alternatives because each would manage the groundwater such that concentrations exceeding the PMPS would be captured and treated. For discharge to surface water, the groundwater will be treated to the NPDES permit limit. For reinjection to groundwater the treatment limit will be to the drinking water standard.

3.9.2.4 Controlling the Source of Releases

These alternatives control the source of releases by containing and treating contaminated groundwater such that it does not migrate to surface water or drinking water sources.

3.9.2.5 Compliance with Applicable Waste Management Standards

This criterion is met because no remediation waste will be generated by the implementation of this alternative.

3.9.2.6 Conclusion

These alternatives meet the threshold screening criteria and are retained for further evaluation.

3.10 Surface Water

3.10.1 Screening Results

The results of the threshold screening for the surface water corrective measures are summarized in **Table 3-8**. An assessment of the threshold criteria for each of the alternatives is provided.

Table 3-8
Threshold Screening for Surface Water Alternatives

Corrective Action Alternative	*Assessment of Threshold Criteria*				*Retained for Detailed Evaluation*
	Overall Protection of Human Health and the Environment	*Attainment of Media Cleanup Standards*	*Control of Sources of Releases*	*Compliance with Applicable Waste Management Standards*	
No Action/Monitor	Not met. Existing risk not controlled.	Not met. Concentrations exceeding PMPS still likely	Not met. Contamination subject to transport to and via surface water	Met. Complies with standards.	No
Paving (of surface water conveyances and/or contaminated soils)	Met. Exposure pathways eliminated.	Met. CAOs met through elimination of sources to SW	Met. Releases controlled by elimination of exposure to SW	Met. Complies with standards.	**Yes**
Capping (of surface water conveyances and/or contaminated soils)	Met. Exposure pathways eliminated.	Met. CAOs met through elimination of sources to SW	Met. Releases controlled by elimination of exposure to SW	Met. Complies with standards.	**Yes**
Groundwater Interceptor Trench	Met. Exposure pathways eliminated.	Met. CAOs met through elimination of sources to SW	Met. Releases controlled by elimination of exposure to SW	Met. Complies with standards (assumes soils do not exceed TCLP).	**Yes**
Pipe Lining (for industrial sewer)	Met. Exposure pathways eliminated.	Met. CAOs met through elimination of sources to SW	Met. Releases controlled by elimination of exposure to SW	Met. Complies with standards.	**Yes**
Pipe Removal/ Replacement (for industrial sewer)	Met. Exposure pathways eliminated.	Met. CAOs met through elimination of sources to SW	Met. Releases controlled by elimination of exposure to SW	Met. Complies with standards.	**Yes**
Pipe Cleaning (for industrial sewer)	Met. Exposure pathways eliminated.	Met. CAOs met through elimination of sources to SW	Met. Releases controlled by elimination of exposure to SW	Met. Complies with standards.	**Yes**
Pipe Plugging (for industrial sewer)	Met. Exposure pathways eliminated.	Met. CAOs met through elimination of sources to SW	Met. Releases controlled by elimination of exposure to SW	Met. Complies with standards.	**Yes**

Although the screening criteria were assessed for each of the potential surface water corrective measures, the actual corrective measures that are applicable to the individual surface water impacts are limited. For this reason, the discussion of the screening results is organized according to the surface water impacts to be corrected, and limited to the corrective actions applicable to each impact. The surface water impacts to be corrected consist of: the lined process lagoon, site runoff, and the industrial sewer discharge. A discussion of the threshold screening of the applicable corrective action(s) for each of these areas is discussed below.

3.10.2 Lined Process Lagoon

The lined process lagoon is an existing body of surface water containing mercury contamination exceeding the PMPS of 0.91 ug/l. This feature will be removed as part of the corrective action program. The surface water currently contained within the lagoon will be treated in the existing on-site wastewater treatment system, and the pond will be filled with clean material. No other alternatives for the lined pond will be retained for evaluation.

This corrective action meets the threshold screening criteria by removing the impounded water exceeding the PMPS, thereby preventing exposure to humans or wildlife, and eliminating the potential for future releases. The corrective measure is in compliance with waste management standards, since the water will be treated in the to meet the plant NPDES discharge limits.

3.10.3 Site Runoff

Stormwater runoff from the areas of the site containing soil above the PMPS has the potential to exceed the PMPS. However, the retained corrective measures for the soil and contamination areas all involve either excavation or capping of soils exceeding the PMPS. These corrective actions will prevent stormwater runoff from contacting contaminated soil, protecting surface water by preventing the migration of contaminants via runoff.

3.10.4 Industrial Sewer

As explained in Section 2, there appears to be an ongoing contribution of mercury to the industrial sewer flow between the wastewater treatment plant and the pH adjustment weir. This is attributed to either residual contamination inside the industrial sewer pipe, or to the infiltration of contaminated groundwater.

The overall corrective action program will most likely include the construction of a new groundwater treatment plant and decommissioning of the existing industrial wastewater treatment plant. This will also likely involve the construction of a new effluent pipe and abandonment of the portion of the industrial sewer currently used to convey treatment plant effluent.

The abandoned industrial sewers will be plugged to prevent discharge of potentially contaminated groundwater infiltration. This corrective action meets the threshold criteria because it controls the source of releases of contaminants to surface water, and attains the media protection standards by maintaining surface water contaminant levels below the PMPS. The alternative prevents exposure to humans and wildlife, and is in compliance with waste management standards, as no waste would be generated by the corrective action.

Section 4
Development of Retained Corrective Measures

4.1 Purpose of Section

The purpose of this section is to develop a conceptual-level description of each of the corrective action alternatives retained in the threshold-screening phase. The alternatives development will provide the level of detail necessary to assess the probable effectiveness, impacts, implementability, and cost of each retained alternative. The information developed in this section will be used to perform the detailed alternatives evaluation presented in Section 5.

4.2 General Considerations

4.2.1 Future Groundwater Controls

As discussed later in this section, each of the alternatives developed and evaluated for corrective actions to address groundwater include the capture and treatment of groundwater downgradient of the HoltraChem Plant and Landfill 1. The recommended alternative for groundwater corrective action will therefore include a barrier wall and groundwater pumping and treatment system. As a result, the development of corrective measures for sediment, soil, and surface water include the assumption that this groundwater barrier wall, collection, and treatment system will be included in the overall corrective action program.

4.2.2 Demolition of Plant Structures

The buildings, tanks, piping, and other miscellaneous equipment and structures comprising the HoltraChem Manufacturing Facility are not addressed by this corrective measures study. However, the development and evaluation of corrective measures for environmental media assume that the Cell Building and the brine process equipment and structures will be demolished and removed prior to execution of the corrective actions. Costs for building demolition and disposal are not included in the estimated cost for each corrective measure.

4.2.3 Corrective Measures Cost Estimates

This section presents cost estimates for each of the individual corrective measures. These estimates include the probable costs for construction, engineering design, and quality assurance inspection during construction. The estimates also include the probable present worth cost of operation, maintenance, and monitoring for a projected 30-year duration.

The estimates included in this report are considered “planning level” estimates and are sufficient for comparative analysis and budget planning purposes, but do not represent firm construction cost estimates. The levels of accuracy of these estimates

are such that the cost of construction would typically be in a range of "plus fifty percent to minus thirty percent" of the stated cost.

4.3 Corrective Measures for Soil

4.3.1 Grouping of Soil Areas for Alternatives Development and Evaluation

For the purpose of developing corrective measures for detailed evaluation, the various soil contamination areas have been consolidated into appropriate groups based on the nature of the soil contamination present, their location and hydrogeologic setting, and the applicable corrective actions. The resulting groups are as follows:

- **Cell Building and Plant area soils** –soils within the area of the manufacturing plant with contamination levels exceeding PMPSs, including the Cell Building soils, and including Landfill 1.

- **Landfills and landfill ridge area** - Landfills 2, 3, 4, and 5, and the fill area located north of Landfills 3 and 4.

- **Chloropicrin spill area** – soils in the area of the former chloropicrin spill with concentrations exceeding the PMPS for chloropicrin.

As discussed in Section 3, the sediment in the North Ditch and Southerly Stream are considered soil contamination areas for the purposes of this CMS. These two areas are considered part of the plant area soils.

4.3.2 Evaluation of Soil Treatment Technologies

As proposed in the CMS work plan, CDM evaluated applicable methods to treat Cell Building soils containing free mercury. The preferred treatment technologies resulting from this evaluation will be incorporated into the corrective action alternatives for the plant area soils. Only alternatives that were considered to be effective and have been demonstrated to be commercially viable were retained for further evaluation. The methods reviewed included technologies for in-situ and ex-situ treatment. The description of each technology considered, and the results of the evaluation are presented below.

4.3.2.1 Direct Current Technologies (DCTs)

Direct current technologies typically use a proprietary alternating current / direct current (AC / DC) power converter to pass a low voltage / low amperage electrical signal through the mercury-contaminated soil matrix via power electrodes. This induced signal generates reduction - oxidation (redox) reactions in the soil and leads to enhance metal mobilization. Ultimately, contaminants migrate towards and are deposited on the electrodes, which are then removed for ex-situ treatment (e.g., retorting or recycling). There are actual in-situ direct current technologies on the

market (i.e, electrokinetic-based Lasagna™), but these have not been tested for treating mercury-contaminated soil. Electrochemical Remediation Technology (ECRT) is another type of direct current technology that has had documented success in treating mercury-contaminated soil.

Effectiveness
Electrochemical treatment is an innovative technology but has not been demonstrated on a full-scale level for removal of mercury from soil. Weiss Associates, using a patented process from Europe, has documented success for a field demonstration in which mercury (both elemental and methylated) was removed from sediment in an open water canal (EPA 2002). They also report success for bench-scale testing in which mercury was removed from soil (Doering 2000). The technology has also been successful in separating other heavy metals from soil at a few sites. Based on limited results from other sites, ECRT could be an effective technology for concentrating subsurface mercury contamination. A treatability study would be required to demonstrate its effectiveness at the HoltraChem Site for recovering mercury in the soil and sediment.

Implementability
According to vendor information the technology can be implemented at the HoltraChem Site, but successful implementation is uncertain

Relative Cost
ECRT has moderate capital costs when compared to the other technologies considered, and no O&M costs.

4.3.2.2 Soil Flushing

Used in conjunction with pump-and-treat systems, in-situ soil flushing involves injection of chemicals in the soil matrix to enhance mercury solubility in groundwater, improving recovery rates of mercury from groundwater. This technology is generally limited to treatment of contaminants impacting groundwater in a dissolved form (e.g., $HgCl^-$, HgS) or as a non-aqueous phase liquid (e.g., elemental mercury).

Effectiveness
The technology has not been well demonstrated and the effectiveness is not known.

Implementability
This technology appears implementable as described in the literature. This conclusion is uncertain however, due to the lack of demonstrated projects.

Relative cost
Cost date for this technology is not available, but the implementation cost is expected to be high due to the reliance on a long-term pump and treat system for recovery of the dissolved mercury.

4.3.2.3 Vitrification

Vitrification is an in-situ method that uses electrically generated high temperature heat to immobilize inorganics (e.g., metals) by incorporating them into a chemically durable, leach resistant, vitreous mass. During this "melting" process, the increased temperature may also volatilize and/or destroy organic contaminants or volatile metal species (e.g., mercury) that must be captured or collected and treated separately. Vitrification can be carried out on excavated soils as well as in-situ, although in-situ processes are preferred due to the lower energy requirements and cost.

Effectiveness

This technology is effective in soils that have mixed wastes (i.e, organics and metals). It is most applicable to sites containing low-volatility metals with high glass solubilities, and is therefore unsuitable for treating mercury since it is highly volatile.

Implementability

Proximity to existing buildings makes this technology difficult to implement and the creation of secondary (off-gas) waste is also a concern.

Relative Cost

Vitrification has high capital costs, and no O&M costs.

4.3.2.4 In-Situ Stabilization/Solidification

In-situ stabilization/solidification generally involve using a stabilizing agent that is applied to the contaminated soil zone to bind the contaminants in place. The binding material (e.g. silica or cement-based, pozzolanic-based, proprietary agent, polymeric, or thermoplastic) is injected into the subsurface via a jet nozzle, or applied using large augers to mix the agent with the contaminated soil. For surface applications, the binding agent can be tilled into the soil matrix. The process immobilizes contaminants within the stabilized mass or binds them in place, thereby reducing their mobility (and their leaching potential).

Effectiveness

The process is effective in reducing the mobility of mercury in soil and sediment with a properly selected binder. However, soil with elemental mercury may be difficult to immobilize. Volume may increase from the addition of reagents. A treatability study would be required to determine the proper formula, in particular for soil with high mercury concentrations. Long-term monitoring would be required for this process to assess leaching into groundwater over time. It is not effective at reducing the toxicity or volume of contaminated soil or sediment.

Implementability

Various in-situ treatment techniques are available. In-situ mixing is less established than ex-situ techniques, primarily because specialized injection and mixing equipment must be used and homogeneous treatment is difficult to ensure.

Relative Cost
The cost of implementation of this alternative is typically low when compared to other in-situ techniques.

4.3.2.5 Retorting

Retorting is an ex-situ thermal heating and distilling process used to extract and recover liquid mercury from contaminated soils or debris via volatilization, cooling, and condensing. The recovered liquid mercury is distilled for purification and resold as product. Once retorted, the remaining material is tested to ensure that hazardous characteristics for mercury have been reduced below TCLP limits. The retorted material is then disposed of, or further treated, depending on the remaining hazardous characteristics.

Effectiveness
Retorting is a Best Demonstrated Available Technology (BDAT) for treating mercury-contaminated soil that is classified as RCRA D009 characteristic waste and has total mercury concentrations greater than 260 mg/kg.

Implementability
This technology is implementable. However, most off-site retort facilities are not configured to treat large quantities of soil, as it is generally not cost effective when compared to disposal in hazardous waste landfills outside the U.S.

Relative Cost
Costs for retort treatment are typically very high compared to other treatment technologies.

4.3.2.6 Ex-Situ Stabilization/Solidification

Ex-situ stabilization/solidification generally involves using a stabilizing agent that is applied to the excavated contaminated soil. Contaminated soil is first excavated, brought to the treatment area, is thoroughly mixed with the binding material (e.g. silica or cement-based, pozzolanic-based, proprietary agent, polymeric, or thermoplastic). The process immobilizes contaminants, thereby reducing their mobility (and their leaching potential).

The treated soil can be backfilled on-site or disposed off-site as hazardous or non-hazardous waste, depending on the TCLP results.

Effectiveness
The process is effective in reducing the mobility of mercury in soil and sediment with properly selected binder. The volume may increase from the addition of reagents. Many vendors with proprietary binding agents are available. A treatability study would be required to determine the proper formula, in particular for soil with high mercury concentrations. Long-term monitoring would be required for this process to assess leaching into groundwater over time. It is not necessarily effective at reducing the toxicity or volume of contaminated soil or sediment.

Implementability
Various vendors are available. However, soil with elemental mercury may be difficult to immobilize. Stabilization/solidification would not be allowed under land disposal regulations for soil with total mercury concentrations above 260 mg/kg.

Relative Cost
The cost for this alternative would typically be low when compared to other ex-situ methods.

4.3.2.7 Physical and Hydraulic Separation Methods

Physical or hydraulic separation would involve ex-situ treatment using one of several wet or dry methods for physically separating elemental mercury from soil, or for reducing the volume of contaminated soil. These methods include, soil washing, wet screening, dry screening, vibration, agitation, and centrifugation. These methods will remove most of the elemental mercury as a separate phase liquid, and may also separate the soil into course and fine fractions. Because most mercury compounds have a strong affinity for the fine fraction of soils, a significant reduction in the volume of contaminated soil can be achieved.

Hydraulic separation typically involves wet screening or soil washing. In wet screening, metallic mercury droplets behave as a separate liquid phase being concentrated in the fines. Rubble and coarse constituents of soils, such as gravel, are initially removed via sieving. Water is used to wash small to medium fractions (~50 mm to > 0.1 mm diameter). Fines (i.e., silts, clays or organics) are separated from the small to medium fractions. The fine fraction, which may contain most of the mercury, is dewatered and subsequently isolated for treatment (e.g., via thermal methods). The larger volume of soil (i.e., small to medium fraction and coarse constituents) can be used as backfill on-site if it meets the PMPS, or disposed as non-hazardous waste. Contaminated soil would likely be sent to a retorting facility or disposed of outside the United States. The wash water used is generally recycled in a closed loop system.

Effectiveness
These methods are effective in reducing the volume of contaminated soil requiring disposal. However, the process neither removes nor stabilizes contaminated mercury within the reduced soil volume. This technique is most effective for soils dominated by coarse materials (i.e., sand and gravel) with some (<20%) fines. The HoltraChem Site is predominantly comprised of sand and silt and therefore would possibly be amenable to such a technology. A sieve analysis and a treatability study would be required to confirm the effectiveness.

Implementability
Treatment by hydraulic or physical separation is technically and administratively feasible.

Relative Cost
Treatment by hydraulic or physical separation has a low to moderate capital cost when compared to other ex-situ technologies.

4.3.2.8 Acid Leaching

Acid leaching is an ex-situ chemical process used to extract mercury from soil using a strong acid to dissolve mercury from the soil medium. Leached mercury is then recovered through an electrolytic recovery system, and the resulting leachate is reprocessed through a granular activated carbon system, recycled, or disposed of. The processed soil is washed with water and air-dried.

Effectiveness
Acid leaching can yield treated soils with leachable concentrations of mercury less than the EPA hazardous waste criteria. Heavily contaminated soils may need to be processed more than once.

Implementability
Acid leaching is technically and administratively feasible. However, the creation of secondary waste streams adds complexity to the corrective action.

Relative Cost
The cost of acid leaching is typically high when compared to other ex-situ technologies.

4.3.2.9 Preferred Soil Treatment Technology

Based on the evaluation of the various treatment technologies discussed above, physical or hydraulic separation techniques would be the preferred treatment technology to be incorporated into the development and evaluation of corrective measures alternatives. These methods, when used to treat mercury-contaminated soil, are proven to be effective in recovering elemental mercury, and reducing the volume of soil exceeding the PMPS. The methods can be readily implemented using commonly available equipment, or experienced vendors. The technologies are also shown to be cost-effective when compared to the other methods considered.

4.3.3 Cell Building and Plant Area Soils

4.3.3.1 Alternatives Developed

As described in Section 2 of this report, there are seventeen distinct areas of soil contamination in the portion of the site referred to as the “plant area”. For the purposes of threshold screening, alternatives for corrective action to address the mercury-contaminated soils associated with the Cell Building were evaluated separately. In order to perform detailed evaluation of alternatives however, this section develops alternative concepts for an integrated approach to remediation of the plant area soils, since this is consistent with the way the corrective action program will most likely be implemented during construction. These integrated approaches

have been developed choosing appropriate combinations of corrective measures that meet the threshold screening criteria and achieve the corrective action objectives.

Six integrated corrective measures alternatives for the plant soils have been developed.

These alternatives are as follows:

Alternative 1: Consolidate the plant area soils inside the proposed groundwater capture area. Cap the consolidated soils with an impervious cap. Cap the Cell Building soils in place.

Alternative 2: Consolidate the plant area soils inside the proposed groundwater capture area. Cap the soils with an impervious cap. Excavate Cell Building soils and dispose of them off site.

Alternative 3: Consolidate the plant area soils inside the proposed groundwater capture area. Cap the soils with an impervious cap. Excavate and treat the Cell Building soils to remove elemental mercury. Dispose of the contaminated fraction of the treated soil off site, and place the clean fraction on site.

Alternative 4: Excavate the plant area soils and place in a lined management unit constructed on site. Excavate and treat Cell Building soils to remove elemental mercury. Dispose of the contaminated fraction of the treated soil off-site, and place the clean fraction in the on-site management unit.

Alternative 5: Excavate and dispose of the plant area soils off site. Excavate and treat Cell Building soils to remove elemental mercury. Dispose of the contaminated fraction of the treated soil off site, and place the clean fraction on site.

Alternative 6: Excavate and treat all plant area soils off site, including the Cell Building soils.

This section develops the alternatives to the level of detail necessary to perform the detailed evaluation and recommendation. Each alternative is discussed in more detail below.

4.3.3.2 Development of Cell Building and Plant Area Soils Alternative 1

The intent of this alternative is to meet the corrective action objectives by managing soil exceeding the PMPS using a containment strategy. The containment system includes an impermeable cap and the proposed groundwater containment system to eliminate the exposure pathways of direct contact, sediment transport via erosion, and groundwater migration.

The key elements of this alternative are described below.

Consolidation
All soils onsite and adjacent to the site will be vegetated, paired or otherwise stabilized to prevent erosion if mercury soil concentration exceeds the PMPS of 2.2 mg/kg. Further, to the extent practically soil will be excavated from areas that have been identified as exceeding the PMPS for mercury of 2.2 mg/kg, and moved to areas of consolidation within the zone of the groundwater containment and capture system. It is anticipated that approximately 33,000 cubic yards of material will be moved from the following areas:

- Used equipment storage area;
- Scrap metal and coal filter storage area;
- Fill area at Nitromethane Building;
- End of railroad car loading area;
- Leach fields #2 and #8;
- Surface soils in the vicinity of the plant;
- SSS-025 area;
- North Ditch fill area;
- North Ditch; and
- Southerly Stream.

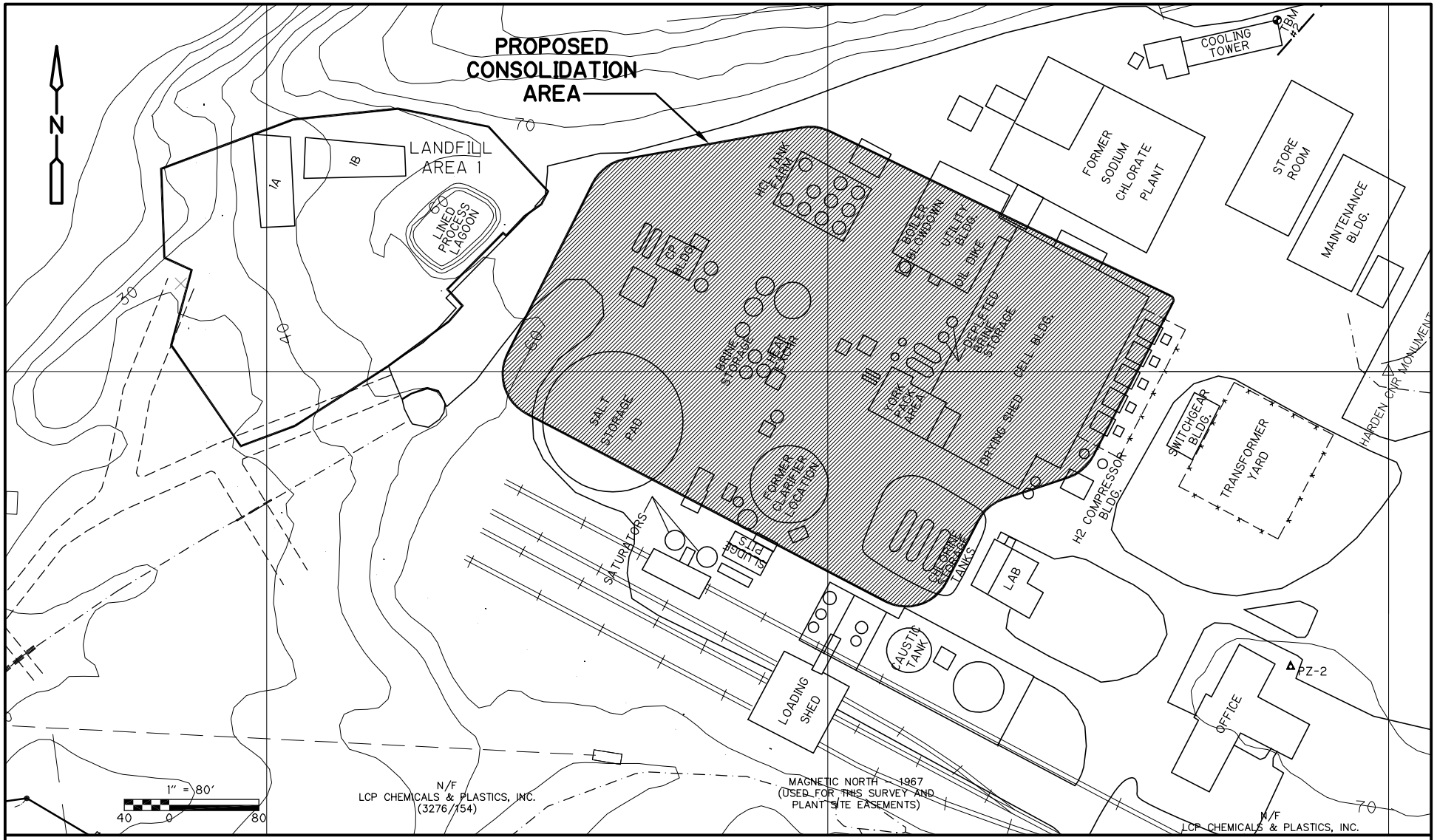
These soils will most likely, be placed and compacted in an area encompassing the footprint of the Cell Building and the mercury-contaminated soils at the retort building, as shown in **Figure 4-1**. Existing pavement, and aboveground structures will be removed prior to placement of the consolidated material.

As discussed in Section 3, the PCB contaminated soil at the transformer area will be excavated and disposed of separately at an off-site disposal facility.

The material comprising Landfill 1, which is in this area, will remain in place, as this landfill already has an impermeable cap, and lies within the groundwater containment system. The Cell Building soils will not be moved or excavated under this alternative.

Capping
The consolidated soil will be compacted, graded for positive drainage, and capped with an engineered soil cap incorporating an impermeable membrane. The cap surface will be vegetated with native grass species.

Site Restoration
After consolidation of soil is accomplished, areas of soil removal will be graded to promote positive drainage. A vegetated soil cover will then be established over all disturbed areas. For the North Ditch and Southerly Stream, the channels will be



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CORRECTIVE MEASURES STUDY

PROPOSED LOCATION OF CONSOLIDATION AREA FOR PLANT SOILS

CDM

FIGURE 4-1

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restored using either grass-lined swales, or riprap, depending on the channel slope, to prevent erosion.

Operation and Maintenance
After construction of this alternative is completed, maintenance and monitoring will be performed consisting of:

- Periodic inspection of the consolidation area cap system,
- Seasonal mowing of the cap area, and
- Groundwater monitoring as discussed later in this section to confirm the effectiveness of the groundwater containment system.

Estimated Cost
The total estimated cost of this alternative is $5,200,000. This estimated cost consists of:

Construction	$4,150,000
Engineering	$850,000
Operation and Maintenance	$200,000
Total	**$5,200,000**

4.3.3.3 Development of Cell Building and Plant Area Soils Alternative 2

The intent of this alternative is to meet the corrective action objectives by managing soil exceeding the PMPS using a strategy of containment combined with source removal. The containment system includes an impermeable cap and the proposed groundwater containment system to eliminate the exposure pathways of direct contact, sediment transport via erosion, and groundwater migration. Source removal includes the excavation and off-site disposal of soil from the Cell Building area contaminated with elemental mercury. The key elements of this alternative are described below.

Excavation and Disposal of Cell Building Soils
After demolition of the Cell Building, soil beneath and around the perimeter of the building containing visual evidence of free elemental mercury contamination would be excavated to the extent practicable loaded into trucks and transported to a licensed off-site disposal facility. This would include, at a minimum, excavation of soil down to the till layer at the brine receiver area and beneath the cell building sump, as evidence of free mercury has been noted at these locations in the past. Approximately 12,000 cubic yards of soil associated with the Cell Building is potentially contaminated with mercury.

This operation would involve temporary stockpiling of excavated material for testing and loading. Transportation would likely involve the use of 20 cubic yard capacity

dump trucks, resulting in approximately 600 round trips between the site and the disposal facility.

Consolidation, Capping, Site Restoration, and Operation and Maintenance
These elements of the corrective action alternative will be essentially the same as for Plant Soils Alternative 1. Approximately 33,000 cy of mercury contaminated soil will be moved and consolidated within the groundwater containment system above the seasonally high groundwater table and capped as described above.

Estimated Cost
The estimated cost of this alternative is $18,800,000. The significant increase in cost of this alternative over Alternative 1 is primarily due to the cost of excavation, transportation and off-site disposal of the Cell Building soils. This cost is based on the assumption that the Cell Building soils would be disposed of at a hazardous waste landfill in Canada. The costs would be significantly higher if the soil is sent to a retorting facility. This estimated cost consists of:

Construction	$16,300,000
Engineering	$2,400,000
Operation and Maintenance	$100,000
Total	**$18,800,000**

4.3.3.4 Development of Cell Building and Plant Area Soils Alternative 3

The intent of this alternative is to meet the corrective action objectives by managing soil exceeding the PMPS using a strategy of containment combined with source removal. This alternative also employs treatment for removal of elemental mercury from the Cell Building soils to reduce the volume of material requiring off-site disposal. The key elements of this alternative are described below.

Excavation, Treatment, and Disposal of Cell Building Soils
After demolition of the Cell Building, soil beneath and around the perimeter of the building containing visual evidence of free elemental mercury contamination would be excavated to the extent practical considering groundwater condition, and treated to remove the free mercury. In addition, the brine receiver area on the west side of the Cell Building and the area beneath the Cell Building sumps will be excavated to the level of the till layer, as evidence of free mercury contamination has been noted at these areas in the past. Approximately 12,000 cubic yards of soil beneath and around the perimeter of the Cell Building is potentially contaminated with elemental mercury from historic discharges.

As discussed earlier in this section, the preferred method of treatment is by hydraulic or physical separation methods. This would involve mobilization of the separation equipment, visual segregation and stockpiling of soil for treatment, treatment of the soil, and stockpiling the treated soil. Recovered mercury from the process will be disposed of through a licensed retort facility. A waste stream consisting fine fractions

of the treated soil may be produced and would be disposed of off site. This would most likely involve disposal at a hazardous waste landfill outside the U.S., but may also involve disposal at a licensed retort facility. Assuming that this waste stream may represent 20 percent of the original soil volume, this would result in approximately 2,400 cy of material requiring off-site disposal, and would result in approximately 120 truck round trips between the site and the disposal facility.

The treated soil would be consolidated inside the groundwater containment system and capped with the other plant area soils. This would likely include replacement of the treated soil within the Cell Building excavation.

Consolidation, Capping, Site Restoration, and Operation and Maintenance
These elements of the corrective action alternative will be essentially the same as for Plant Soils Alternative 2. Approximately 43,000 cy of mercury-contaminated soil will be consolidated within the groundwater containment system and capped as described for Alternatives 2. Approximately 10,000 cy of this material will be treated cell building soil. If this material meets the PMPS of 2.2 mg/kg, it will be placed in the cell building excavation. The remainder of the soil will be placed above the seasonal high groundwater table.

Estimated Cost
The estimated cost of this alternative is $12,100,000. This represents a cost savings over Alternative 2 due to the anticipated reduction in the volume of soil requiring off site disposal. This estimated cost consists of:

Construction	$10,000,000
Engineering	$2,000,000
Operation and Maintenance	$100,000
Total	**$12,100,000**

4.3.3.5 Development of Cell Building and Plant Area Soils Alternative 4

The intent of this alternative is to meet the corrective action objectives by managing soil exceeding the PMPS using a strategy of containment. The containment will be accomplished by placing soil from areas identified as exceeding the PMPS for mercury in a lined management unit. This management unit would meet the technical requirements for a RCRA Subtitle C hazardous waste landfill.

The key elements of this alternative are described below.

Regulatory Considerations
This alternative includes construction of a management unit in a previously unaffected area outside the footprint of the contaminated soil areas. The management unit is likely to be considered a Corrective Action Management Unit (CAMU) under the RCRA regulations, rather than consolidation of an area of contamination. Consequently, this alternative would likely require treatment of soil excavated from the Cell Building area, since some samples taken from this area exceed 260 mg/kg.

Soil with mercury concentrations exceeding this criteria are subject to RCRA land disposal restrictions and therefore must be treated by retort, or disposed of outside the U.S.

Construction of Lined Management Unit
The lined management unit would most likely be constructed on a wooded area of the property east of the plant and north of the nitromethane building as shown in **Figure 4-2**.

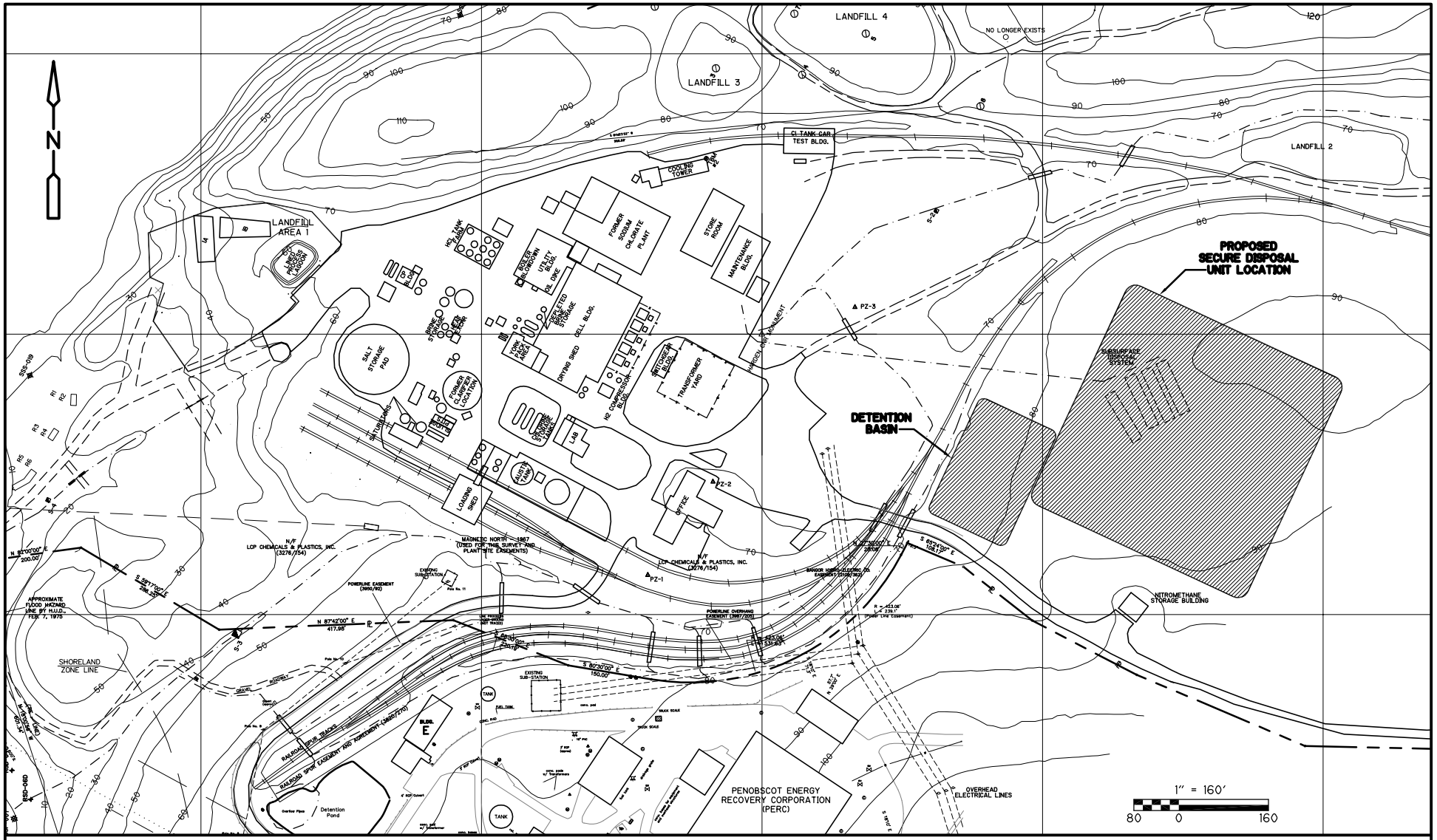
Construction would involve the following elements:

- Clearing, and grading approximately 10 acres of woodland;
- Construction of the base, liner, and berm system;
- Installation of leachate collection piping, leachate collection tank and pumping system;
- Construction of stormwater swales and detention basin;
- Construction of an access road;
- Placement of the waste within the unit;
- Final grading of the waste surface; and
- Construction of the cap and gas venting system.

The management unit liner system would consist of a double layer impermeable composite liner. The cap system would consist of a sand venting layer, impermeable layer incorporating a synthetic membrane, soil protection layer, and topsoil for support of vegetation. The design of the liner and cap systems would conform to RCRA Subtitle C requirements.

Excavation, Treatment, and Placement of Cell Building Soils
After demolition of the Cell Building, soil beneath and around the perimeter of the building containing visual evidence of free elemental mercury contamination would be excavated and treated to remove the free mercury. This would include at a minimum, excavation beneath the brine receiver area and Cell Building sump, as discussed for Alternative 3.

Approximately 12,000 cubic yards of soil beneath and around the perimeter of the Cell Building is potentially contaminated with elemental mercury from historic discharge.



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PROPOSED LOCATION OF SECURE MANAGEMENT UNIT

CDM

FIGURE 4-2

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As discussed for Alternative 3, the preferred method of treatment is by hydraulic or physical separation methods. The contaminated fine soil fraction would be disposed of at a hazardous waste landfill outside the U.S., but may also involve disposal at a licensed retort facility. Using a general assumption that this waste stream may represent 20 percent of the original soil volume, this would result in approximately 2,400 cy of material requiring off-site disposal, and would result in approximately 120 truck round trips between the site and the disposal facility. The remainder of the treated soil would be placed in lifts and compacted within the on-site management unit, or could be placed in the cell building excavation if it meets the 2.2 mg/kg PMPS.

Excavation and Placement of Other Plant Area Soils

Soil will be excavated to the extent practical considering groundwater condition, from areas that have been identified as exceeding the PMPS for mercury of 2.2 mg/kg, and moved to the management unit.

It is anticipated that approximately 35,000 cubic yards of material will be moved from the following areas:

- Retort Building;
- Used equipment storage area;
- Scrap metal and coal filter storage area;
- Fill area at Nitromethane Building;
- End of railroad car loading area;
- Leach fields No. 2 and No. 8;
- Surface soils in the vicinity of the plant;
- SSS-025 area;
- North Ditch fill area;
- North Ditch; and
- Southerly Stream.

These soils will be excavated and placed in compacted lifts in the on-site management unit. After placement of all the soil, the management unit capping system would be constructed as described above.

Site Restoration

After excavation and placement of the plant area soils in the management unit, areas of soil removal will be graded to promote positive drainage. A vegetated soil cover will then be established over all disturbed areas. For the North Ditch and Southerly Stream, the channels will be restored using either grass-lined swales, or riprap, depending on the channel slope, to prevent erosion.

Operation and Maintenance

After construction of this alternative is completed, maintenance and monitoring will be performed consisting of:

- Collection and treatment or disposal of leachate,
- Periodic inspection of the management unit cap system,
- Seasonal mowing of the cap area, and
- Groundwater monitoring.

Estimated Cost
The estimated cost of this alternative is $16,500,000. This estimated cost consists of:

Construction	$13,800,000
Engineering	$2,600,000
Operation and Maintenance	$100,000
Total	**$16,500,000**

4.3.3.6 Development of Cell Building Plant Area Soils Alternative 5

The intent of this alternative is to meet the corrective action objectives by managing soil exceeding the PMPS using off-site disposal. The alternative also employs treatment of the Cell Building soils to reduce the volume of hazardous waste requiring disposal.

The key elements of this alternative are described below.

Excavation, Treatment, and Off-Site Disposal of Cell Building Soils
After demolition of the Cell Building, soil beneath and around the perimeter of the building containing visual evidence of free elemental mercury contamination would be excavated to the extent practicable and treated to remove the free mercury. This would include at a minimum, excavation of the brine receiver area and Cell Building sump, as discussed for Alternatives 3 and 4.

This element of the corrective action alternative is essentially the same as for Alternative 4 above, except that the cleaned fraction of soil resulting from the treatment operations would be disposed of off site in a licensed industrial waste landfill. The contaminated fine soil fraction would be disposed of at a hazardous waste landfill outside the U.S., but may also involve disposal at a licensed retort facility.

In total, approximately 12,000 cubic yards of soil would require off-site disposal. Assuming 20 cubic yard capacity trucks are used, this would result in approximately 600 truck round trips between the site and the disposal facilities.

If the level of treatment reached is sufficient to produce soil that meets the media protection standards, replacement of the cleaned soil within the Cell Building excavation may also be performed.

Excavation and Disposal of Plant Area Soils
This element of the corrective action is essentially the same as Alternative 4, except that the excavated soil would be transported and disposed of in a licensed off-site industrial waste landfill. It is anticipated that approximately 35,000 cubic yards of material will be excavated from these areas.

This operation would involve temporary stockpiling of excavated material for testing and loading. Transportation would likely involve the use of 20 cubic yard capacity dump trucks, resulting in approximately 1,800 round trips between the site and the disposal facility.

Site Restoration
After excavation and placement of the plant area soils in the management unit, areas of soil removal will be graded to promote positive drainage. A vegetated soil cover will then be established over all disturbed areas.

For the north ditch and southerly stream, the channels will be restored using either grass-lined swales, or riprap, depending on the channel slope, to prevent erosion.

Operation and Maintenance
After the vegetated cover over the excavation areas and drainage channels is established, no operations or maintenance activities are necessary for this alternative.

Estimated Cost
The estimated cost of this alternative is $17,000,000. This estimated cost consists of:

Construction	$15,000,000
Permitting and Design	$2,000,000
Operation and Maintenance	$0
Total	**$17,000,000**

4.3.3.7 Development of Cell Building and Plant Area Soils Alternative 6

The intent of this alternative is to meet the corrective action objectives by managing soil exceeding the PMPS using off-site disposal. The key elements of this alternative are described below.

Excavation and Off-Site Disposal of Cell Building Soils
After demolition of the Cell Building, soil beneath and around the perimeter of the building containing visual evidence of free elemental mercury contamination would be excavated to the extent practicable, and disposed of in a licensed off-site disposal facility. This would include at a minimum, soil from beneath the brine receiver area and Cell Building sump, as discussed for Alternatives 3, 4, and 5. During excavation the soil would be segregated based on indications of contamination, such as visible elemental mercury, or field screening for mercury vapor. The excavated soil would be stockpiled, tested for disposal, and disposed of according to its level of mercury contamination. Soil that is determined to be hazardous waste due to mercury

contamination would be disposed of at a hazardous waste landfill outside the U.S., but may also involve disposal at a licensed retort facility. Soil that is not hazardous waste, but exceeds the PMPS of 2.2 mg/kg of mercury would be disposed of in an industrial waste landfill.

In total, approximately 12,000 cubic yards of soil would require off-site disposal. Assuming 20 cubic yard capacity trucks are used, this would result in approximately 600 truck round trips between the site and the disposal facilities.

Excavation and Disposal of Plant Area Soils
This element of the corrective action is essentially the same as Alternative 5. Soil from areas exceeding the PMPS of 2.2 mg/kg of mercury would be transported and disposed of in a licensed off-site industrial waste landfill. It is anticipated that approximately 36,000 cubic yards of material will be excavated from these areas.

This operation would involve temporary stockpiling of excavated material for testing and loading. Transportation would likely involve the use of 20 cubic yard capacity dump trucks, resulting in approximately 1,800 round trips between the site and the disposal facility.

Site Restoration
After excavation and placement of the plant area soils in the management unit, areas of soil removal will be graded to promote positive drainage. A vegetated soil cover will then be established over all disturbed areas. For the north ditch and southerly stream, the channels will be restored using either grass-lined swales, or riprap, depending on the channel slope, to prevent erosion.

Operation and Maintenance
After the vegetated cover over the excavation areas and drainage channels is established, no operations or maintenance activities are necessary for this alternative.

Estimated Cost
The estimated cost of this alternative is $24,800,000. The increase in cost for this alternative when compared to Alternative 5 results from eliminating the treatment of Cell Building soils, which increases the amount of material assumed to require hazardous waste disposal. This estimated cost consists of:

Construction	$24,100,000
Engineering	$700,000
Operation and Maintenance	$0
Total	**$24,800,000**

4.3.4 Landfills and Landfill Ridge Area Soil

4.3.4.1 Alternatives Developed

As discussed in Section 3, Landfills 1, 3, 4, and 5 have been capped with an impervious geomembrane capping system, will not have waste in contact with groundwater, and will be the subject of long-term groundwater monitoring. Therefore, the PMPSs and corrective action objectives for these landfills are adequately addressed without additional corrective action. The development of corrective measures for detailed evaluation is therefore not necessary for Landfills 1, 3, 4, and 5.

The remaining areas with soil exceeding the PMPS of 2.2 mg/kg include Landfill 2 and the fill material in the former gravel pit at the landfill ridge area. This section includes the development of appropriate alternatives for corrective action at these locations. However, for the purpose of comparison, the impacts and costs of removing the other landfills are summarized later in this section.

Five alternatives met the threshold screening criteria. These alternatives are as follows:

Alternative 1: No Action combined with groundwater monitoring to confirm contaminants do not migrate via groundwater.

Alternative 2: Cap Landfill 2 and the landfill ridge area soils with an impermeable engineered cap system. Monitor groundwater.

Alternative 3: Consolidate Landfill 2 and the landfill ridge area soils into the plant area inside the proposed groundwater containment and treatment system. Cap the consolidated soils with an impermeable engineered cap system.

Alternative 4: Excavate Landfill 2 and the landfill ridge area soils and place it in a lined management unit constructed on site.

Alternative 5: Excavate Landfill 2 and the landfill ridge area soils and dispose of it in a licensed off-site disposal facility.

This section develops the alternatives to the level of detail necessary to perform the detailed evaluation and recommendation. Each alternative is discussed in more detail below.

4.3.4.2 Development of Landfills and Landfill Ridge Area Soil Alternative 1

The intent of this alternative is to meet the corrective action objectives by managing soil exceeding the PMPS using a containment strategy. Containment is achieved through the existing soil covers. The containment system is monitored by groundwater testing directly downgradient of the two locations to confirm that

contaminants do not migrate from the locations via groundwater. This alternative is based on recent data that indicates that groundwater has not been impacted at these locations. This alternative is also relies on the existing soil covers over these areas to continue to prevent direct contact with the contaminated soil and migration of contaminants via erosion. The key elements of this alternative are described below.

Operation and Maintenance

A vegetated soil cover over the areas has already been established. Operation and maintenance will consist of seasonal mowing to maintain the grass cover, and long-term groundwater monitoring. Groundwater monitoring will consist of sampling from existing wells adjacent to each area. A 30-year monitoring duration is assumed.

Estimated Cost

The estimated cost of this alternative is $1,000,000. This estimated cost consists of:

Construction	$0
Engineering	$0
Operation and Maintenance	$1,000,000
Total	**$1,000,000**

4.3.4.3 Development of Landfills and Landfill Ridge Area Soil Alternative 2

The intent of this alternative is to meet the corrective action objectives by managing soil exceeding the PMPS using a containment strategy. The containment system includes an impermeable cap to prevent migration of contaminants due to percolation of rainfall and snowmelt. The containment system is monitored by groundwater testing directly downgradient of the two locations to confirm that contaminants do not migrate from the locations via groundwater. This alternative is based on recent data that indicates that groundwater has not been impacted at these locations.

The key elements of this alternative are described below.

Capping

An impermeable cap system would be installed over the contaminated soil areas. This cap system would incorporate a geosynthetic membrane layer, soil protection layer, and a vegetation support (topsoil) layer. The cap surface would be vegetated with native grass species. Elements will be incorporated into the corrective action design to divert groundwater and surface water away from the landfill to the extent practical.

Operation and Maintenance

Operation and maintenance will consist of seasonal mowing to maintain the grass cover, and long-term groundwater monitoring. Groundwater monitoring will consist of sampling from existing wells adjacent to each area. A 30-year monitoring duration is assumed.

Estimated Cost
The estimated cost of this alternative is $1,900,000. This estimated cost consists of:

Construction	$750,000
Engineering	$150,000
Operation and Maintenance	$1,000,000
Total	**$1,900,000**

4.3.4.4 Development of Landfills and Landfill Ridge Area Soil Alternative 3

The intent of this alternative is to meet the corrective action objectives by managing soil exceeding the PMPS using a containment strategy. The containment system includes an impermeable cap and the proposed groundwater containment system to eliminate the exposure pathways of direct contact, sediment transport via erosion, and groundwater migration.

The key elements of this alternative are described below.

Consolidation
Soil will be excavated from the landfill ridge area and Landfill 2, and moved to the plant area within the zone of the proposed groundwater containment and capture system. Approximately 44,000 cubic yards of material would be moved based on preliminary estimates.

These soils would most likely be placed and compacted in an area encompassing the footprint of the Cell Building and the mercury-contaminated soils at the Retort Building. Existing pavement, and aboveground structures will be removed prior to placement of the consolidated material.

Capping
The consolidated soil will be compacted, graded for positive drainage, and capped with an engineered soil cap incorporating an impermeable membrane. The cap surface will be vegetated with native grass species.

Site Restoration
After consolidation of soil is accomplished, areas of soil removal will be graded to promote positive drainage. A vegetated soil cover will then be established over all disturbed areas.

Operation and Maintenance
After construction of this alternative is completed, maintenance and monitoring will be performed consisting of:

- Periodic inspection of the consolidation area cap system,
- Seasonal mowing of the cap area, and

- Groundwater monitoring as discussed later in this section to confirm the effectiveness of the groundwater containment system.

Estimated Cost
The estimated cost of this alternative is $2,700,000. This estimated cost consists of:

Construction	$2,400,000
Engineering	$300,000
Operation and Maintenance	$0
Total	**$2,700,000**

4.3.4.5 Development of Landfills and Landfill Ridge Area Soil Alternative 4

The intent of this alternative is to meet the corrective action objectives by managing soil from these locations using a strategy of containment. The containment will be accomplished by placing the soil in a lined management unit. This management unit would meet the technical requirements for a RCRA Subtitle C hazardous waste landfill.

The key elements of this alternative are described below.

Regulatory Considerations
This alternative includes construction of an engineered management unit in a previously unaffected area outside the footprint of the contaminated soil areas. The management unit is likely to be considered a corrective action management unit (CAMU) under the RCRA regulations, rather than consolidation of an area of contamination. Consequently, this alternative would require treatment of soil that exceeds hazardous waste criteria for mercury. Data from the landfill ridge area indicates that this soil would likely not exceed the hazardous waste criteria, but very little information is available regarding the concentrations of mercury in Landfill 2. This alternative has been developed based on the assumption that treatment would not be necessary for the material excavated from Landfill 2.

Construction of Lined Management Unit
The lined management unit would be constructed on a wooded area of the property east of the plant and north of the Nitromethane Building. Construction would involve the following elements:

- Clearing, and grading approximately 10 acres of woodland;
- Construction of the base, liner, and berm system;
- Installation of leachate collection piping, leachate collection tank and pumping system;
- Construction of stormwater swales and detention basin;

- Construction of an access road;
- Placement of the waste within the unit;
- Final grading of the waste surface; and
- Construction of the cap and gas venting system.

The management unit liner system would consist of a double layer impermeable composite liner. The cap system would consist of a sand venting layer, impermeable layer incorporating a synthetic membrane, soil protection layer, and topsoil for support of vegetation. The design of the liner and cap systems would conform to RCRA Subtitle C requirements.

Excavation and Placement in Management Unit
Material from the landfill ridge area and Landfill 2 exceeding the PMPS for mercury of 2.2 mg/kg would be excavated and placed in the management unit. Approximately 44,000 cubic yards of material would be moved based on preliminary estimates. These soils will be excavated and placed in compacted lifts in the on-site management unit. After placement of all the soil, the management unit capping system would be constructed as described above.

Site Restoration
After soil excavation is completed, areas of soil removal will be graded to promote positive drainage. A vegetated soil cover will then be established over all disturbed areas.

Operation and Maintenance
After construction of this alternative is completed, maintenance and monitoring will be performed consisting of:

- Collection and treatment or disposal of leachate;
- Periodic inspection of the management unit cap system;
- Seasonal mowing of the cap area; and
- Groundwater monitoring.

Estimated Cost
The estimated cost of this alternative is $4,000,000. This estimated cost consists of:

Construction	$3,600,000
Engineering	$400,000
Operation and Maintenance	$0
Total	**$4,000,000**

4.3.4.6 Development of Landfills and Landfill Ridge Area Soil Alternative 5

The intent of this alternative is to meet the corrective action objectives by managing soil from the landfill ridge area and Landfill 2 using off-site disposal. The key elements of this alternative are described below.

Excavation and Off-Site Disposal

Material from the landfill ridge area and Landfill 2 exceeding the PMPS for mercury of 2.2 mg/kg would be excavated and disposed of in licensed off-site disposal facilities. The excavated soil would be stockpiled, tested for disposal, and disposed of according to its level of mercury contamination. Soil that is determined to be hazardous waste due to mercury contamination would be disposed of at a hazardous waste landfill outside the U.S., but may also involve disposal at a licensed retort facility. Soil that is not hazardous waste, but exceeds the PMPS of 2.2 mg/kg of mercury would be disposed of in an industrial waste landfill.

Approximately 44,000 cubic yards of material would be moved based on preliminary estimates. Assuming 20 cubic yard capacity trucks are used, this would result in approximately 2,200 truck round trips between the sites and the disposal facilities.

Site Restoration

After soil excavation is completed, areas of soil removal will be graded to promote positive drainage. A vegetated soil cover will then be established over all disturbed areas.

Operation and Maintenance

No operations or maintenance activities are necessary for this alternative.

Estimated Cost

The estimated cost of this alternative is $25,400,000. This estimated cost consists of:

Construction	$25,000,000
Engineering	$400,000
Operation and Maintenance	$0
Total	**$25,400,000**

4.3.4.7 Removal of Landfills 1,2,3,4 and 5

The removal of Landfills 1, 3, 4 and 5 are not included in the alternative developed for the landfills and landfill ridge area, for the reasons stated in Section 3.4.2. However, the cost, comparative emissions impacts, and the truck traffic impacts of removing all of the landfills have been estimated for the purposes of comparison.

The estimated cost of excavating landfills 1, 2, 3, 4 and 5 and disposing the material in a licensed disposal facility would be in the range of $60 million to $90 million. This estimated cost assumes that the material would be excavated, loaded, and trucked to a hazardous waste landfill outside the US. Approximately 92,000 cubic yards of

material from these landfills would require disposal under this scenario. At approximately 20 cubic yards per truck, this would require approximately 4,600 truck roundtrips to and from the site through the surrounding community. Excavating and loading this large volume of waste would result in the potential for significant mercury air emissions and use a greater exposure through potential accidents with the truck traffic. A comparison of relative emissions rates from the various soil corrective measures is discussed in Section 4.3.6. As illustrated by this comparative estimate, the removal of all of the landfills would have approximately twice the potential total mercury air emissions than the on-site consolidation of Landfill 2 and the Landfill Ridge Area, and more than three times higher than the cell building soils alternative with the highest emissions potential.

4.3.5 Chloropicrin Spill Area Soil

4.3.5.1 Alternatives Developed

As discussed in Section 3, four alternatives for corrective action to address the chloropicrin spill area met the threshold screening criteria. These alternatives are as follows:

Alternative 1: No Action combined with the proposed groundwater containment and treatment system.

Alternative 2: Construct an engineered membrane cap system over the spill area.

Alternative 3: Treat the contaminated soil using in-situ chemical oxidation.

Alternative 4: Treat the contaminated soil using soil vapor extraction combined with vapor phase treatment.

This section develops the alternatives to the level of detail necessary to perform the detailed evaluation and recommendation. Each alternative is discussed in more detail below.

4.3.5.2 Development of Chloropicrin Spill Area Soil Alternative 1

The intent of this alternative is to meet the corrective action objectives by managing soil exceeding the PMPS for chloropicrin using a containment strategy. The containment relies on the fact that the contaminated soil is approximately 6 to 8 ft below the ground surface, which eliminates the exposure pathways of direct contact and sediment transport via erosion. The containment also relies on the proposed groundwater containment system to eliminate the exposure pathway of and through groundwater migration. Additionally, natural attenuation processes will be instrumental in removing chloropicrin contamination from the soils.

The key elements of this alternative are described below:

Operation and Maintenance
This would consist of sampling and analysis for chloropicrin as part of the groundwater-monitoring program that would be performed as part of the groundwater containment system-monitoring program.

This program is discussed later in this section as part of the development of groundwater corrective action alternatives.

Estimated Cost
The estimated cost of this alternative is $300,000. This estimated cost consists of:

Construction	$0
Engineering	$0
Operation and Maintenance	$300,000
Total	**$300,000**

4.3.5.3 Development of Chloropicrin Spill Area Soil Alternative 2

The intent of this alternative is to meet the corrective action objectives by managing soil exceeding the PMPS for chloropicrin using a containment strategy. The alternative incorporates an engineered impermeable cap system to prevent direct contact and contaminant migration via erosion. The containment also relies on the proposed groundwater containment system to eliminate the exposure pathway of and through groundwater migration.

The key elements of this alternative are described below.

Capping
An impermeable cap system would be installed over the area with soil exceeding the Chloropicrin PMPS of 0.125 mg/kg. This cap system would incorporate a geosynthetic membrane layer, soil protection layer, and a vegetation support (topsoil) layer. The cap surface would be vegetated with native grass species.

Operation and Maintenance
Operation and maintenance will consist of seasonal mowing to maintain the grass cover, and long-term groundwater monitoring. This would consist of sampling and analysis for chloropicrin as part of the groundwater-monitoring program that would be performed as part of the groundwater containment system-monitoring program. This program is discussed later in this section as part of the development of groundwater corrective action alternatives.

Estimated Cost
The estimated cost of this alternative is $400,000. This estimated cost consists of:

Construction	$70,000
Engineering	$30,000
Operation and Maintenance	$300,000
Total	**$400,000**

4.3.5.4 Development of Chloropicrin Spill Area Soil Alternative 3

The intent of this alternative is to meet the corrective action objectives using in-situ treatment to reduce the concentrations of chloropicrin in the soil. Treatment would involve the introduction of hydrogen peroxide into the subsurface to oxidize the chloropicrin.

The key elements of this alternative are described below.

In-Situ Oxidation

This would involve of the construction of chemical injection trenches, piping, and storage tank. The conceptual remediation system would consist of the installation of three 90-ft long shallow trenches for the injection of the chemicals into the subsurface. The trenches would be approximately 3 feet wide by 5 feet deep, backfilled with pea gravel and covered with an impermeable polyethylene sheet. Perforated piping would be installed in the trenches and would be connected to an above ground-piping manifold. A 10,000-gallon HDPE storage tank and associated piping would supply the chemical to the subsurface. The chemicals would be injected via gravity into the trenches. It is anticipated that chemical injection would be conducted approximately four times a year for a period of up to 3 years. The expected end products for chemical oxidation would be carbon dioxide, water, chloride and nitrate ions. Soil samples would be obtained to confirm the reduction in chloropicrin concentrations to below the PMPS.

Operation and Maintenance

After termination of the treatment process, no operations and maintenance is necessary for this alternative.

Estimated Cost

The estimated cost of this alternative is $900,000. This estimated cost consists of:

Construction	$200,000
Engineering	$150,000
Operation and Maintenance	$550,000
Total	**$900,000**

4.3.5.5 Development of Chloropicrin Spill Area Soil Alternative 4

The intent of this alternative is to meet the corrective action objectives using soil vapor extraction and treatment to reduce the concentrations of chloropicrin in the soil.

The key elements of this alternative are described below.

Soil Vapor Extraction and Treatment

This alternative would employ positive placement blowers to apply a vacuum to the subsurface via wells or trenches and to remove the contaminated vapors. The extracted vapors would then be thermally treated prior to discharge to the atmosphere using a fume incinerator.

The properties of chloropicrin present challenges in the design of the soil vapor extraction (SVE) system. Chloropicrin, also known as trichloronitromethane is a clear, colorless, oily liquid with a strong, sharp, highly irritating odor. Chloropicrin has a moderate vapor pressure (18.3 mmHg 20 ^{o}C) and exists as a liquid at room temperature. The OSHA threshold limit value (TLV) is 0.1 ppmv. Chloropicrin is a stable chemical below 234 ^{o}F but above this temperature is can become a very dangerously reactive chemical. Materials that are incompatible with chloropicrin include PVC, PVDC, fiberglass and aluminum. Chloropicrin will react with such chemicals as organic amines, strong oxidizers and strong reducing agents.

The chloropicrin concentrations that would be removed via SVE under this alternative are not expected to approach levels that may cause shock reactions in the treatment equipment. However, safety devices would be installed such as rupture disks and water seals to reduce accidental damage.

The conceptual remediation system would include up to 25 SVE extraction wells installed to a depth of approximately 25 feet and horizontally spaced approximately 20 feet apart. These wells would be combined into a piping manifold. The piping would connect to a 25 Hp positive displacement blower capable of producing up to 500 scfm at an applied vacuum of up to 10 inches of mercury. The fume incinerator would be capable of destroying the chloropicrin by a minimum of 99.5%. Off gas treatment would consist of a hydrochloric acid scrubber.

Soil samples would be obtained to confirm the reduction in chloropicrin concentrations to below the PMPS.

Operation and Maintenance
After termination of the treatment process, no operations and maintenance is necessary for this alternative.

Estimated Cost
The estimated cost of this alternative is $1,500,000. This estimated cost consists of:

Construction	$500,000
Engineering	$100,000
Operation and Maintenance	$900,000
Total	**$1,500,000**

4.3.6 Assessment of Relative Mercury Emissions from Soil Corrective Measures

For the purpose of evaluating the short-term impacts of the various corrective measures alternatives, CDM calculated a scaled number for each soil corrective measure that represents the relative potential for total mercury emissions that may be generated in the implementation of each alternative. This scaling method is used because it is not feasible to develop direct estimates of the potential emissions from

each alternative, since a direct estimate is dependent on many variables that cannot be quantified prior to actual implementation.

The scaled mercury emissions numbers were calculated for each alternative using the following considerations:

- The volume of material excavated from each soil contamination area
- Mercury concentrations from soil samples taken from each area
- The number of times soil from each area must be handled during the corrective action

These inputs were used to calculate a number that represents total units of mercury handled for each corrective measure alternative. The calculated numbers for all the corrective measures were then assigned a number on a scale of zero to ten. With ten representing the alternative with the highest potential total emissions throughout implementation, and zero representing alternatives with no potential for mercury emissions.

Each of the corrective measures for the Plant Area and Cell Building Soils and for the Landfills and Landfill Ridge Area Soils were assessed for potential mercury emissions using this process. The results of this assessment are as follows:

Plant Area and Cell Building Soils:

Alternative 1 – Consolidate and cap soils in groundwater capture area. Cap Cell Building soils in place. ***Relative emissions number: <1***

Alternative 2 - Consolidate and cap soils in groundwater capture area. Dispose of Cell Building soils off-site. ***Relative emissions number: 2***

Alternative 3 - Consolidate and cap soils in groundwater capture area. Treat Cell Building Soils on-site. ***Relative emissions number: 2***

Alternative 4 – Place soils in lined management unit on site. Treat Cell Building soils on-site. ***Relative emissions number: 3***

Alternative 5 – Excavate and dispose of all soils off-site. Treat Cell Building soils on-site. ***Relative emissions number: 3***

Alternative 6 – Dispose of all soils off-site, no on-site treatment. ***Relative emissions number: 2***

Landfills and Landfill Ridge

Alternative 1 – No Action, monitor. ***Relative emissions number: 0***

Alternative 2 – Cap Landfill 2 and landfill ridge area soils with impermeable cap, monitor. ***Relative emissions number: 0***

Alternative 3 – Consolidate Landfill 2 and landfill ridge area soils inside groundwater capture area and cap. ***Relative emissions number: 5***

Alternative 4 – Excavate Landfill 2 and landfill ridge area soils and place in lined management unit on-site. ***Relative emissions number: 5***

Alternative 5 – Excavate Landfill 2 and landfill ridge area soils and dispose of the soil off-site. ***Relative emissions number: 3***

Alternative 6 – Excavate all landfills and disposal of the soil off-site. ***Relative emissions number: 10***

4.4 Corrective Measures for Sediment

4.4.1 Alternatives Developed

As discussed in Section 3, five alternative corrective measures for Southern Cove sediments met the threshold screening. Three alternatives for sediment corrective action have been developed in this section based on the five retained alternatives. These alternatives are as follows:

Alternative 1: Dredge the sediments from the cove. Consolidate the dredged sediment within the proposed groundwater capture area. Cap the consolidated sediments soils with an impervious cap.

Alternative 2: Dredge the sediments from the cove. Dispose of the dredged sediments off site.

Alternative 3: Apply in-situ direct current technology (DCT) to the cove sediments to remove mercury from the sediment.

The intent of Alternative 1 is to prevent direct contact with the dredged sediment and prevent leaching of contaminants from the sediment. Stabilization is also a method to control leaching of contaminants from the sediment, but would not provide an additional degree of protection from exposure when compared to the consolidation and capping alternative (Alternative 1), or to the offsite disposal alternative (Alternative 2). The stabilization options were therefore not carried through in the development of alternatives for detailed evaluation.

This section develops the alternatives to the level of detail necessary to perform the detailed evaluation and recommendation. Each alternative is discussed in more detail below.

4.4.2 Development of Sediment Alternative 1

The intent of this alternative is to meet the corrective action objectives by removing mercury-contaminated sediment from the Southern Cove. The sediments would then be contained on site beneath an engineered impermeable cap system to eliminate exposure pathways of direct contact, sediment transport via erosion, and groundwater migration.

The key elements of this alternative are described below.

Outfall Area Dredging

The majority of the outfall area is underwater during low tide and will require contaminated sediment removal by dredging. This alternative involves the use of dredging methods that control sediment re-suspension and reduce the need for dewatering. At this time, the use of a proprietary DryDredge ™ unit is anticipated, because of its relatively low mobilization cost, low increase in water content in the spoils, and ability to control sediment re-suspension during the dredging operation. This unit has also the advantage to provide an onboard-sorting element to remove large cobbles before sending the material to an onboard pumping unit that permits transportation of the material by piping to shore. Other advantages of the DryDredge ™ unit include its small size and its ability to dredge in low water depth is significant to the logistics of this project. At shore, the sediment will then be sent to a sorting unit to separate coarse-grained sediments. The fine-grained sediments (particles smaller than 3/8-inch in diameter) will be pumped to the dewatering process. The coarse-grained sediment will be placed in the consolidation area for capping.

Mud Flat Area

The mud flat area is uncovered during low tide and accessible from the shore. As mentioned in the description of the work to be done, the sediment in the mud flat area has relatively high water content. Under this alternative, the contaminated sediment will be removed with conventional excavation equipment during low tide.

It is anticipated that the sediment will be cut to desired depth using low ground pressure tractor dozers or loaders, pushed or transported to a centralized area, and loaded into a bin with a crane and clamshell or equivalent material handling unit. The material will then be sent to a sorting unit to separate coarse-grained sediments. The fine-grained sediments (particles smaller than 3/8-inch apparent diameter) will be pumped to the dewatering process. The coarse-grained sediment will be placed in the consolidation area for capping.

Dewatering Method
It is anticipated that only particles finer than 3/8-inch will require dewatering. The same dewatering method would be employed for both the outfall area and the mud flat area. The dewatering method would involve pumping the sediment into a Geotube™. Geotubes are large tubes made of filter fabrics designed to resist high pressure pumping allowing water to filtrate though the filter fabric without letting very fine elements to escape from the tube. The tubes would be placed in areas lined with HDPE liner to collect the water for treatment, if necessary. The dewatering process and sediment consolidation is usually achieved within a two-week period. Once the desired dewatering is achieved, the tubes are opened and the material moved to the consolidation area for capping. The suitability of the sediments for dewatering using Geotubes must be confirmed by bench-scale testing.

Capping
The consolidated dewatered sediment will be compacted, graded for positive drainage, and capped with an engineered soil cap incorporating an impermeable membrane. The cap surface will be vegetated with native grass species. The final volume of material to be capped will depend on the actual volume removed, and the extent of dewatering achieved. It is anticipated that between 8,000 and 12,000 cubic yards of sediment will be dredged and consolidated.

Operation and Maintenance
After construction of this alternative is completed, maintenance and monitoring will be performed consisting of:

- Periodic inspection of the consolidation area cap system;
- Seasonal mowing of the cap area; and
- Groundwater monitoring as discussed later in this section to confirm the effectiveness of the groundwater containment system.

Estimated Cost
The estimated cost of this alternative is $6,200,000. This estimated cost consists of:

Construction	$5,600,000
Engineering	$550,000
Operation and Maintenance	$50,000
Total	**$6,200,000**

4.4.3 Development of Sediment Alternative 2

The intent of this alternative is to meet the corrective action objectives by removing mercury-contaminated sediment from the Southern Cove. The sediments would then be disposed off in an off-site disposal facility. The key elements of this alternative are discussed below.

Dredging and Dewatering
These elements are essentially identical to Alternative 1, except that the dewatered sediments would be stockpiled for loading and off-site disposal.

Transportation and Disposal
After dewatering the stockpiled sediments would be tested for disposal, loaded and shipped using dump trucks to a licensed off-site disposal facility. It is anticipated that an off-site industrial waste landfill will be used for disposal of between 8,000 and 12,000 cubic yards of sediment. This would generate approximately 400 to 600 round trips between the site and the disposal facility.

Operation and Maintenance
No operations or maintenance activities are necessary for this alternative.

Estimated Cost
The estimated cost of this alternative is $9,500,000. This estimated cost consists of:

Construction	$8,950,000
Engineering	$550,000
Operation and Maintenance	$0
Total	**$9,500,000**

4.4.4 Development of Sediment Alternative 3

The intent of this alternative is to meet the corrective action objectives by removing mercury directly from the Southern Cove sediments using direct current technology (DCT). The key elements of this alternative are discussed below.

In-Situ Treatment
As part of this Corrective Measures Study several DCT processes were researched including electrokinetics and electro-chemical remediation. A proprietary technology marketed by Weiss Associates, Emeryville, CA, appears to be the most promising due to the applicability of the process, and Weiss's experience with actual field application of the technology. This technology is an application of "electrochemical remediation technology" (ECRT).

The application of this technology involves burying steel or graphite electrodes in the cove sediments. The electrodes would be connected via cable conductors to an AC/DC converter located on shore. The converter delivers a proprietary AC/DC signal to the electrodes that is said to induce mobilization of the contaminants towards the electrodes. Examples of actual full-scale application of this technology are few, so the technology is considered unproven. However, if successful, the application of this technology would result in mercury from the soil plating on the electrodes, which are then removed from the sediment and disposed of. The vendors anticipate being able to reach and average mercury concentration in the cove of less than the cleanup goal of 2.2 mg/kg within several months.

Transportation and Disposal
The only waste stream expected to be generated from this alternative would be the spent electrodes. These would be disposed of through a permitted retort facility.

Operation and Maintenance
After completion of the treatment process, no operations and maintenance is necessary for this alternative.

Estimated Cost
The estimated cost of this alternative is $4,530,000. This estimated cost consists of:

Construction	$4,120,000
Engineering	$410,000
Operation and Maintenance	$0
Total	**$4,530,000**

4.5 Corrective Measures for Groundwater

4.5.1 Alternatives Developed

As discussed in Section 3, three alternatives for corrective action to address groundwater met the threshold screening criteria. These alternatives are as follows:

Alternative 1: Construct an impermeable groundwater barrier wall downgradient of the plant area to capture contaminated groundwater. Install a groundwater extraction system to collect contaminated groundwater captured by the barrier wall. Modify the on-site wastewater treatment plant to appropriate processes for treatment of site groundwater exclusively. Treat the groundwater on site and discharge treated effluent via a surface water discharge to the river, or via reinjection to groundwater.

Alternative 2: Construct an impermeable groundwater barrier wall downgradient of the plant area to capture contaminated groundwater. Install a groundwater extraction system to collect contaminated groundwater captured by the barrier wall. Construct a tank truck or tank car loading facility. Extract groundwater and ship to off-site treatment facility.

Alternative 3: Construct an impermeable groundwater barrier wall downgradient of the plant area to capture contaminated groundwater. Install an adsorbtive treatment gate for in-situ treatment of groundwater.

This section develops the alternatives to the level of detail necessary to perform the detailed evaluation and recommendation. Each alternative is discussed in more detail below.

4.5.2 Development of Groundwater Alternative 1

The intent of this alternative is to achieve the corrective action objectives by managing groundwater exceeding the PMPS using a strategy of containment, extraction, and treatment. The containment system is intended to prevent the migration of contaminated groundwater to the Penobscot River, or to drinking water supplies. The key elements of this alternative are discussed below.

Barrier Wall Construction

The groundwater barrier wall is a common element to each of the alternatives. The barrier wall will be constructed using the bentonite slurry trench method. The barrier wall will be located to the west of the plant and Landfill 1, approximately as shown in **Figure 4-3**. The barrier wall would extend from the bedrock ridge at the northern edge of Landfill Area 1 along the downgradient edge of the existing landfill cap and curve to cross the north ditch just down stream of the monitoring well B-316 cluster such that it intersects the zone of influence of the existing groundwater collection trench at the southerly stream. This alignment will encompass the known and potential source areas associated with the manufacturing plant and Landfill 1. The exact location and extent will be determined during the design phase. The barrier wall will extend vertically into the existing till layer, resulting in a maximum depth of approximately 80 ft.

Construction of the barrier wall will involve excavation of a trench through the entire overburden sand and gravel aquifer and into the low permeability till. A biodegradable polymer is typically used to keep the excavation open during construction. The wall is formed of a soil-bentonite or similar clay slurry, which placed in the excavated trench and keyed into the underlying till.

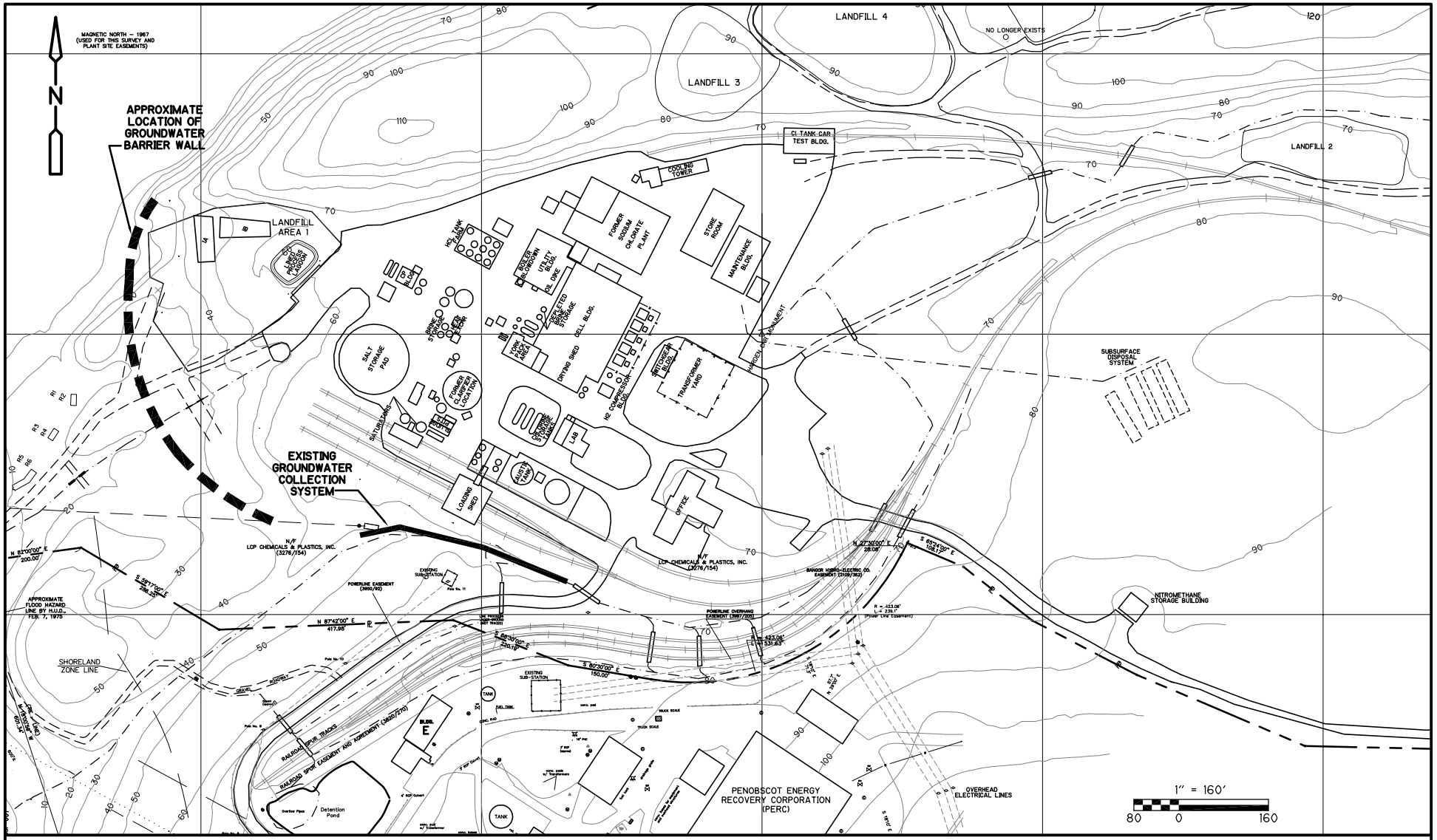
Design of the slurry trench will require additional soils data collection and groundwater compatibility testing.

Construction of the barrier wall will include:

- Clearing and grubbing the alignment
- Construction of a level working platform
- Slurry mixing equipment setup
- Excavation of the slurry trench
- Spoils management
- Site restoration

Groundwater Extraction System

Groundwater will be collected upgradient of the barrier wall with two to three, 4-inch diameter collection wells equipped with submersible pumps. The volume of water expected is approximately 5 gpm. The purpose of the extraction wells will be to maintain lower groundwater elevations on the plant side of the barrier wall than on



MALLINCKRODT INC.
HOLTRACHEM MANUFACTURING SITE
CORRECTIVE MEASURES STUDY

PROPOSED LOCATION OF GROUNDWATER BARRIER WALL

CDM

FIGURE 4-3

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the river side. The extracted groundwater will be pumped to the treatment facility, which is described below.

Groundwater Treatment
It is anticipated that initially, groundwater will be treated with the Plant's existing wastewater treatment system. However, this system, although effective, is not designed specifically for groundwater and is extremely expensive to operate. Therefore, it is expected that a new system will be designed and constructed to treat groundwater.

Groundwater Discharge
Discharge of treated groundwater to surface water requires a National Pollution Discharge Elimination System (NPDES) permit. Treated groundwater could also be re-injected within the groundwater containment area on-site if treated to meet the PMPS for groundwater. Alternatively, groundwater could be treated in-situ to meet the groundwater PMPS before it would discharge to the Penobscot River.

The barrier wall is assumed to eliminate the transport of mercury through groundwater between the plant and the river. Therefore, the flux of mercury from the site to the river under the barrier wall alternatives is the amount in the effluent of the groundwater treatment system, plus what is in any groundwater that is not captured and the contribution from surface water. Assuming the treatment plant effluent is 65 parts per trillion and operates at five gallon per minute, approximately 1 gram per year or 0.0022 lbs per year will be discharged from the treatment system. As described in Section 2.4.2 approximately 0.01 lbs/year can be estimated for the rest of site groundwater and as described in Section 2.4.3 approximately 0.015 lbs/year can be estimated from surface water at the PMPS. Therefore the total flux of mercury under this groundwater alternative is less than 0.03 lbs/yr. In the first footnote of Table 1 - Numeric Preliminary Media Protection Standards, MEDEP states that at achievement of the groundwater PMPS it must be demonstrated that surface water PMPS is being attained or that untreated groundwater discharge will not significantly lower the existing water quality before groundwater capture and treatment can be terminated. In other words, when groundwater meets the PMPS, which are drinking water standards, it can flow to the river provided that it does not significantly lower existing river water quality.

CDM has calculated the impact of discharging site groundwater that meets the mercury PMPS. At the lowest flows expected in the river, the 7 day – 10 year low flow (7Q10 flow) of 4000 cubic feet a second, the calculated increase in the river mercury concentration would be less than 5.6×10^{-6} ppb. At the average flow of 16,400 cubic feet a second, the calculated increase in the river concentration would be less than 1.4×10^{-6} ppb. These concentrations indicate that the discharge of groundwater at the mercury PMPS, which is the drinking water standard, would not significantly lower river surface water quality to a measurable degree.

Operation and Maintenance
Operation and maintenance for this alternative will consist of operating and maintaining the groundwater pumping and treatment system. Operation and maintenance would also include downgradient groundwater monitoring to confirm the integrity of the barrier wall.

Pumped groundwater will also be tested to assess the reduction in contaminant concentrations to determine the required duration of pumping and treatment.

Estimated Cost
The estimated cost of this alternative is $11,800,000. This estimated cost consists of:

Construction	$4,100,000
Engineering	$800,000
Operation and Maintenance	$6,900,00
Total	**$11,800,000**

4.5.3 Development of Groundwater Alternative 2

The intent of this alternative is to achieve the corrective action objectives by managing groundwater exceeding the PMPS using a strategy of containment, extraction, and off-site treatment and disposal. The key elements of this alternative are discussed below.

Barrier Wall and Groundwater Extraction System
These items would be identical to Alternative 1.

Tank Car Loading Facility
The assumed mode of transportation for groundwater to the off –site treatment facility is via rail car. This alternative would therefore require the construction of a facility to load railroad tank cars. One of the existing railroad sidings would be used for this purpose. The loading equipment would consist of pumps and piping, and may include a fixed storage tank.

Transportation and Off-Site Treatment
After loading, the groundwater would be shipped via rail to a permitted off-site treatment facility for treatment and disposal. This would result in a negligible 0.0022 lbs / year less mercury discharge to the Penobscot River than on-site treatment (the amount calculated to be discharged by the on-site treatment plant).

Operation and Maintenance
Operation and maintenance for this alternative would consist of operating the groundwater pumping system, and tending the railcar loading operations. Operation and maintenance would also include downgradient groundwater monitoring to confirm the integrity of the barrier wall. Pumped groundwater will also be tested to assess the reduction in contaminant concentrations to determine the required duration of pumping and treatment.

Estimated Cost
The estimated cost of this alternative is $41,100,000. The increase in cost of this alternative when compared to Alternative 1 is due to the significant cost of transportation and off-site treatment. This estimated cost consists of:

Construction	$2,100,000
Engineering	$500,000
Operation and Maintenance	$38,500,000
Total	**$41,100,000**

4.5.4 Development of Groundwater Alternative 3

The intent of this alternative is to achieve the corrective action objectives by managing groundwater exceeding the PMPS using a strategy of containment and in-situ treatment using a barrier wall and subsurface adsorptive wall. The key elements of this alternative are discussed below.

Barrier Wall Construction
This item is identical to Alternative 1 and 2.

Adsorptive Wall Construction
In-situ treatment of mercury-contaminated groundwater could potentially be accomplished using a permeable subsurface zone packed with sulfur-impregnated carbon media. This media is effective in treating groundwater to levels below the PMPS for mercury in groundwater in aboveground treatment systems, but is unproven in the form of an in-situ treatment system.

Construction of the adsorptive wall would include excavation to create an opening in the groundwater barrier wall for the channeling of groundwater through the adsorptive zone. The exact configuration of the adsorptive wall would be determined during the design phase, but would potentially consist of a sheet-pile lined excavation with perforations on the inlet and outlet end. The excavation would be backfilled with the sulfur-impregnated carbon media and covered. The adsorptive wall must be designed for periodic replacement of the carbon media. Size and dimensions of the permeable zone would be determined based on the required contact time between the flowing groundwater and the media.

The performance of the adsorptive potential barrier has not been demonstrated but it is assumed that it will reduce the mercury to at least the PMPS for groundwater, or it would not be employed. Therefore if the assumed flow rate is five gpm and the concentration is 2 ug/l the flux of mercury under this alternative would be 0.044 lbs/year. As described in Section 4.5.2 discharge of groundwater at the PMPS would not significantly lower existing surface water quality.

Operation and Maintenance
Operation and maintenance for this alternative would include periodic replacement of the adsorptive media, and transportation and disposal of the media. Operation and maintenance would also include monitoring groundwater downstream of the barrier wall and adsorptive gate.

Estimated Cost
The estimated cost of this alternative is $6,200,000. This estimated cost consists of:

Construction	$3,000,000
Engineering	$800,000
Operation and Maintenance	$2,400,000
Total	**$6,200,000**

4.6 Corrective Measures for Surface Water

4.6.1 Corrective Measures Developed

As explained in Section 2, the applicable corrective measures for each of the potential impacts to surface water are as follows:

Lined process lagoon: Removal
Site runoff: Excavation, covering, capping
Industrial sewer: Pipe plugging

Each of the corrective measures is described in more detail below.

4.6.2 Removal of the Lined Process Lagoon

This corrective action will consist of pumping the existing standing water in the lagoon to the wastewater treatment system, where it will be treated to limits required in the current NPDES permit. The empty lagoon will then be backfilled with clean soil, graded for proper drainage, and covered with a vegetated cover consisting of 6 inches of topsoil, and seeded.

The estimated cost of this corrective action is $100,000.

4.6.3 Site Runoff

The excavation, capping, or covering of contaminated soil to prevent transport via runoff will be accomplished as part of the soil and sediment corrective measures, and is discussed previously in this section.

4.6.4 Industrial Sewer Plugging

After the anticipated decommissioning of the existing industrial wastewater treatment plant, the industrial sewer serving as the effluent conduit from the plant will be abandoned. The remaining portions of the industrial sewer have already been abandoned. These underground pipes will be plugged immediately upstream of the

existing effluent weir (Outfall 002). The plugging operation will involve excavating to expose the buried pipes, and plugging them with concrete. A clay dam will also be installed in the pipe trench for each exposed pipe, for the purpose of preventing the migration of contaminated groundwater along the pipe bedding. This will involve backfilling with imported clay soil.

The estimated cost for this corrective action is $50,000.

Section 5
Evaluation of Retained Corrective Measures

5.1 Detailed Evaluation Balancing Criteria and Process

This section presents the detailed evaluation of the corrective action alternatives and the resulting recommended alternative for each contaminated media area. Only alternatives that met all of the threshold criteria were evaluated. The threshold screening process is discussed in Section 3.

The detailed evaluation follows the process outlined in the CMS Work Plan and meets the requirements of the Consent Decree and the RCRA guidance. The evaluation assesses each of the corrective measures alternatives with respect to five "balancing criteria" which are:

- Long-term reliability and effectiveness;
- Reduction in toxicity, mobility and/or volume;
- Implementability;
- Short-term effectiveness; and
- Cost.

The balancing criteria assessment took into consideration the individual assessment parameters outlined in the CMS workplan, and resulted in the ranking of the alternative as "low", "moderate", or "high" for each criterion. **Table 5-1** provides the general evaluation parameters and an explanation of the rationale used to rank the alternatives.

Costs presented in this section for each alternative are representative of the present worth of all of the components of the alternative costs. The development of the cost estimates is explained in more detail in Section 4.

The balancing criteria rankings and costs were used to determine the alternative that represents the best balance of the five selection factors. The alternative deemed to achieve the highest overall rating across the selection factors was selected as the recommended corrective action.

5.2 Evaluation of Corrective Measures for Soils

5.2.1 Cell Building and Plant Area Soils

In Section 3, six corrective measures for Cell Building and plant area soils were retained for further evaluation. A detailed discussion of each corrective measure with respect to the five RCRA balancing criteria is presented in this section. A summary of the balancing criteria screening for soils are presented in **Table 5-2**.

Table 5-1
Ranking Criteria for Evaluating Corrective Measures

Balancing Criteria	General Evaluation Parameters	Rank Rationale		
		High	**Moderate**	**Low**
Long-term reliability and effectiveness	1) Reliability and effectiveness 2) Life expectancy of the corrective measure 3) Operation and maintenance requirements	Corrective measure scores high for all three parameters.	Corrective measure scores high for two parameters.	Corrective measure scores high for one parameter.
Reduction in toxicity, mobility and/or volume	Degree and permanence in reduction of: 1) Toxicity 2) Mobility and 3) Volume	Corrective measure achieves reduction in all three parameters.	Corrective measure achieves reduction in two parameters.	Corrective measure achieves reduction in one parameter.
Implementability	1) Constructability 2) Availability of technology, equipment and specialists 3) Time required to comply with PMPS 4) Required confirmatory sampling 5) Need for major approvals and permits 6) Required institutional controls	Corrective measure scores high for five to six parameters.	Corrective measure scores high for three to four parameters.	Corrective measure scores high for one to two parameters.
Short-term effectiveness	1) Exposure 2) Volatilization 3) Cross-media contamination 4) Health & Safety issues 5) Traffic 6) Noise	Corrective measure has short-term impacts for one to two parameters.	Corrective measure has short-term impacts for three to four parameters.	Corrective measure has short-term impacts for five to six parameters.
Cost	1) Capital Costs 2) O&M Costs	Actual estimated costs considered in evaluation		

Table 5-2
Balancing Criteria Assessment for Cell Building and Plant Area Soils

No.	Description of Corrective Action Alternative	Assessment of Balancing Criteria				
		Long-term reliability and effectiveness	Reduction in toxicity, mobility and/or volume	Implementability	Short-term effectiveness	Costs
1	**Consolidate and Cap in GW Capture Area/Cap cell Building Soils in-place**	Moderate	Low	Moderate	Moderate	$5,200,000
2	**Consolidate and Cap in GW Capture Area/Dispose cell Building Soils off-site**	Moderate	Moderate	Moderate	Low	$18,800,000
3	**Consolidate and Cap in GW Capture Area/Treat Cell Building Soils on-site**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**$12,100,000**
4	**Excavate/Place in On-Site Management Unit/Treat Cell Building Soils**	High	Moderate	Low	Low	$16,500,000
5	**Excavate/Dispose all soil off-site/Treat Cell building soil on-site prior to disposal**	High	Moderate	Moderate	Low	$17,000,000
6	**Exacavate/No treatment/Off-site disposal**	High	Moderate	High	Low	$24,800,000

Note: Alternative in bold is the preferred alternative for that media.

5.2.1.1 Alternative 1: Consolidate and Cap in Groundwater Capture Area/Cap Cell Building Soils in Place

This alternative would involve excavating soil from areas identified as exceeding PMPS levels and consolidating the soil within the groundwater containment area. Cell Building soils would be left in place and the area of consolidated soil including the Cell Building area would be capped by an engineered and impervious cap.

Long-Term Reliability and Effectiveness

Consolidation would be effective in managing soils containing contaminants of concern (COCs) above the corresponding PMPSs. The cap containment would be effective in isolating contaminated soils from human and ecological exposure and from cross-contaminating other uncontaminated media or areas of the site. The engineered cap would prevent COCs from leaching to groundwater due to infiltration of precipitation. The potential for contaminant transport from soil via groundwater would be addressed by the active groundwater containment and collection system.

This alternative would be reliable and have indefinite lifetime expectancy if the integrity of the cap is maintained and groundwater collection and treatment is performed as long as required. Long-term groundwater monitoring would be performed to determine the need for continued operation of the groundwater collection and treatment system and if contamination is migrating from the capped area.

After construction of this alternative is completed, maintenance and monitoring would be performed consisting of:

- Annual inspection of the consolidation area cap system,
- Seasonal mowing of the cap area, and
- Groundwater monitoring to confirm the effectiveness of the groundwater containment system.

Capping is a proven and reliable technology for contaminated soils. Overall, this alternative would be effective long-term in preventing direct contact, and soil and sediment contamination via erosion and overland runoff, and preventing COCs from leaching to groundwater and surface water.

In conclusion, this alternative is ranked moderate in long-term reliability and effectiveness. This ranking considers that the alternative is judged to be highly reliable and effective in meeting the corrective action objectives. However, this reliability and effectiveness is dependent on active groundwater collection and treatment, and maintenance of the capping system, reducing the ranking from “high”.

Reduction of Toxicity, Mobility and/or Volume
This alternative would result in a reduction in the mobility of contaminants through the following means:

- Preventing contaminant migration via erosion
- Preventing transport of contaminants to groundwater via infiltration of precipitation
- Placing excavated soil above the groundwater table to reduce the potential for groundwater contamination
- Preventing direct contact with the contaminated soil
- Preventing the migration of soil contamination from the site via groundwater by means of the groundwater collection and treatment system.

The reduction in mobility achieved by the cap system is permanent, assuming the integrity of the cap is maintained. The reduction in mobility achieved by the groundwater collection system relies on the active operation of this system. However, this alternative does not achieve reduction in toxicity or volume of mercury because the contaminated soils are consolidated on site.

In conclusion, this alternative is ranked low for this criterion, because it achieves reduction in mobility of the contaminants, but no reduction in toxicity or volume of contaminant on-site.

Implementability
This alternative is implementable as its construction involves common techniques including soil excavation, placement and compaction, and capping of the consolidated area.

Of all the soil options being considered the alternative would likely take the least time to construct and thereby the least amount of time to comply with the PMPS.

This alternative will require the collection of post-excavation samples.

Consolidation of contaminated soils is a concept allowed and encouraged by RCRA regulations. Because there are no actions constituting disposal and because the concept achieves the correction active objectives, only the approval of EPA and MEDEP is required to implement this corrective measure.

Standard and commonly used excavation equipment like backhoes and excavators would be used for excavation, while dump trucks would be used to move the material to the consolidation area. Standard construction equipment would be used for compacting soils, installing the geomembrane and the vegetated cover. An

approved and qualified sub-contractor would be hired to install the membrane and cap on the filled area.

Institutional controls would include a deed restriction for the site and access restrictions to the capped area to maintain its integrity and prevent accidental excavation.

In conclusion, this alterative is ranked moderate for this criterion because it is readily constructible using available technology, equipment and personnel. It also achieves the PMPS in a reasonable time period and does not require major approvals and permits. However, this alternative would require confirmatory sampling and institutional controls.

Short-Term Effectiveness
Consolidation of soil into the area of groundwater containment will require excavation and short-haul transportation. This will result in temporary increased exposure of contaminants to the environment and associated increased potential for volatilization, dust generation and overland runoff during construction. Air monitoring, dust control and silt runoff control would be performed.

Workers would be exposed to the COCs present in the soil during excavation of contaminated areas and compaction of the consolidated area. Exposure would be limited to site workers and would be addressed through the Health and Safety Plan. Truck traffic and associated equipment noise would be limited to the site.

Therefore, the short-term effectiveness of this alternative is considered moderate

Cost
The estimated cost for this alternative is $5,200,000.

5.2.1.2 Alternative 2: Consolidate and Cap in Groundwater Capture Area/ Dispose Cell Building Soils Off-Site

This alternative would involve excavating soil from areas identified as exceeding PMPS levels and consolidating the soil within the groundwater containment area. Soil beneath and around the perimeter of the Cell Building containing evidence of free elemental mercury contamination would be excavated to the extent practicable, loaded into trucks and transported to a licensed off-site disposal facility.

Long-Term Reliability and Effectiveness
Long-term reliability of this alternative is equivalent to Alternative 1. The life expectancy of Alternative 2 expected to be similar to that of Alternative 1. Operations and maintenance requirements would be the same. Therefore, this alternative is ranked as moderate for this criterion.

Reduction of Toxicity, Mobility and/or Volume
This alternative will reduce the volume of contaminated soil by excavation and off-site disposal of Cell Building soils. Consolidation and capping will reduce mobility. Therefore, this alternative is ranked moderate in terms of reduction of toxicity, mobility and volume.

Implementability
The implementability of Alternative 2 is similar to Alternative 1. This alternative has the additional components of excavation of Cell Building soils, their transportation and disposal off-site. These additional components are implementable. Confirmatory sampling and institutional control requirements would be the same as those required for Alternative 1. Therefore, the implementability of this alternative is ranked as moderate.

Short-Term Effectiveness
Due to an increased exposure to contaminated soils during off-site transportation, there is a greater potential for volatilization, and cross-contamination taking place during excavation and transportation. In addition, there would be off-site traffic and noise impacts due to transportation of waste materials off-site. Up to 1,200 truck trips to and from the site would be required under this alternative. Therefore, the short-term effectiveness of this alternative is ranked low.

Cost
The estimated cost of this alternative is $18,800,000.

5.2.1.3 Alternative 3: Consolidate and Cap in Groundwater Capture Area/Treat Cell Building Soils On-site

Alternative 3, like Alternatives 1 and 2 would involve excavating soil from areas identified as exceeding PMPS levels and consolidating the soil within the groundwater containment area. Consolidated soil would be capped using an engineered impermeable cap system. Soil beneath and around the perimeter of the Cell Building containing evidence of free mercury contamination would be excavated to the extent practicable and treated on-site to remove free mercury. Treated soil would be consolidated within the groundwater capture area under the engineered cap. The free mercury-containing fraction would be disposed of at a licensed disposal facility.

Long-Term Reliability and Effectiveness
Consolidation would be effective in managing soils containing contaminants of concern (COCs) above the corresponding PMPSs. The engineered cap containment system would be effective in isolating contaminated soils from human and ecological exposure and from cross-contaminating other uncontaminated media or areas of the site. The engineered cap would prevent COCs from leaching to groundwater due to infiltration of precipitation. The potential for contaminant transport from soil via groundwater would be addressed by the active groundwater containment and collection system. This alternative would be reliable and have indefinite lifetime

expectancy if the integrity of the cap is maintained and groundwater collection and treatment is performed as long as required. Long-term groundwater monitoring would be performed to determine the need for continued operation of the groundwater collection and treatment system. The consolidation of plant area soils beneath an engineered cap within the area of groundwater capture, collection and treatment is not expected to extend the duration of operation of the groundwater collection and treatment system beyond the time frame that would be expected for a management unit. This is because consolidated soils would be placed above the groundwater table to prevent the contact with groundwater, and the engineered cap would prevent infiltration and the generation of leachate.

Operation and maintenance requirements of Alternative 3 are the same as for Alternatives 1 and 2.

In conclusion, this alternative is ranked moderate in long-term reliability and effectiveness. This ranking considers that the alternative is judged to be highly reliable and effective in meeting the corrective action objectives. However, this reliability and effectiveness is dependent on active groundwater collection and treatment, and active maintenance of the capping system, reducing the ranking from high.

Reduction of Toxicity, Mobility and/or Volume

This alternative would result in a reduction in the mobility of contaminant through the following means:

- Preventing contaminant migration via erosion
- Preventing transport of contaminants to groundwater via infiltration of precipitation
- Placing excavated soil above the groundwater table to reduce the potential for groundwater contamination
- Preventing direct contact with the contaminated soil
- Preventing the migration of soil contamination from the site via groundwater by means of the groundwater collection and treatment system.

The reduction in mobility achieved by the engineered cap system is permanent, assuming the integrity of the cap is maintained. The reduction in mobility achieved by the groundwater collection system relies on the active operation of this system.

This alternative will achieve significant reduction in the volume of contaminated soil on-site by excavation of Cell Building soils, and further volume reduction through treatment to remove free mercury.

In conclusion, this alternative is ranked moderate for this criterion, because it achieves reduction in volume and mobility of the contaminants, but no reduction in toxicity.

Implementability
This alternative is constructible with standard excavation and capping equipment. It does involve a treatment process (hydraulic and physical methods) for Cell Building soils. However, soil separation techniques are proven technologies and are readily implementable. The time required for construction would be the same as or slightly longer than Alternative 2 due to the need to process soil on-site. The effectiveness of this alternative will be measures by post-excavation sampling and groundwater monitoring. Extensive approvals are not anticipated for this alternative. Therefore, the implementability of this alternative is ranked as moderate.

Short-Term Effectiveness
Short-term impacts associated with contaminant exposure, volatilization and worker health are similar to Alternative 2. However, due to the reduction in volume of material that would be transported off-site (estimated 220 truck trips vs. 1,200), Alternative 3 will result in significantly lower short term impacts off-site due to reduced truck traffic, noise and the potential for off-site releases. Therefore, this alternative is ranked moderate for this criterion.

Cost
The estimated cost of this alternative is $12,100,000.

5.2.1.4 Alternative 4: Excavate and Consolidate Soils in On-Site Management Unit/Treat Cell Building Soils

This alternative will involve excavation of Cell Building area soils followed by treatment using hydraulic and physical methods. The clean fraction of the soil would be used as fill on-site while the contaminated fraction would be either sent to a retorting facility or disposed of outside of the U.S. Other contaminated soil will be excavated and placed in an on-site, lined management unit. A leachate collection system would be installed to collect leachate from the management unit.

Long-Term Reliability and Effectiveness:
Long-term reliability of this alternative is rated as high because it does not rely on an active groundwater containment system. However, the groundwater capture and treatment system will still be installed to address groundwater downgradient of the plant. The life expectancy of the management unit is indefinite if it is properly maintained. Operations and maintenance would include mowing, monitoring, leachate collection and treatment. Because a groundwater treatment system will still be required as part of the overall remedy for the site, the construction of a management unit including the leachate collection and treatment system, is redundant and results in additional operations and maintenance issues for this alternative which will result in higher operation and maintenance requirements than Alternatives 1, 2, and 3.

Reduction of Toxicity, Mobility and/or Volume
This alternative would reduce the mobility and volume of contaminants but would not reduce the toxicity. Therefore, this alternative ranks moderate on this criterion.

Implementability
A management unit is constructible, but would require extensive earthwork. Construction of an on-site management unit would also delay the cleanup of other areas of the site until the management unit is approved to accept soil. Confirmatory sampling requirements are similar to those of other alternatives considered. As described above, monitoring requirements would be greater than those for other alternatives being considered. Time frames for obtaining approvals for the management unit and other issues related to approval, will likely impede its timely construction, thus adversely affecting the implementability of this alternative. Institutional controls and access limitations would be required under this alternative but these are not expected to be significantly different from what is anticipated for other alternatives being considered. Therefore, the implementability of this alternative is ranked low.

Short-Term Effectiveness
A relatively large (approximately 10 acres), previously uncontaminated area of the site would have to be cleared and grubbed to construct the secure management unit. Excavation and placement of soil at the unit would result in exposure of contaminants, volatilization and potential cross media contamination to a greater extent than Alternatives 1 through 3. Although truck traffic and earthmoving equipment would be largely limited to the site, noise generated from these activities would be greater than and last longer than would result from Alternatives 1 through 3. Therefore, the short-term effectiveness of this alternative ranked low.

Cost
The estimated cost of this alternative is $16,500,000.

5.2.1.5 Alternative 5: Excavate and Dispose of all Soils Off-site/Treat Cell Building Soils On-site Prior to Disposal

Soil from areas identified as exceeding PMPSs except the Cell Building area soils would be excavated and disposed off-site. Soil beneath and around the perimeter of the Cell Building containing evidence of free mercury contamination would be excavated to the extent practicable, and treated on-site to remove free mercury. The Cell Building area soils would be excavated and treated by hydraulic and physical methods to reduce the volume of the contaminated fraction. The free mercury-containing fraction would be disposed of at a licensed disposal facility. The clean fraction would be used as fill on-site within the groundwater capture area.

Long-Term Reliability and Effectiveness
Long-term reliability of this alternative is ranked high as all soils exceeding PMPSs would be excavated, transported and disposed off-site at a hazardous or non-hazardous waste facility (disposal location dependant on soil characterization). The

Cell Building soils would be excavated, treated and disposed of. Therefore, this alternative is considered reliable and effective, as contamination above the PMPS would be removed thereby reducing the risk present at the site. No operations or maintenance activities are necessary for this alternative once the cover over the excavation areas is vegetated.

Reduction of Toxicity, Mobility and/or Volume
This alternative would result in a reduction in, mobility and volume of contaminants present in the on-site soils. It does not reduce the toxicity. Therefore, it is ranked as moderate for this criterion.

Implementability
Excavation and transportation off-site are proven technologies and standard equipment and readily available subcontractors can be used. Implementability of Cell Building soil treatment is the same as that for Alternative 3 and 4. This alternative will achieve PMPS levels upon excavation of these areas assuming that all soils above PMPS are removed. Confirmatory sampling would be required and performed. Special permits and institutional controls are not required. Therefore, this alternative is ranked as moderate for implementability.

Short-Term Effectiveness
Short-term environmental impacts of this alternative would include exposure of contaminants, volatilization and potential cross media contamination during excavation, hydraulic and physical processing of Cell Building soils and transportation of soils off-site. Transportation of soil off-site for treatment would also result in significant truck traffic (estimated 4,800 truck trips) and noise off-site and the potential for off-site release and cross-contamination of other areas. Therefore, this alternative is ranked low for short-term effectiveness.

Cost
The estimated cost of this alternative is $17,000,000.

5.2.1.6 Alternative 6: Excavate/No Treatment/Off-Site Disposal

This alternative consists of excavating soil from areas identified as exceeding PMPS levels and disposing of the soil in permitted off-site hazardous or industrial waste landfills.

Long-Term Reliability and Effectiveness
Long-term reliability and effectiveness of this alternative is similar to Alternative 5 and therefore is ranked high for this criterion.

Reduction of Toxicity, Mobility and/or Volume
Reduction of toxicity, mobility and/or volume characteristics of this alternative are similar to Alternative 5 and therefore, this alternative is ranked moderate for this criterion.

Implementability
The implementability of this alternative is similar to Alternative 5 except that treatment will not be performed on-site therefore, this alternative is ranked high moderate for this criterion.

Short-Term Effectiveness
Short-term effectiveness of this alternative is similar to Alternative 5 although additional off-site truck traffic and noise would result from the greater volume of soil transported off-site. Therefore, this alternative is rated low for this criterion.

Cost
The estimated cost of this alternative is $24,800,000. The higher cost is a result of the larger quantity of soil requiring off-site transport and disposal.

5.2.1.7 Recommended Alternative for Cell Building and Plant Area Soils

Alternative 3, consolidate and cap in the groundwater containment area and treat Cell Building soils on-site, is the recommended alternative. It achieves source removal for the most contaminated material. It is readily implementable, as it does not involve extensive permitting or lengthy approval process. It is also more favorable in terms of short-term impacts, since it avoids clearing and construction of a new lined management unit on-site, and adverse off-site impacts and risks associated with transportation of soil to an off-site facility. Its long-term reliability is based on an active groundwater collection and treatment system. Monitoring would also be performed to document long-term reliability.

In summary, Alternative 3 is recommended because:

- It meets the corrective action objectives for soils.
- It is reliable and effective in preventing exposure or release to the environment through the groundwater capture system (which will be installed regardless).
- In conjunction with the groundwater collection and treatment system, this alternative is equivalent in effectiveness as Alternative 4.
- It reduces the mobility and volume of hazardous waste on-site by removing the Cell Building soils that contain elemental mercury.
- It has fewer short-term impacts than an on-site management unit since it maintains the footprint of the soil pile inside the plant area, instead of requiring construction of a new management unit in a previously unaffected area.
- It has a higher short-term effectiveness than Alternatives 2, 5 and 6 because there would be significantly fewer truck trips off-site and resulting noise and risks.

- It is the least expensive of the alternatives that achieve equivalent source reduction and prevention of releases.

5.2.2 Landfills and Landfill Ridge Area Soils

In Section 3, five corrective measures considered for the landfills and the landfill ridge area soil were retained for further evaluation. In this section the retained corrective measures are evaluated with respect to the RCRA balancing criteria. A summary of the balancing criteria screening is presented in **Table 5-3**.

5.2.2.1 Alternative 1: No Action /Monitoring

Under this alternative no active remediation would be performed, but groundwater monitoring would be conducted to confirm that contaminants are not migrating via the groundwater/surface water pathway. If monitoring indicates a release in the future, additional corrective measures would be required.

Long-Term Reliability and Effectiveness

Long-term reliability and effectiveness would be achieved by this alternative through the containment provided by the existing soil covers and long-term groundwater monitoring. The containment system will be monitored by groundwater testing downgradient of both locations to confirm that contaminants do not migrate from the locations via groundwater. Available data indicates that groundwater has not been impacted at these locations. This alternative relies on the existing soil covers over these areas to continue to prevent direct contact with the contaminated soil and migration of contaminants via erosion. A vegetated soil cover over the areas has already been established. Operation and maintenance will consist of seasonal mowing to maintain the grass cover, and long-term groundwater monitoring.

Groundwater monitoring will consist of sampling from existing wells adjacent to each area. A 30-year monitoring duration is assumed. The life expectancy of soil covers is indefinite if appropriately maintained. Institutional controls would be required to prevent excavation and limit access to the area under this alternative. Therefore, this alternative ranks moderate for this criterion

Reduction in Toxicity, Mobility and/or Volume

This alternative does not reduce mobility through the existing soil covers and it does not reduce the toxicity and/or volume of the contamination. Therefore this alternative is ranked low on this criterion.

Implementability

This alternative is highly implementable, as it does not involve any activity except for groundwater monitoring.

Short-Term Effectiveness

Short-term effectiveness of this alternative is high, as it does not create any short-term adverse environmental, worker related or community related impacts.

Table 5-3
Balancing Criteria Assessment for Landfill 2 and Landfill Ridge Area Soils

No.	Description of Corrective Action Alternative	Assessment of Balancing Criteria				
		Long-term reliability and effectiveness	Reduction in toxicity, mobility and/or volume	Implementability	Short-term effectiveness	Costs
1	**No Action/Monitoring**	Moderate	Low	High	High	$1,000,000
2	**Upgrade cap on Landfill 2 /Cap the Landfill Ridge Area Soils (in-place)**	**Moderate**	**Low**	**High**	**High**	**$1,900,000**
3	**Consolidate Landfill 2 and Landfill Ridge Area Soils within the GW containment area**	Moderate	Low	Moderate	Moderate	$2,700,000
4	**Exacavate Landfill 2 and Landfill Ridge Area Soils/ Place On-Site Management Unit**	High	Low	Low	Low	$4,000,000
5	**Exacavate Landfill 2 and Landfill Ridge Area Soils/ Dispose off-site**	High	Moderate	High	Low	$25,400,000

Note: Alternative in bold is the preferred alternative for that media.

Cost
The estimated cost of this alternative is $1,000,000.

5.2.2.2 Alternative 2: Upgrading the Cap on Landfill 2 and Capping the Landfill Ridge Area Soil (in-place)

This alternative would involve installing an engineered, low permeability cap containing a geomembrane on Landfill 2 and the Landfill ridge area soils. Impacted soil and sediment adjacent to Landfill 2 would be consolidated into the landfill footprint. A groundwater-monitoring network would be established.

Long-Term Reliability and Effectiveness
This alternative is also ranked moderate for this criterion although it is considered more reliable and effective than relying on the existing soil covers. The engineered low-permeability caps would limit infiltration through contaminated media and therefore, limit potential impacts to groundwater. Groundwater monitoring would provide continuing evaluation of the effectiveness of the remedy. The caps would also isolate the contaminated contents of Landfill 2 and the landfill ridge area soil from cross-contaminating other areas via erosion. The alternative would be effective in the long-term as long as the integrity of the caps is maintained. The life expectancy of a cap is indefinite if it is properly maintained.

The capped area would be adjacent to a slope at the edge of the river. However, this slope was stabilized previously as part of an interim corrective action. The stability of this slope will be analyzed again as part of the design of the capped area. This stability issue is not expected to make the alternative infeasible.

Operation and maintenance would consist of seasonal mowing to maintain the grass cover, and long-term groundwater monitoring. Groundwater monitoring is a standard and relatively easy way of measuring effectiveness of this alternative. Groundwater monitoring would consist of sampling from existing wells or newly installed wells downgradient of each area. A 30-year monitoring duration is assumed.

Reduction in Toxicity, Mobility and/or Volume
The presence of an engineered cap will reduce the mobility of the contaminants of concern present in contents of Landfill 2 and Landfill Ridge Area soils. This reduction in mobility would be achieved for as long as the integrity of the cap is maintained. However, this alternative will not reduce the volume or toxicity of the contaminated material. Therefore, this alternative rates low in the reduction of toxicity, mobility and volume.

Implementability
This alternative will effectively manage soils containing concentrations above the PMPS. This alternative is fairly easy to implement as it involves upgrading the cap on Landfill 2 and installing a cap on the landfill ridge area soils. Capping is a reliable and standard technology with readily available materials and contractors. Standard

construction equipment would be used for compacting soils, installing the geomembrane and the vegetated cover. An approved and qualified sub-contractor would be hired to install the membrane or the cap on the filled area.

Limited confirmatory sampling would be required to document consolidation of soil material with concentrations greater than the PMPS in the vicinity of the fill areas. The effectiveness of this corrective measure would be determined by taking post-excavation samples at the end of excavation. Extensive approvals are not anticipated for this alternative. Institutional controls would be required to prevent excavation and limit access to the landfills. Institutional controls would include a deed restriction for the site and an access restriction to the capped area to maintain its integrity and prevent accidental excavation. Therefore, this alternative is ranked high for implementability.

Short-Term Effectiveness
The short-term effectiveness of this alternative is ranked high because very limited areas of contaminated soils are expected to be disturbed during construction. In general, remedial construction will entail the addition of materials to construct an engineered cap over the fill materials. Therefore, exposure of contaminants, volatilization and the potential for cross media contamination would be low. Construction activities and associated noise would be limited to the site.

Cost
The estimated cost of this alternative is $1,900,000.

5.2.2.3 Alternative 3: Excavate and Consolidate Landfill 2 and the Landfill Ridge Area Soils within the Groundwater Capture Area and Cap In-place

This alternative would move the mercury-containing materials from the landfill ridge area soils and Landfill 2 into the area where active groundwater control is planned. The current location being considered for consolidation is within the western footprint of the manufacturing planned. Groundwater monitoring would be performed.

Long-term Reliability and Effectiveness
Long-term reliability and effectiveness of this alternative is ranked moderate. The alternative's long-term reliability is based on the groundwater containment, collection and treatment system.

The cap containment would be effective in isolating contaminated soils from human and ecological exposure and from cross-contaminating other uncontaminated media or areas of the site. The engineered cap would prevent COCs from leaching to groundwater.

This alternative would be reliable and have indefinite lifetime expectancy if the integrity of the cap is maintained and groundwater collection and treatment is

performed as long as required. Long-term groundwater monitoring would be performed to determine the need for continued operation of the groundwater collection and treatment system and if contamination is migrating from the capped area.

After construction of this alternative is completed, maintenance and monitoring would be performed consisting of:

- Annual inspection of the consolidation area cap system,
- Seasonal mowing of the cap area, and
- Groundwater monitoring as discussed later in this section to confirm the effectiveness of the groundwater containment system.

Capping is a proven and reliable technology for contaminated soils. Overall, this alternative would be effective long-term in limiting soil contamination and preventing COCs from leaching to groundwater and surface water.

Reduction in Toxicity, Mobility and/or Volume
Excavation and capping limit the mobility of the contamination but do not reduce the toxicity or the volume of the contamination. Therefore, this alternative is ranked low for reduction in toxicity, mobility and volume.

Implementability
The degree of difficulty associated with constructing this alternative is moderate as it involves excavation, consolidation, compaction, and capping of the consolidated area. Standard excavation equipment like backhoes and excavators would be used for excavation, while dump trucks would be used to move the material to the consolidation area. Standard construction equipment would be used for compacting soils, installing the geomembrane and the vegetated cover. An approved and qualified sub-contractor would be hired to install the membrane or the cap on the filled area. Alternative 3 would take longer to construct than alternative 2 but less than Alternative 4.

Consolidation would not require a lengthy permitting process.

Confirmation, post-excavation sampling would be performed at excavated areas and long-term groundwater monitoring would be performed to assess and document the effectiveness of the alternative.

Institutional controls would include a deed restriction for the site and access restrictions to the capped area to maintain its integrity and prevent accidental excavation.

Therefore this alternative is ranked moderate for this criterion.

Short-term effectiveness
Consolidation of soil into the groundwater containment area will require excavation and short-haul transportation. This will result in temporary increased exposure of contaminants to the environment and associated increased potential for volatilization, dust generation and overland runoff during construction. Air monitoring, dust control and silt runoff control would be performed.

Workers would be exposed to the COCs present in the soil during excavation of contaminated areas and compaction of the consolidated area. Exposure would be limited to site workers and would be addressed through the Health and Safety Plan.

Truck and equipment traffic and associated noise would be limited to the site, and this alternative would not require the clearing of previously unimpacted land.

Therefore, the short-term effectiveness of this alternative is considered moderate.

Cost
The estimated cost of this alternative is $2,700,000.

5.2.2.4 Alternative 4: Excavate Landfill 2 and the Landfill Ridge Area Soil, Place in a Management Unit

This alternative would involve excavating the material in Landfill 2 and the Landfill Ridge Area soils and moving it to an on-site, lined management unit. A leachate collection system would be incorporated into the design of the unit. Groundwater monitoring would be performed to determine if contaminants are leaching into the groundwater.

Long-term Reliability and Effectiveness
Long-term reliability and effectiveness of this alternative is ranked as high because of the design and monitoring elements of the secure management unit.

Reduction in Toxicity, Mobility and/or Volume
This alternative would reduce mobility, but not reduce toxicity or volume. Therefore, this alternative is ranked low for this criterion.

Implementability
The implementability of this alternative is ranked low. A management unit is constructible, but would require extensive earthwork. Construction of an on-site management unit would also delay the cleanup of other areas of the site until the management unit is approved to accept soil. Confirmatory sampling requirements are similar to those described for other alternatives considered. As described above, monitoring requirements would be greater than those for other alternatives being considered. Time frames for approval of this lined management unit and other issues related to approval, will likely impede its timely construction, thus adversely affecting the implementability of this alternative. Institutional controls and access limitations would be required under this alternative but these are not expected to be

significantly different from what is anticipated for other alternatives being considered.

Short Term Effectiveness
Short-term effectiveness of this alternative ranked low. A relatively large (approximately 10 acres), previously uncontaminated area of the site would have to be cleared and grubbed to construct the management unit. Excavation and placement of soil at the unit would result in exposure of contaminants, volatilization and potential cross media contamination to a greater extent than Alternatives 1 through 3. Although truck traffic and earthmoving equipment would be largely limited to the site, noise generated from these activities would be greater than and last longer than would result from Alternatives 1 through 3.

Cost
The estimated cost of this alternative is $4,000,000.

5.2.2.5 Alternative 5: Excavate Landfill 2 and the Landfill Ridge Area Soils/Dispose Off-Site

This alternative would entail the excavation, transportation, and off-site disposal of the material in Landfill 2 and the landfill ridge area soil. The excavated material would be transported by truck or railcar to a facility permitted to accept the material.

Long-term Reliability and Effectiveness
Long-term reliability and effectiveness is ranked high because contaminated material would be removed from the site. Operations and maintenance requirements for these areas would be eliminated.

Reduction in Toxicity, Mobility and/or Volume
This alternative would reduce volume and mobility but not the toxicity and is therefore ranked moderate for this criterion.

Implementability
Excavation and transportation off-site are proven technologies and standard equipment and readily available subcontractors can be used. This alternative will achieve PMPS levels upon excavation of these areas assuming that all soils above PMPS are removed. Confirmatory sampling would be required. Special permits and institutional controls are not required. Therefore, this alternative is ranked high for implementability.

Short-term Effectiveness
Short-term environmental impacts of this alternative would include exposure of contaminants, volatilization and potential cross media contamination during excavation and transportation of soil off-site. Transportation of soil off-site for treatment would result in increased truck traffic and noise off-site and the potential for off-site release and cross-contamination of other areas. Therefore, this alternative is ranked low for short-term effectiveness.

Cost
The estimated cost of this alternative is $25,400,000.

5.2.2.6 Recommended Alternative for Landfill 2 and Landfill Ridge Area Soil

Alternative 2, Cap in-place, is the recommended alternative because it will meet corrective action objectives by eliminating soil erosion and rainfall infiltration to the groundwater thereby limiting any potential contamination of surface water. Each alternative would be reliable and effective in meeting the corrective action objectives if properly implemented and monitored. However, off-site disposal or placement in an on-site management unit is less favorable in terms of implementability, short-term impacts and cost compared to cap in-place.

Specifically for Landfill 2, Alternative 2 is recommended because:

- The capping system would be reliable and effective in eliminating the existing route of contaminant release via the transport of fine sediment from the landfill to the Southerly Stream.
- The capping system will reduce the mobility of contaminants by reducing the potential for precipitation to percolate through the waste and prevent the migration of fine sediments from the landfill into the Southerly Stream.
- Any other alternative except for the capping in-place alternative poses an unnecessary short-term risk of release to the air or runoff. Construction of an on-site secure management unit will impact previously unaffected areas leading to potential of cross-contamination.
- The alternative is the most readily implementable.
- Capping in-place is the lowest cost alternative that meets all corrective action objectives for landfills.

For the landfill ridge area (former gravel pit) soils, Alternative 2 is again the recommended alternative because:

- Under this alternative the only route for release of mercury from this area is through groundwater, which has not been impacted, and would be monitored.
- Moving this material to another location poses an unnecessary short-term risk of release to the air or via runoff, and additional cost.
- The proposed cap system will isolate material that is above the groundwater table and preclude migration due to percolation of precipitation.

5.2.3 Chloropicrin Spill Area Soil

In Section 3, five corrective measures were considered for the chloropicrin spill area. All five met the initial RCRA threshold criteria screening and were evaluated against the RCRA balancing criteria. A summary of the balancing criteria assessment for the chloropicrin spill area is presented in **Table 5-4**.

5.2.3.1 Alternative 1: No Action/Monitoring

Under this alternative no active remediation would be performed but groundwater monitoring would be conducted to confirm that contaminants do not migrate via groundwater. Groundwater capture, collection and treatment would occur as part of the overall groundwater remedy.

Long-term Reliability and Effectiveness

This alternative would achieve a moderate level of long-term reliability and effectiveness based on the chloropicrin contamination being at 6-8 feet depth and the groundwater containment and collection system. The groundwater containment system would be relied upon to capture any contaminants leaching to the groundwater table. The life expectancy of this alternative would be indefinite assuming that the groundwater collection and treatment system would not be discontinued until groundwater was documented to be sustained at concentrations less than the PMPS. Groundwater monitoring, which is a tested and reliable means of assessing contamination present in the groundwater, will be performed to assess and document the effectiveness of the alternative.

Therefore, this alternative is ranked moderate because, although effective, it relies on the operation of the groundwater collection and treatment system.

Reduction of Toxicity, Mobility and/or Volume

The groundwater collection system will reduce the potential mobility of chloropicrin, Natural attenuation and continued leaching of chloropicrin to groundwater and its subsequent removal will serve to reduce the volume of the contaminant in soil.. Therefore, this alternative is ranked moderate for reduction of toxicity, mobility and/or volume.

Implementability

This alternative is highly implementable as it requires only groundwater monitoring. No special equipment or specialists would be needed for implementing this corrective measure. The effectiveness of the corrective measure would be measured using groundwater monitoring performed as part of groundwater containment system monitoring program.

Short-term Effectiveness

The short-term effectiveness of this alternative is high, as the contamination is present at a depth of 6-8 feet and no active remediation would be performed at the site.

Table 5-4
Balancing Criteria Assessment for Chloropicrin Spill Area

No.	Description of Corrective Action Alternative	Assessment of Balancing Criteria				
		Long-term reliability and effectiveness	Reduction in toxicity, mobility and/or volume	Implementability	Short-term effectiveness	Costs
1	**No Action/Monitoring**	**Moderate**	**Moderate**	**High**	**High**	**$300,000**
2	**Engineered Cap (In-Place)**	Moderate	Low	High	High	$400,000
3	**In-situ Oxidation**	High	Moderate	Moderate	Moderate	$900,000
4	**Soil Vapor Extraction (SVE)**	High	High	Low	Low	$1,500,000

Note: Alternative in bold is the preferred alternative for that media.

Cost
The estimated cost of this alternative is $300,000.

5.2.3.2 Alternative 2: Engineered Cap In-Place

This alternative will involve the construction of an in-place, engineered membrane cap system over the chloropicrin spill area.

Long-term Reliability and Effectiveness
The cap will prevent infiltration and run-off from leaching into the groundwater table. Groundwater monitoring for chloropicrin would be performed as a part of the groundwater containment system-monitoring program. Groundwater monitoring is a tested and reliable means of assessing contamination present in the groundwater. It is a relatively straightforward technology requiring simple sampling equipment and installation of monitoring wells. This alternative relies on the groundwater containment system and natural attenuation processes to remove concentrations of the contaminant from the soil and the groundwater table. Institutional controls would include a deed restriction for the site and an access restriction for the capped area. The cap would have an indefinite lifetime if properly maintained.

Therefore, this alternative is ranked moderate because, although effective, it relies on the groundwater collection and treatment system.

Reduction of Toxicity, Mobility and/or Volume
This alternative is ranked low in reduction of toxicity, mobility and/or volume because the alternative does not destroy the contaminants or reduce its toxicity. However, the engineered cap will significantly reduce the mobility of contaminant. This reduction in mobility of the contaminant would be sustained as long as the integrity of the cap is maintained.

Implementability
It is readily implementable especially in conjunction with consolidation and capping activities proposed for the plant area. The degree of difficulty associated with constructing the cap would be low. Standard construction equipment will be used in the construction of this alternative and an approved and qualified sub-contractor would be hired to install the membrane at the capped area.

The effectiveness of the corrective measure would be measured using groundwater monitoring as discussed under long-term effectiveness. This would be performed as part of the groundwater containment system monitoring program. Institutional controls would include a deed restriction for the site and an access restriction for the capped area to prevent accidental excavation of the area. Therefore, this alternative ranks high for implementability

Short-term Effectiveness
The short-term effectiveness of this alternative is high. It would not lead to contaminant volatilization or exposure of workers to contamination, or cross-media

contamination because the contamination is present at a depth of 6-8 feet. Therefore, this alternative is equally protective of the environment in the short-term as the No Action alternative.

Cost
The estimated cost of this alternative is $400,000.

5.2.3.3 Alternative 3: In-situ Oxidation

Under this alternative chloropicrin contaminated soil would be treated using in-situ chemical oxidation by injecting oxidizing chemicals. A vapor extraction system may also be installed to treat the gaseous by-products generated as a result of the treatment method.

Long-term Reliability and Effectiveness
This alternative will achieve high level of long-term reliability and effectiveness by destroying chloropicrin present in the soil to carbon dioxide, water, chloride and nitrate ions. In-situ oxidation is a proven technique for destruction of volatile organic compounds in soil. Soil samples would be obtained to confirm the reduction in chloropicrin concentrations to below the PMPS. The life expectancy of this alternative is permanent after an anticipated approximate three-year chemical injection period. No institutional controls or operation and maintenance activities are planned upon the termination of the oxidation treatment therefore; this is regarded as a reliable and effective technology in the long-term.

Reduction in Toxicity, Mobility and/or Volume
In-situ oxidation would reduce the toxicity, mobility and volume of chloropicrin contamination present in the soil. This would be achieved by the oxidation and destruction of chloropicrin by the oxidizing chemicals. This treatment is irreversible and therefore the reduction achieved in toxicity, mobility and volume would be permanent. However, potentially toxic gaseous by-products may be generated which would need to be collected and treated by a soil vapor extraction system. Therefore, this alternative ranks moderate for this criterion.

Implementability
In-situ oxidation is a readily available technology for contaminated soils. Below PMPS values will not be attained immediately but would be achieved during the lifetime of the technology application estimated to be within 3 years. The treatment may lead to the production of off-gases, which would be treated by vapor extraction. Vapor extraction points would likely be installed by direct push methods to avoid bringing chloropicrin-contaminated soil to the surface. As the alternative involves digging trenches, setting up piping and storage tank for the chemical, therefore this alternative is moderately constructible. Some air permitting and monitoring is anticipated for this alternative.

The efficiency of the technology would be assessed by taking confirmatory soil samples to document the decrease in concentration of chloropicrin to below PMPS

levels. No institutional requirements would be required for this alternative. Therefore, this alternative is ranked moderate for this criterion.

Short-term Effectiveness
The implementation of the in-situ oxidation technology would not have short term environmental impacts from the deep chloropicrin contamination. However, there are potential short-term impacts associated with the by-products of chloropicrin oxidation. Some of the potential gaseous by-products are toxic and therefore, a soil vapor extraction system may be required in conjunction with the injection of an oxidizing agent. As mentioned above, injection points would likely be installed by direct push methods to avoid bringing chloropicrin-contaminated soil to the surface. As material will not be excavated or moved off-site the potential of cross-media contamination, exposure to workers and volatilization does not exist. Therefore, this alternative is rated moderate for short-term effectiveness.

Cost
The estimated cost of this alternative is $900,000.

5.2.3.4 Alternative 4: Soil Vapor Extraction (SVE)

This alternative would involve treating chloropicrin contaminated soil using soil vapor extraction combined with vapor phase treatment.

Long-term Reliability and Effectiveness
This alternative will achieve high level of long-term reliability and effectiveness by extracting chloropicrin vapors present in the soil to an incinerator, which would destroy chloropicrin with a minimum 99.5% efficiency. This would reduce the chloropicrin concentrations present in the soil to below PMPS levels over-time. Off-gases would be sent to a hydrochloric acid scrubber. SVE is a proven technique for destruction of volatile organic compounds in soil. Soil samples would be obtained to confirm the reduction in chloropicrin concentrations to below the PMPS. The life expectancy of this alternative is about 1-2 years after which the treatment would be stopped based on the results of the confirmatory sampling. No institutional controls or operation and maintenance activities are planned upon the termination of the SVE treatment therefore; this is regarded as a reliable and effective technology in the long-term.

Reduction in Toxicity, Mobility and/or Volume
High level of reduction in toxicity, mobility and volume would be achieved by the soil vapor extraction technology. SVE would effectively reduce toxicity, mobility and volume of chloropicrin contamination present in the soil by recovering and destroying the chloropicrin. This treatment is irreversible and therefore the reduction achieved in toxicity, mobility and volume would be permanent. Gaseous by-products would be treated by a soil vapor extraction system while the residual concentrations in the soil would be removed by natural processes over-time.

Implementability
Soil vapor extraction is a readily available technology. The treatment will lead to the production of off-gases, which would be treated by a hydrochloric acid scrubber. Vapor extraction points would likely be installed by direct push methods to avoid bringing chloropicrin-contaminated soil to the surface. Direct push installed injection points are not typically as efficient as drill rig installed points. Since the alternative involves, digging trenches, or vapor extraction wells, piping manifolds and vacuum system, this alternative is rated low on constructability.

The efficiency of the technology would be assessed by taking confirmatory soil samples to document the decrease in concentration of chloropicrin to below PMPS levels. No institutional control requirements would be required for this alternative. No extensive permitting process is anticipated for this alternative.

There are also concerns in implementing this technology for chloropicrin as described below. Overall, the implementability of this alternative is rated low.

Short-term Effectiveness
Short-term effectiveness of this alternative is low. There are potential short-term impacts associated with the extraction and treatment of chloropicrin-laden vapors at the surface. Chloropicrin is an acutely toxic VOC and when concentrated is potentially reactive, explosive, shock and temperature sensitive. Some of the potential treatment by-products are also toxic. Therefore, this alternative is rated low for short-term effectiveness.

Cost
The estimated cost of this alternative is $1,500,000.

5.2.3.5 Recommended Alternative for Chloropicrin Spill Area Soil

The recommended alternative for the Chloropicrin Spill Area is Alternative 1, No Action / Monitoring. The no-action alternative is preferred because potential impacts to groundwater are managed through the groundwater collection and treatment system and natural attenuation processes are expected to reduce the contaminant concentrations over time. Alternative 2, the engineered cap, is not preferred because it is no more effective in preventing the migration of the contaminant and it would slow the processes of natural attenuation.

Alternative 1 meets all corrective action objectives for the chloropicrin spill area soil. Additionally, Alternative 1 is easily implementable and has no adverse short-term effects. The remaining alternatives provide no additional protection for the increased short-term impacts and costs over Alternative 1.

5.3 Evaluation of Corrective Measures for Sediment

In Section 3, five corrective measures for the sediments of the Southern Cove were retained in the screening process. The No Action / Monitoring alternative was not retained for further evaluation. Based on these five alternatives, three corrective

measures were developed in Section 4 for evaluation. In this section the three corrective measures are evaluated against the RCRA balancing criteria. A summary of the balancing criteria screening for sediments is presented in **Table 5-5**.

5.3.1 Alternative 1: Dredging/On-Site Consolidation in the Groundwater Containment Area

This alternative would entail removal and dewatering of mercury containing sediments from the Southern Cove via dredging. The dewatered sediment would be consolidated with plant area soils within the groundwater containment area.

Long-term Reliability and Effectiveness

This alternative would be effective in removing discrete areas of sediment containing localized elevated concentrations of mercury above the PMPS of 2.2 mg/kg. The engineered cap containment would prevent erosion of soils and leaching of contaminants to the groundwater table. Silt barriers and silt curtains would be employed to limit migration of sediment during dredging. The removal of sediment at the Southern Cove is considered a permanent solution at the cove. No operations or maintenance activities are necessary at the cove however; maintenance and monitoring activities would be performed on the engineered cap within the groundwater containments area.

Institutional controls like deed restrictions for the site and access restrictions would be required to maintain the integrity of the engineered cap. Consolidating the sediment under an engineered cap will effectively isolate the contaminated sediments and prevent contamination from leaching to the groundwater table as long as the integrity of the cap is maintained. The life expectancy of a cap is indefinite if properly maintained.

Because the contaminants placed beneath the engineered cap are effectively isolated, this alternative is not expected to extend the duration of operation of the groundwater collection and treatment system, any longer than would be the case if a lined management unit were used.

This alternative is ranked moderate for this criterion because it relies in part on the groundwater containment area collection and treatment system.

Reduction in Toxicity, Mobility and/or Volume

This alternative is rated as moderate for reduction of toxicity, mobility and the volume of the contaminants. Dredging of contaminated sediment and placement under an engineered cap will effectively curtail the mobility of the COCs to groundwater and surface water. It will remove the volume of contaminated sediment at the cove where it is a concern, but it will not reduce the volume of contaminated material at the site. There will be a reduction the potential for greater toxicity because the mechanism for transformation to the more toxic methylmercury will be eliminated.

Table 5-5
Balancing Criteria Assessment for Southern Cove Sediments

No.	Description of Corrective Action Alternative	Assessment of Balancing Criteria				
		Long-term reliability and effectiveness	Reduction in toxicity, mobility and/or volume	Implementability	Short-term effectiveness	Costs
1	**Dredge/On-Site Consolidation under Cap**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**$6,000,000**
2	**Dredge/Off-site Disposal**	High	High	Moderate	Low	$9,500,000
3	**In-Situ Electrokinetics**	Moderate	Moderate	Low	Low	$4,500,000

Note: Alternative in bold is the preferred alternative for that media.

Implementability
Sediment dredging is implementable although the engineering challenges are considerable. A DryDredge ™ would be used to implement the technology and silt curtains / barriers would be used to prevent re-suspension of the sediments. This type of machinery is supplied by a limited number of contractors. The dredged sediment would be dewatered using "geotubes" made of geotextiles and the water would be treated on-site. Confirmatory sampling would be performed. A Natural Resources Protection Act permit would be required for work in the Southern Cove. Institutional controls would include access restrictions to the capped area to maintain its integrity and prevent accidental excavation. Management of re-suspended sediment and dewatering, and transportation of sediment all will require considerable engineering design. Therefore, dredging is ranked as moderate for this criterion.

Short-term Effectiveness
Short-term impacts due to the implementation of this alternative would include resuspension of sediment during dredging. Dredging would also adversely impact the ecosystem and the environment present in the Southern Cove. However, this would recover over-time. Handling and transportation of the material to the consolidation area within the groundwater containment area would also lead to potential cross-contamination of previously uncontaminated areas. Therefore, there would be some adverse short-term effects associated with this alternative and it is therefore rated moderate for this criterion.

Cost
The estimated cost of this alternative is $6,000,000.

5.3.2 Alternative 2: Dredging/Off-site Disposal

This alternative would entail the removal and dewatering of mercury containing sediments from the Southern Cove via dredging. The material would be disposed of at a licensed off-site disposal facility.

Long-term Reliability and Effectiveness
Long-term effectiveness is high for this alternative because the source of contamination would be removed from the site. No long-term institutional controls or operational and maintenance activities would be required at the cove or the site. Other reliability and effectiveness considerations are the same as for Alternative 1.

Reduction in Toxicity, Mobility and/or Volume
Dredging of the cove sediment and disposal off-site will lead to reduction of toxicity, mobility and volume of the contaminants at the site. Therefore, this alternative rates high in reduction of toxicity, mobility and volume of contaminants.

Implementability
The implementability of this alternative is similar to Alternative 1 and therefore ranked moderate.

Short-term Effectiveness
The short-term effectiveness of this alternative is ranked lower than Alternative 1 because the dredged sediment would be transported off-site. Off-site transportation and creates the potential of cross-contaminating areas during transportation and will result in additional off-site impacts impact due to increased truck traffic and noise. Therefore, this alternative is ranked low for short-term effectiveness.

Costs
The estimated cost of this alternative is $9,500,000.

5.3.3 Alternative 3: In-Situ Electrokinetics

Electrokinetics involves the placement of electrodes in the sediment and the application of a proprietary current arrangement that reportedly causes mercury to migrate to and plate on the electrodes. Electrodes are then removed and either disposed or sent to a retort facility. Sampling would be performed to confirm the degree of mercury removal and the residual concentrations in the sediment.

Long-term Reliability and Effectiveness
The reliability and effectiveness of this emerging technology has not been proven through a full-scale demonstration. Therefore, a pilot study would be necessary to demonstrate its viability at the cove. If the results of the pilot study indicate the removal of mercury in sediment to below the PMPS, this technology could be considered highly reliable and effective in the long-term. It is purported that the technology would be successful in decreasing mercury concentrations to below PMPS levels in 6-12 months. No operation or maintenance activities would be associated with this alternative upon completion. This alternative has been ranked moderate for this criterion because it has yet to be proven.

Reduction in Toxicity, Mobility and/or Volume
This technology would involve the plating of mercury on the electrodes of the system, which would reduce the mobility and volume of the contaminants. Also depending on the form of mercury that plates on to the electrodes, it may also reduce the toxicity of the mercury. Therefore, this alternative would lead to significant reductions in the toxicity, mobility and volume of the contaminant, making this alternative rate high in this category. This alternative has been ranked moderate for this criterion because it has yet to be proven.

Implementability
This technology may be implementable, but bench scale testing and/or a pilot study would be required. Implementing the technology on a full-scale will present engineering design challenges as well. However, this technology has been used at very few sites. There is only one vendor that is licensed to design and apply the technology in the U.S. and there is little data that the technology has been successfully applied to environments similar to the Southern Cove. A Natural Resource Protection Act permit would be required. Confirmatory sampling would also be required. Therefore, this technology has been rated low for implementability. No institutional

controls are planned under this alternative. Therefore, this alternative is ranked low for this criterion because its implementability is unproven.

Short-term Effectiveness
In-situ electrokinetics reportedly works quickly, in most cases in a matter of months. Placing and removal of electrodes would lead to re-suspension of sediments but it would be much less than that involved in dredging. Although not well documented there is a potential of gaseous by-products being generated by the implementation of this technology. This would be ascertained during the pilot scale study at the site. The electrodes along with mercury accumulated on them would have to be disposed of at an off-site disposal facility or retorting facility. This could potentially lead to cross-contamination issues during transport of the material. Electrokinetics reportedly does not have the same magnitude of adverse short-term impacts that are associated with dredging of sediments and is therefore ranked low for this criterion.

CDM does not recommend In-situ Electrokinetics, due to its lack of demonstrable effectiveness. However, this alternative may be reconsidered based on a successful pilot testing performed on HoltraChem site media.

Cost
The estimated cost of this alternative is $4,500,000.

5.3.4 Recommended Alternative for Cove Sediments

Alternative 1, Dredging/On-site Placement in the Consolidation Area, is the recommended alternative. RCRA allows for and encourages consolidation of contaminated material on site. The Southern Cove has always been considered a part of the site. The material in the Southern Cove is similar to and contiguous with other contaminated material on the site, including the sediments in the Southerly Stream. Therefore, the material from the cove will be treated the same as consolidation of other material at the site.

The effectiveness of Alternative 1 is equivalent to Alternative 2 in the removal of material from the Southern Cove. Alternative 1 is also equivalent to Alternative 2 in effectiveness because the potential for migration of contaminants from the consolidated dredged material would be negligible due to the proposed engineered cap system and the groundwater containment system. Alternative 1 will have significantly less short-term impact to the community than Alternative 2 because transportation of material off-site is not necessary.

5.4 Evaluation of Corrective Measures for Groundwater

All three corrective measures considered for groundwater met the initial threshold screening criteria in Section 3. In this section these corrective measures are evaluated against the RCRA balancing criteria. A summary of the balancing criteria screening for groundwater is presented in **Table 5-6**.

5.4.1 Alternative 1: Groundwater Cut-off Barrier/Groundwater Extraction System/On-Site, Ex-Situ Treatment

This corrective measure would involve the construction of an impermeable groundwater barrier wall down gradient of the plant area and Landfill 1. The captured groundwater would be extracted and treated on-site, and discharged to the river.

Long-term Reliability and Effectiveness

This corrective measure would achieve a high level of long-term reliability and effectiveness.

The impermeable groundwater barrier wall would capture and prevent contaminated water from flowing to the Penobscot River. This captured groundwater would be extracted and treated on-site. This will prevent contaminated groundwater from flowing into the river.

The life expectancy of the barrier wall is indefinite. With proper operation and maintenance the life expectancy of the groundwater extraction system is also indefinite. Operation and maintenance would include downgradient groundwater monitoring to confirm the integrity of the barrier wall. Groundwater within the barrier wall will also be tested periodically to assess the reduction in contaminant concentrations and to determine the required duration of collection and treatment.

Long-term institutional controls associated with this alternative include requirements to operate the system until the PMPS are met, access restrictions and prohibitions on the development and use of untreated groundwater. Therefore, this alternative is ranked moderate for this criterion.

Reduction in Toxicity, Mobility and/or Volume

This alternative would be highly effective in reducing the toxicity, mobility and volume of the contaminants present in the groundwater. The groundwater barrier wall and the extraction system will achieve reduction in volume and mobility of the contaminant, while the WWTP plant would be effective in reducing toxicity through treatment. As this process will eventually remove and in the case of VOCs destroy the contamination present in the groundwater, it is considered an irreversible and permanent process. Any residuals present in the groundwater would be naturally attenuated.

Implementability

This alternative will achieve PMPS/drinking water levels in the groundwater upgradient of the barrier wall over a period of time. The degree of difficulty associated with constructing this technology is moderate as it involves the construction of a barrier wall, groundwater extraction system and potentially a modified WWTP. Standard construction equipment and appropriate slurry trench technology would be used to construct this alternative. A Natural Resources

Table 5-6
Balancing Criteria Assessment for Ground Water

No.	Description of Corrective Action Alternative	Assessment of Balancing Criteria				
		Long-term reliability and effectiveness	Reduction in toxicity, mobility and/or volume	Implementability	Short-term effectiveness	Costs
1	**Cutoff barrier/Extraction/ On-Site Ex-Situ Treatment**	**Moderate**	**High**	**Moderate**	**Moderate**	**$11,800,000**
2	**Cutoff barrier/Extraction/ Off-Site Treatment**	Moderate	High	Moderate	Low	$41,000,000
3	**Cutoff barrier/In-Situ Treatment**	Moderate	High	Moderate	High	$6,000,000

Note: Alternative in bold is the preferred alternative for that media.

Protection Act permit would be required. Therefore, this alternative is ranked moderate for this criterion.

Short-term Effectiveness
Short-term effectiveness of this alternative is moderate as workers would be exposed to contamination during construction of the trench and the extraction system. Volatilization of contaminants during materials handling will also be an issue. The corrective measure will address the contamination of the surface water pathway, thereby preventing contaminated groundwater from being discharged to the Penobscot. Traffic and noise short-term adverse effects of the alternative would be largely limited to the site. The implementation of the barrier wall construction activities may lead to short term cross-media impacts.

Cost
The estimated cost of this alternative is $11,800,000.

5.4.2 Alternative 2: Groundwater Cut-off Barrier/Groundwater Extraction System/Off-Site, Ex-Situ Treatment

This corrective measure would involve the construction of an impermeable groundwater barrier wall down gradient to the plant area. The captured groundwater would be extracted and sent off-site for treatment.

Long-term Reliability and Effectiveness
The long-term reliability of this alternative is similar to Alternative 1 and is therefore ranked moderate.

Reduction in Toxicity, Mobility and/or Volume
Reduction of toxicity, mobility and/or volume characteristics of this alternative are identical to that of Alternative 1. Therefore, this alternative is ranked high in reduction of toxicity, mobility and volume.

Implementability
The overall implementability of this alternative is to Alternative 1 and is moderate. Modifications to the WWTP would not be necessary.

Short-term Effectiveness
Short-term impacts would result from sending groundwater off-site for treatment. This alternative can potentially lead to cross-contamination of areas during transportation. In addition, off-site transportation and disposal will generate associated traffic and noise. Therefore, the short-term effectiveness of this alternative is ranked low for this criterion.

Cost
The estimated cost of this alternative is $41,000,000.

5.4.3 Alternative 3: Groundwater Cut-off Barrier/In-Situ Groundwater Treatment

This corrective measure would involve the construction of an impermeable groundwater barrier wall down gradient of the plant area. The captured groundwater would be treated in-situ by an adsorptive treatment gate packed with sulfur-impregnated carbon media.

Long-term Reliability and Effectiveness

The long-term reliability and effectiveness of this alternative is ranked as moderate because, even though sulfur-impregnated carbon media has been used effectively in aboveground treatment systems, its effectiveness in an in-situ treatment system is currently unproven. During the corrective measures process and after design and implementation of a groundwater Interim Remedial Measure, the potential for implementation of an adsorptive gate system will continue to be investigated and evaluated. The long-term reliability and effectiveness of the groundwater barrier wall remains the same as discussed in Alternative 1. Operation and maintenance for this alternative would include periodic replacement of the adsorptive media, and transportation and disposal of the media. Operation and maintenance would also include monitoring groundwater downstream of the barrier wall and adsorptive gate. Institutional controls associated with this alternative are similar to Alternative 1.

Reduction in Toxicity, Mobility and/or Volume

Reduction of toxicity, mobility and/or volume characteristics of this alternative, if effective is expected to be the same as the other containment, collection and treatment alternatives. This alternative is therefore ranked high for this criterion.

Implementability

The overall implementability of this alternative is similar to Alternative 1 because the design and construction requirements are similar. The degree of difficulty associated with constructing this technology is moderate as it involves the construction of a barrier wall, and an adsorptive media gate. Standard construction equipment and appropriate slurry trench technology would be used to construct this alternative. As discussed above, the effectiveness of this corrective measure would be assessed by periodic groundwater monitoring. Institutional controls associated with this alternative are similar to those for Alternatives 1 and 2. Therefore, the overall implementability of this alternative is moderate.

Short-term Effectiveness

Short-term effectiveness of this alternative is initially similar to Alternative 1. However, once treatment was performed in-situ, no groundwater would be extracted and transferred across the site or off-site thus limiting exposure and the potential for cross-contamination of other areas. Therefore, this alternative is rated higher in short-term effectiveness than Alternatives 1 and 2.

Cost

The estimated cost of this alternative is $6,000,000.

5.4.4 Recommended Alternative for Groundwater

Alternative 1, Groundwater cut-off barrier / Groundwater Extraction System / On-site, ex-situ treatment is recommended as the preferred alternative for groundwater. Alternative 1 is chosen because it is equally protective and due to its substantially lower cost when compared to off-site disposal. An additional advantage of Alternative 1 over Alternative 2 is that it would prevent cross-contamination of uncontaminated areas due to off-site treatment of groundwater.

The extracted groundwater will be treated to the extent required by the site surface water discharge permit, which requires the use of best available technology, and discharged to the Penobscot River via a surface water discharge.

The feasibility of and cost for an in-situ adsorptive gate will continue to be developed. Current unknowns include the amount of media required and the frequency of replacement. Because all alternatives considered include the installation of the barrier wall and collection and treatment of groundwater, pilot testing of alternative treatment methods such as the adsorptive gate media can be performed at a later date.

5.5 Evaluation of Corrective Measures for Surface Water

As discussed in Section 4, the corrective measures identified for surface water are limited to removal of the Lined Process Lagoon, and plugging of the industrial sewer. Other corrective measures that will positively impact surface water are removal or management of soil and stream / ditch sediments, which are described under Section 5.2.1. A groundwater interceptor trench has already been installed in the one area where it is warranted. Surface water specific technologies are applicable to specific sections of the industrial sewer and / or the portion of the Southerly Stream that flows through the plant in a culvert. The application of corrective measures for surface water will be sequential or determined by the specific circumstance.

The recommended alternative for surface water is:

- Removal of the Lined Process Lagoon
- Continued operation of the groundwater interceptor trench
- Plugging of the industrial sewer

Section 6
Recommended Corrective Action Program

6.1 Purpose of Section

This section presents the overall recommended corrective action program for the HoltraChem Site, and summarizes the rationale for choosing each recommended corrective action. The recommended corrective action program is consistent with the results of the detailed evaluation of the individual corrective measures. It also considers the ability to integrate the preferred corrective actions for each media into an overall program to meet the corrective action objectives.

The main components of the overall corrective action are as follows:

- Excavate to the extent practicable and treat elemental mercury-contaminated soils beneath the cell building
- Consolidate and cap plant area soils
- Cap Landfill 2 and landfill ridge area soils
- Dredge Southern Cove sediments and consolidate and cap them with plant area soils
- Construct groundwater containment, collection, and treatment system
- Plug and abandon industrial sewers
- Perform operations, maintenance, and monitoring

In addition, groundwater monitoring is recommended for the plant area, chloropicrin spill area, landfills, and the landfill ridge area.

A description of the scope of each of the recommended corrective action components is described in the remainder of this section. The descriptions are organized by media type, consistent with the previous sections of the report.

6.2 Cell Building and Plant Area Soils

6.2.1 Recommended Corrective Action

The recommended corrective action for the Cell Building and plant area soils is Alternative 3, which involves excavation and treatment of the Cell Building soils and consolidation and capping of the treated cell building soils and the remainder of the plant area soils. The scope of this corrective measure is explained in more detail below.

6.2.2 Scope of Cell Building Soils Corrective Action

After demolition of the Cell Building, soil with visual indications of elemental mercury will be excavated to the extent practicable from the Cell Building footprint and perimeter. This will include, at a minimum, excavating soil beneath the brine receiver area and Cell Building sump to the till layer, as evidence of elemental mercury contamination has been noted at these locations in the past. The excavated soil will be treated on site using physical or hydraulic separation methods, such as soil washing or vibration, to remove mercury from the soil, and to reduce the volume of mercury-containing soil. The mercury-contaminated waste resulting from the treatment operations will be disposed of through a permitted disposal facility. The treated soil will be consolidated with the other excavated plant area soils above the seasonally high groundwater table and covered with an impermeable engineered cap within the groundwater containment area or placed back in to the excavation if soils meet the PMPS. The cap will extend over the former Cell Building footprint.

6.2.3 Scope of Plant Area Soils Corrective Action

The remaining plant area soils from areas exceeding the mercury PMPS of 2.2 mg/kg will be consolidated into the groundwater containment area and capped. Soils that require excavation to achieve consolidation will be placed above the seasonally high groundwater table. This will involve excavation of the following areas:

- Used equipment storage area
- Scrap metal and coal filter storage area
- Fill area at Nitromethane Building
- End of railroad car loading area
- Leach field
- Surface soils in the vicinity of the plant
- SSS-025 area
- North Ditch fill area
- North Ditch
- Southerly Stream

The soil from these areas will be compacted in lifts in an area encompassing the cell building and retort building footprints. The consolidation area will then be graded for

proper drainage and capped with an engineered soil cover incorporating an impermeable membrane to prevent rainfall and snowmelt infiltration.

6.2.4 Rationale for Recommendations

This corrective action is recommended based on the results of the balancing criteria evaluation. This evaluation indicates that Alternative 3 achieves the best balance of fulfilling selection criteria. The key reasons for this recommendation are discussed below.

The corrective action is reliable and effective in meeting the corrective action objectives. Excavated mercury-contaminated soil will be placed above the groundwater table under an impermeable engineered cap, effectively preventing exposure to, or future release of mercury. Excavation and treatment of the cell building soils achieves the highest degree of effectiveness in meeting the corrective action objectives for this material, which is a potential source of continued release to groundwater. Furthermore, the planned groundwater capture system will create a groundwater containment area and will be effective in preventing the off-site release of mercury resulting from the greatly reduced, but still present, potential for transport of mercury from soil via groundwater. Because the contaminants placed beneath the cap are effectively isolated, this alternative is not expected to extend the duration of operation of the groundwater collection and treatment system, any longer than would be the case if a lined management unit were used.

Alternative 4, which involves placement of the contaminated soil within a lined management unit rates slightly higher in effectiveness because it does not rely on an active groundwater collection system. However, this advantage must be considered small, in light of the fact that the groundwater capture system is an integral component of the overall corrective action program, and will be implemented regardless of the selected soil alternative. The management unit may also include a leachate collection system, which must be actively maintained to achieve the expected effectiveness of Alternative 4, creating duplicate operation and maintenance requirements.

Under the criterion of reduction in toxicity, mobility, and/or volume, the recommended alternative provides the advantage of achieving source removal for the most contaminated material (Cell Building soils). The contamination from soils remaining on site is effectively immobilized by the engineered cap system and groundwater containment system. The recommended alternative is equivalent or better than the other alternatives in meeting this criterion.

Alternative 3 is readily implementable. In particular, no special construction techniques or equipment are necessary to implement this corrective action. When the issue of required approvals is considered, the recommended alternative is favorable as the concept of consolidation is allowed and encouraged by RCRA regulations.

Only the approval of the recommended corrective action by MEDEP and EPA would be required to implement this corrective measure. This contrasts with Alternative 4, which would likely require a significant and lengthy approval process, as it includes the construction of a new management unit on site, and would have a significantly longer construction schedule thereby leaving the contaminated materials uncontrolled for a longer period of time. This must be considered when comparing the alternatives.

Short-term impacts of the recommended alternative are few. Contrasting with Alternative 4, which has the added short-term impact of requiring the clearing of approximately 10 acres of unimpacted, forested land, the construction of the management unit on a previously unaffected area of the site, and longer duration of construction-related impacts. Alternatives 2, 5, and 6 also compare unfavorably to the recommended alternative when short-term effectiveness is considered, primarily due to the impact and risk of truck traffic through the surrounding community to and from the site. Alternative 5 in particular, would result in an estimated 4,800 truck roundtrips through the surrounding community. The recommended alternative in contrast, will involve an estimated 220 truck roundtrips.

In summary, this corrective action (Alternative 3) is recommended because:

- It meets the corrective action objectives for soils.
- It is reliable and effective in preventing exposure or release to the environment through the groundwater capture system.
- It reduces the mobility and volume of hazardous waste on-site by removing the Cell Building soils that contain elemental mercury.
- It has fewer short-term impacts than an on-site secure management unit since it maintains the footprint of the soil pile inside the plant area, instead of requiring construction of a new landfill in an unaffected area.
- It has fewer short-term impacts to the community than off-site disposal since it will result in fewer truck trips to and from the site.
- It is the least expensive of the alternatives that achieve equivalent source reduction and prevention of releases.

6.3 Landfills and Landfill Ridge Area

6.3.1 Recommended Corrective Action

The recommended corrective action for Landfill 2 and the landfill ridge area soils is Alternative 2, which involves capping these areas in-place. The scope of this corrective measure is explained in more detail below.

6.3.2 Scope of Corrective Action

Landfill 2 and the landfill ridge area fill material from the former gravel pit will be capped in place. The cap will consist of an engineered soil cover incorporating an impermeable membrane. The cap will be graded for proper drainage and will incorporate a soil protection layer a vegetation support layer consisting of topsoil seeded with native grasses.

6.3.3 Rationale for Recommendations

This corrective action is recommended because it will meet corrective action objectives by reducing soil erosion and rainfall infiltration to the groundwater thereby potential contamination of surface water. Each alternative would be reliable and effective in meeting the corrective action objectives if properly implemented and monitored. However, off-site disposal or placement in an on-site management unit are less favorable in terms of implementability, short-term impacts and cost compared to cap in-place.

Specifically for Landfill 2, this corrective action (Alternative 2) is recommended because:

- The capping system would be reliable and effective in eliminating the existing route of contaminant release via the transport of fine sediment from the landfill to the Southerly Stream.
- The capping system will reduce the mobility of contaminants by reducing the potential for precipitation to percolate through the waste and prevent the migration of fine sediments from the landfill into the Southerly Stream.
- Any other alternative except for the capping in-place alternative poses an unnecessary short-term risk of release to the air and surface runoff. On-site placement in a management unit will impact previously unaffected areas leading to potential of cross-contamination.
- The alternative is readily implementable.
- Capping in-place is the lowest cost alternative that meets all of the corrective action objectives.

For the Landfill Ridge Area (former gravel pit) soils, Alternative 2 is again the recommended alternative because:

- Under this alternative the only route for release of mercury from this area is through groundwater, which has not been impacted, and would be monitored.

- Moving this material to another location poses an unnecessary short-term risk of release to the air or via runoff, and additional cost.

The proposed cap system will result in material that is above the groundwater table and safe from migration due to the percolation of precipitation.

6.4 Chloropicrin Spill Area Soil

The recommended corrective action for the chloropicrin spill area is no action (Alternative 1). This alternative achieves the corrective action objectives by preventing human and wildlife exposure to the contaminant due to the fact that the contaminant is eight feet or greater below grade. Migration of the contaminant is prevented by the groundwater containment system, while the concentrations of chloropicrin in the soil would be reduced over time due to natural attenuation processes. This alternative is preferred over the other alternatives because:

- The capping alternative does not provide an increase in protection, but is significantly more expensive. The capping alternative would also slow the process of natural attenuation of the chloropicrin contamination.

- The treatment alternatives provide theoretically quicker reduction in the source of contaminant, but otherwise do not result in reduced risk of exposure to humans or the environment. These alternatives also have a much higher cost, increased complexity of implementation, and in the case of SVE, have a risk of release of the toxic chloropicrin vapor to the atmosphere and subsequent exposure to site workers, and other receptors.

6.5 Southern Cove Sediments

6.5.1 Recommended Corrective Action

The recommended corrective action for the Southern Cove sediments is Alternative 1. This involves dredging the cove sediments and consolidating them with the plant soils within the groundwater containment system. The scope of this corrective measure is explained in more detail below.

6.5.2 Scope of Corrective Action

Sediments in the outfall area and mudflat area identified as exceeding the mercury PMPS of 2.2 mg/kg will be dredged from the cove. The material will be dewatered and solidified if necessary to improve its handling and strength characteristics. The processed dredge spoils will then be consolidated and capped inside the groundwater containment system with the plant area soils.

The direct current technology known as “electro-chemical remediation technology” (ECRT) appeared from the corrective measures evaluation to be a promising alternative to dredging. It is not currently recommended however due to the lack of a

full-scale implementation track record. This alternative may be reconsidered for recommendation however, if the effectiveness of the technology is demonstrated by successful full-scale application and pilot testing on sediments at other sites.

6.5.3 Rationale for Recommendations

Alternative 1 is recommended. This consists of consolidating and capping the dredged sediments within the groundwater capture area. This corrective measure is applicable to the Southern Cove because, it has always been considered part of the HoltraChem site. The material in the cove is similar to and contiguous with the other contaminated material on the site including the sediments in the Southerly Stream. Therefore, the cove sediments should be treated the same as other site soil and sediments regarding the applicability of consolidation as an appropriate corrective measure.

The rationale for recommending this alternative is based on the balancing criteria evaluation. This evaluation indicates that Alternative 1 achieves the best balance of fulfilling the selection criteria. The key reasons for this recommendation are discussed below.

The corrective action objectives will be met by the removal of the sediments from the cove. The potential migration of contaminant from the consolidated dredged material will be prevented by the proposed engineered cap system and the groundwater capture system within the groundwater containment area, which are reliable and effective means of preventing releases and exposure, as discussed previously in this section. Because the contamination placed beneath the cap are effectively isolated, this alternative is not expected to extend the duration of operation of the groundwater collection and treatment system any longer than would be the case if a lined management unit were used.

Alternative 1 will have significantly less short-term impact to the community due to the reduction in truck traffic over Alternative 2. Approximately 800 to 1,200 truck roundtrips through the surrounding community will be avoided by consolidating the sediments within the groundwater containment area.

ECRT, although it has theoretical advantages over dredging, including cost and minimal disturbance, is not currently recommended, due to its lack of a track record in full-scale projects. However, if it were effective this alternative would be preferred due to its stated ability to remove mercury from the sediment with minimal disturbance to the cove area, and potentially lower cost. Therefore, this technology may be reconsidered if additional applicability data becomes available, but only after successful pilot testing performed on site sediment.

6.6 Groundwater

6.6.1 Recommended Corrective Action

The recommended corrective action for the site groundwater is Alternative 1. This involves constructing a groundwater cutoff slurry wall, groundwater extraction system, and groundwater treatment plant. The scope of this corrective measure is explained in more detail below.

6.6.2 Scope of Corrective Action

This will consist of the installation of a slurry trench barrier wall downgradient of the plant and Landfill 1. A series of groundwater pumping wells will be installed upgradient of the barrier wall. Contaminated groundwater will be pumped from the wells to a groundwater treatment system. The intent of this containment, collection, and treatment system is to prevent contaminated groundwater from the plant area from migrating off-site and entering the Penobscot River.

The treatment system will be designed to remove contaminants of concern from the extracted groundwater such that the treated groundwater can be discharged through the existing permitted surface water outfall.

During the corrective measures process, the potential for implementation of an adsorptive gate system for in-situ treatment of groundwater will continue to be investigated and evaluated. This system may be implemented in the future if its feasibility and effectiveness is can be demonstrated such that it is an acceptable alternative to the pump and treat system.

6.6.3 Rationale for Recommendations

Alternative 1 is recommended because it is equally protective, has fewer short-term impacts, and is significantly less expensive when compared to off-site disposal.

Alternative 2 would required truck or rail transportation, and would result in the associated potential impacts and risks to the surrounding community.

The feasibility of and cost for an in-situ adsorptive gate will continue to be developed. Current unknowns include the amount of media required, the frequency of replacement, and the effectiveness of the media in a subsurface environment. Because all alternatives considered include the installation of the barrier wall and collection and treatment of groundwater, pilot testing of alternative treatment methods such as the adsorptive gate media can be performed at a later date.

6.7 Surface Water

For the surface water impacts requiring corrective action, only limited alternatives are appropriate, and comparative evaluations were therefore not necessary to arrive at

the recommended corrective actions. The recommended corrective actions to address the potential surface water impacts are explained below.

6.7.1 Removal of the Lined Process Lagoon

The standing water within the lined process lagoon will be pumped to the existing wastewater treatment plant, where it will be treated to limits required in the current NPDES permit. Residual sediment will be removed from the bottom of the lagoon and disposed of at a permitted off-site disposal facility. The empty lagoon will then be backfilled with clean soil, graded for proper drainage, and covered with a vegetated cover consisting of 6 inches of topsoil, and seeded.

6.7.2 Industrial Sewer Plugging

After the anticipated decommissioning of the existing industrial wastewater treatment plant, the industrial sewer serving as the effluent conduit from the plant will be abandoned. The abandoned branches of the industrial sewer will then be plugged immediately upstream of the existing effluent weir (Outfall 001).

The plugging operation will involve excavating to expose the buried pipes, and plugging them with concrete. A clay dam will also be installed in the pipe trench for each exposed pipe, for the purpose of preventing the migration of contaminated groundwater of contaminated groundwater along the pipe bedding. This will involve backfilling with imported clay soil. Site restoration will consist of grading, loaming, and seeding.

6.8 Operations, Maintenance, and Monitoring

After construction of the corrective action program, operations, maintenance and monitoring will be performed. This will consist of the following elements:

- Operation and maintenance of the groundwater pumping and treatment system.
- Monitoring groundwater downgradient of the barrier wall, Landfill 2 and the landfill ridge.
- Seasonal mowing of the soil caps at the consolidation area, the landfills, and the landfill ridge area soils.
- Inspection of the capped areas, and cap repairs (if necessary).

The operation of the groundwater pumping and treatment system will continue until it is determined by test data that the concentrations of contaminants of concern have been reduced such that the PMPS are met.

6.9 Application of Emerging Corrective Action Technologies

As discussed above, two corrective action technologies were evaluated and not recommended for the overall program due to the lack of industry experience with full-scale application, and the resulting uncertainties about their implementability and effectiveness. These technologies consisted of the use of an adsorptive gate for in-situ treatment of groundwater, and direct current technologies for the in-situ recovery of mercury from sediment and soil.

Each of these technologies, although not part of the overall recommended corrective action program, have potentially significant advantages. For this reason, these technologies may continue to be considered for implementation, if their success can be demonstrated during the course of the corrective action program.