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DRAFT ADDENDUM
ENGINEERING EVALUATION/COST ANALYSIS

RAYMARK-SHORE ROAD
STRATFORD, CONNECTICUT

RESPONSE ACTION CONTRACT (RAC), REGION I

For
U.S. Environmental Protection Agency

By
Tetra Tech NUS, Inc.

EPA Contract No. 68-W6-0045
EPA Work Assignment No. 035-NSEE-01H3
TtNUS Project No. N0162

July 1999

TETRA TECH NUS, INC.

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James J. Davis, P.E.
Task Manager

Heather M. Ford
Project Manager

George D. Gardner, P.E.
Program Manager

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A Detailed Cost Estimate

1.0 INTRODUCTION

This Addendum supplements the Draft Final Engineering Evaluation/Cost Analysis (EE/CA) Report dated June 1999 for the Shore Road Study Area located in Stratford, Connecticut.

The EE/CA was developed to evaluate the need for a Non-Time-Critical Removal Action (NTCRA) for the contaminated soils within the Study Area. This Draft Addendum was developed at the direction of EPA to evaluate a RCRA-type cap, in response to public comment presented at a public meeting. This Addendum supplements the EE/CA Report by providing a detailed analysis of one additional removal alternative for the contaminated soils. All other information in the EE/CA will remain unchanged. Where pertinent, references to the EE/CA will be made and supplemented. At the direction of EPA, this Addendum only addresses issues that affect this single additional alternative.

All figures and appendices referenced in the Draft Final EE/CA remain unchanged. One new additional figure, 4-2, is presented to depict the new alternative's design that was the basis for the cost figures. Table 4-1 has been revised in this Addendum to present a summary of costs for all four alternatives. No other tables have been changed.

2.0 NON-TIME-CRITICAL REMOVAL ACTION OBJECTIVES

All information remains unchanged in this section.

3.0 DEVELOPMENT OF REMOVAL ACTION ALTERNATIVES

Table 3-1 in the Draft Final EE/CA, Summary Technologies and Process Options, presented the criteria used to screen technologies and process options based on effectiveness, implementability, and cost. Based on these criteria, all containment options were eliminated from consideration. The reason for elimination was based on rainfall infiltration into the contaminated soils for a permeable cap and the potential for frequent flooding of the Study Area for an impermeable cap. However, public comments to date have expressed a desire to review the cap alternative in detail. Based on that expression of interest, EPA has decided to prepare this Addendum for a low-permeability cap for the Study Area. An impermeable cap meets applicable and relevant and appropriate regulations (ARARs) and was selected for this additional review over the permeable cap (which does not meet ARARs, specifically the CTDEP's pollutant mobility criteria).

All other information in this section remains unchanged.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

This detailed Alternative Analysis for the placement of a low-permeability multi-media cap over the Study Area provides information to facilitate selection of a specific treatment option. All sections referenced below are the sections in the Draft Final EE/CA. Information in each section is not repeated, just modified for applicability to the new alternative.

4.1 Development of Removal Action Alternatives

In the Draft Final EE/CA, three excavation removal alternatives were developed to address the lead, asbestos, dioxin, and PCB contaminated soil-waste/fill present at the Study Area. All of these alternatives remove various quantities of contaminated waste from the Study Area. One additional alternative has now also been developed to address contaminated soil-waste/fill. This fourth alternative evaluated under the EE/CA is a capping-in-place alternative and would not remove any waste from the Study Area. The fourth alternative, the subject of this EE/CA Addendum, will be compared to the three excavation alternatives to provide a range of alternatives for consideration. All alternatives would leave some waste in place, as none of the excavation alternatives would remove waste below the water table; as such, all four alternatives would require institutional controls on the property to prevent activities that could allow contact with the remaining waste.

The fourth alternative would, however, raise the grade of the Study Area by approximately four feet. All current site activities could continue, but adjustments for site grade would need to be made.

4.2 Alternatives Evaluation Criteria

The evaluation criteria for this fourth alternative include a review of its effectiveness, implementability, and cost. There are no changes in the criteria for this fourth alternative as presented in the Draft Final EE/CA.

4.3 Individual Analysis of Removal Action Alternatives

Detailed descriptions and evaluations of the fourth alternative using the criteria are presented below. The state and community acceptance criteria will be further addressed following the receipt of comments during the public comment period. A summary of the costs is presented in the Revised Table 4-1 in this Addendum. Cost details are provided in Attachment A.

4.3.1 Alternative 4 – Capping, Institutional Controls, and Monitoring

This section includes a description of the conceptual design and the detailed analysis of Alternative 4.

4.3.1.1 Detailed Description of Alternative 4

Alternative 4 is a containment option that would prevent direct contact with and leaching from the contaminated soil-waste/fill at the Study Area. A RCRA multi-media cap system was selected by EPA as the representative containment option. The cap would be designed to allow current-use activities to continue, including the use of Shore Road and operation of the Housatonic Boat Club. In conjunction with the cap construction, geotechnical and groundwater flow analyses of the Study Area would be performed as well as modifications to the shoreline and utilities in the area. Finally, at the completion of these activities, institutional controls would be implemented to restrict future use of the Study Area and limit human contact with contamination left in place.

A description of the major components of Alternative 4 is presented below.

Cap System

A multi-media low-permeability cap system, in accordance with RCRA Subtitle C, would be installed to prevent risks to human health from direct contact or incidental ingestion of soil-

REVISED TABLE 4-1
COST ESTIMATE SUMMARY
DRAFT FINAL ENGINEERING EVALUATION/COST ANALYSIS
RAYMARK- SHORE ROAD, STRATFORD, CONNECTICUT

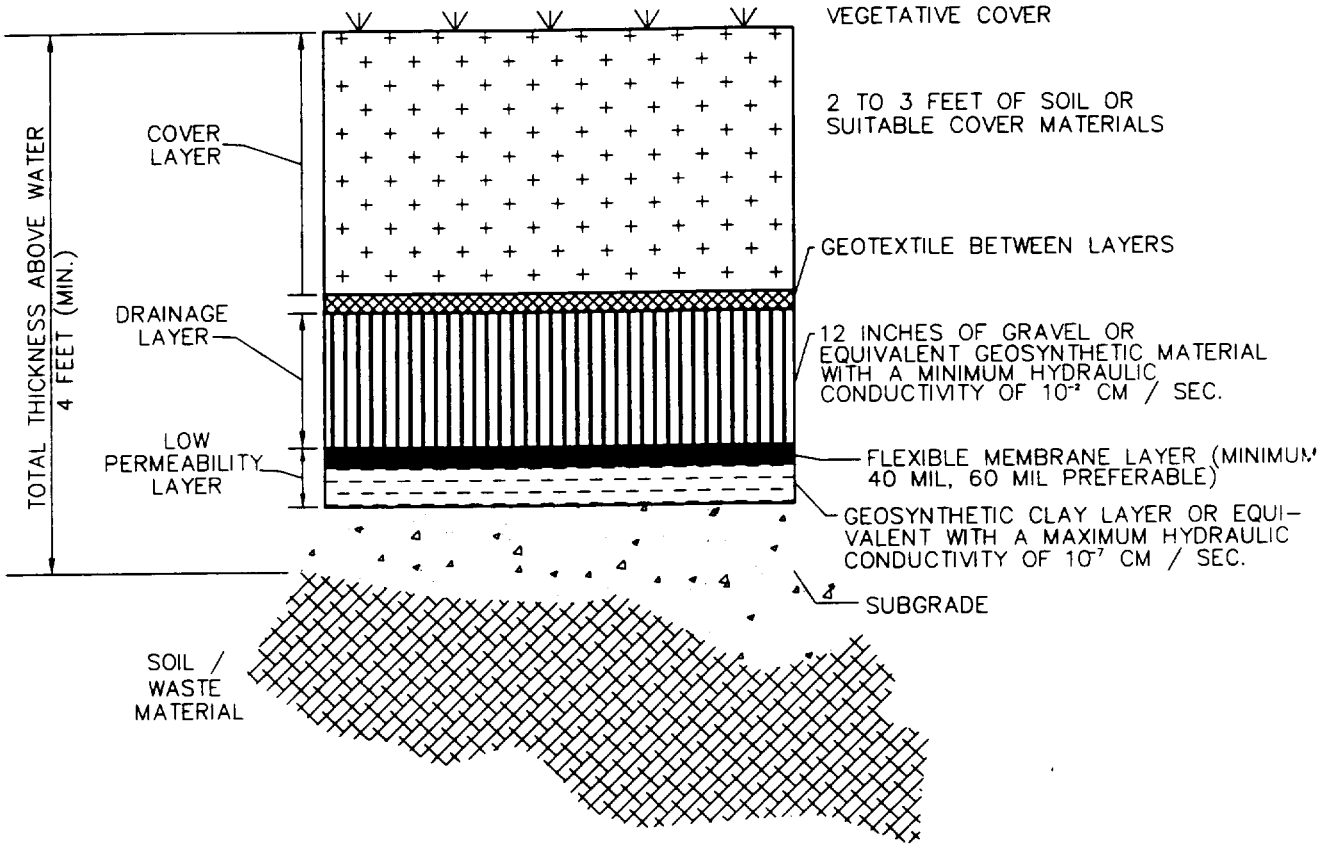
Alternative	Description	Capital Costs	Annual O&M Costs	Capital Costs (in year 25)	Present Worth[1]
1	Excavation (4' in unpaved areas/2' in paved areas) and Site Restoration				
	Option 1 ~ In-Town Storage	$3,717,736	$24,783		$3,819,351
	Option 2 ~ Out-of-Town Disposal	$68,438,089	$16,154		$68,504,323
2	Excavation (2' over entire Study Area) and Paving				
	Option 1 ~ In-Town Storage	$2,890,076	$24,783		$2,991,690
	Option 2 ~ Out-of-Town Disposal	$38,965,399	$16,154		$39,031,633
3	Excavation to 5.5 Foot Depth and Site Restoration				
	Option 1 ~ In-Town Storage	$5,187,179	$24,783		$5,288,793
	Option 2 ~ Out-of-Town Disposal	$104,807,210	$16,154		$104,873,444
4	Low-Permeability Capping	$4,168,231	$37,267	$1,458,943	$4,899,490

[1] Alternatives 1 through 3 include annual O&M costs for 5 years; Alternative 4 includes annual O&M costs for 30 years.

waste/fill contaminants and to minimize infiltration and resulting leaching of organics and metals into groundwater. For this EE/CA Addendum, an upper-layer-only RCRA multi-media cap system was evaluated. A multi-media low-permeability cap usually consists of, in descending order, a cover lay, a drainage layer, a double-barrier low-permeability layer, a vapor control layer (although not required for this Study Area), and the subgrade. Each of these layers is discussed in detail below. The upper-layer cap system would be installed over approximately 4 acres of the Study Area. No impermeable bottom liner and leachate collection system would be installed beneath the soil-waste/fill.

The conceptual cap system design was developed based on the requirements of 40 CFR 264.310, the Design and Construction of RCRA/CERCLA Final Covers guidance document (EPA/625/4-91/025, May 1991), the CTDEP's Remediation Standard Regulations, and the cap design for the Raymark Facility. A cross section of the conceptual cap system is presented on Figure 4-2 of this Addendum (figure numbering in the addendum is a continuation of that from the Draft Final EE/CA). Descriptions of the individual cap layers are summarized as follows:

Cover Layer - The primary objective of this layer of the cap is to provide protection from erosion and frost (frost line in this area is 20 to 25 inches). The cover may consist of a vegetative cover or a surface layer comprised of hardened or armored material (such as stones or cobbles) or asphalt if vegetative growth is not desired. For cost estimating purposes, a 2- to 3-foot soil layer with a vegetative cover was assumed for the entire Study Area. This will allow the 4-foot cap depth to be consistent throughout the site. Some site areas will be paved and require less soil cap; some areas will need more cap material to maintain site grades. For the areas of Shore Road and the parking lot that will be asphalt paved, the final pavement surface will be approximately at grade with the surrounding cover areas. A surface slope of 3 percent is recommended to promote runoff while inhibiting erosion, although lesser slopes can be used if necessary to be consistent with land use. The final slope of the surface would be dependent on the actual use of the Study Area,



CROSS-SECTIONAL VIEW

NOTES:

1. NOT TO SCALE
2. PLAN NOT TO BE USED FOR DESIGN.
3. GEOTEXTILES ARE USED TO SEPARATE THE DIFFERENT LAYERS IN THE CAP AND TO PROVIDE LATERAL REINFORCEMENT AND STABILITY.

CONCEPTUAL CAP DESIGN	FIGURE 4-2
RAYMARK – SHORE ROAD	
EE / CA ADDENDUM	
STRATFORD, CONNECTICUT	

DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J. DAVIS	DATE:	JULY 28, 1999
SCALE:	NOT TO SCALE	ACAD NAME:	DWG\RAYMARK\OU5\EECA_ADD\CONC_CAP.DWG

TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658-7899

the type of surface materials used, and how runoff will be managed. Surface runoff would be diverted to surface drains.

The secondary objective of this layer is to serve as a barrier to the cap. Since the Study Area is not completely fenced (and includes a public road and working business), this layer provides additional protection from accidental intrusion into the soil-waste/fill by Study Area users.

Although not shown on Figure 4-2, a warning barrier layer will be installed within approximately one foot of the surface grade to alert a person digging to cease. The warning barrier will be a brightly colored layer such as a light permeable fabric.

Drainage Layer - The drainage layer conveys water that infiltrates through the cover to areas outside of the cap, such as to a storm drain. This layer should be sloped so as to reduce the potential for infiltrated water to pond over the underlying low permeability layer. The drainage layer can be a geosynthetic material or coarse sand/gravel (less than 3/8 inch) with a minimum hydraulic conductivity of 1×10^{-2} cm/sec or transmissivity of 3.5×10^{-5} m^2/sec. For cost estimating purposes, a 12-inch thick coarse sand/gravel layer was assumed. A geotextile filter fabric should be placed over the drainage layer to prevent clogging of the drainage layer by the entry of fine-grained particles into the drainage layer. Precipitation infiltration that reaches this layer would be channeled to a toe drain and would ultimately be discharged to storm drains. It is assumed that no permits are required for the discharges involved. Also, this drainage layer provides additional thickness to maintain the 4-foot cap thickness and provide additional frost protection.

Low Permeability Layer - This layer should be designed to minimize the potential for infiltration of precipitation into the underlying soil-waste/fill materials. A 3 percent slope after settling is recommended by the RCRA/CERCLA cover guidance document (EPA, 1991). A double barrier is required to be consistent with the guidance for design of RCRA hazardous waste covers. The top barrier should be a

flexible membrane layer (FML) of at least 40 mil thickness. EPA Region I guidance indicates that the FML minimum thickness should be at least 60 mils. The FML should be of sufficient thickness to withstand any future use of the cap surface. The lower barrier should have a maximum permeability of 1×10^{-7} cm/sec and may consist of a geosynthetic clay layer (GCL) (which typically has a permeability 1×10^{-9} cm/sec or lower) or 2 feet of clay compacted to the target permeability.

Vapor Control Layer – The standard conceptual RCRA cap design includes a vapor control layer whose purpose is to capture and channel potential gas-phase VOCs out from under the cover. Because VOCs are only minimally present in the soil-waste/fill materials in the Study Area and vapor build-up is not expected to be significant, a vapor control layer is not included for this cap. It is assumed that no or minimal off gases exist from sediment or peat under the Study Area given the length of time the Study Area soil-waste/fill has been in place (over 30 years); however this will be more closely examined during the design phase of the project.

Subgrade - The base layer of the cap system should be a well compacted and smooth surface that has sufficient subgrade material to prevent puncture of the barrier layer from direct contact with soil-waste/fill particles that can puncture the lower permeable layer. The subgrade also is used to create the appropriate slope and grade for drainage of the upper layers. The current surface of the Study Area would be covered with a sand layer to provide an acceptable subgrade surface. The existing Shore Road and Housatonic Boat Club parking lot would be left in place underneath the capping system. For purposes of the cost estimate, it was assumed that an average 12-inch thick subgrade layer will be required over the Study Area, with variation in thickness as required by the topography.

The actual materials for the cap system would be determined during the engineering design and would depend on the actual future land use of the Study Area.

The capped area is expected to encompass all contaminated soil-waste materials at the Study Area (approximately 4 acres of area). Some consolidation of materials within the Study Area will be done, particularly in the area of utilities (creating a clean-zone) and along the shoreline. Surface run-on and run-off controls may be required given the large surface area the cap system is anticipated to cover.

Sheet Piling

Because of the grade change resulting from the addition of the approximately 4-foot thick cap, reworking of the shoreline will be required. To support the additional height and overburden of the cap along the shoreline, steel sheet piling will be driven into the river bank to create a seawall. It is assumed that most of the existing riprap material and concrete blocks will remain in place and the sheet piling will be placed in or at the edge of the existing slope. The sheets will be driven before the cap is constructed and left sticking up 4 to 5 feet above existing grade. The cap will then be constructed behind the wall and built up to approximately the top of the sheets. The purpose of the sheet piling is for shore stability and not to prevent groundwater migration. The geotechnical investigation will determine the details of the sheet piling design. Groundwater flow modeling would be required to predict the changes to groundwater flow once the wall is installed.

The steel sheet piling should have an expected life of 25 years and will be treated for the intertidal environment (probably by electroplating) to minimize corrosion from the Housatonic River. The O&M costs include the replacement of the sheet piling once during the life of the project (at year 25). Quarterly inspections during low tide are also assumed in the cost estimate.

Geotechnical Engineering and Groundwater Flow Investigation and Design

A geotechnical engineering investigation would be conducted preceding the design of the cap system to aid in cap and sheet pile wall design. In addition to cap stability, the geotechnical investigation is needed to analyze the settlement potential under the load of

the cap as well as the load-bearing capacity for the new Shore Road (which will carry truck and boat-trailer traffic), the Housatonic Boat Club's parking lot, and any future structures constructed above the cap. Potential settlement and subsidence as the result of loading could damage the cap system and promote possible human exposures and contaminant migration. The foundation of the Housatonic Boat Club building would also be examined to determine if cap construction would affect its stability. The geotechnical investigation would include determining the characteristics of the fill and soils along the shoreline to determine the design requirements of the sheet pile system.

Due to lack of sufficient groundwater flow data in the Study Area, a field investigation would be conducted to determine flow rates and flow patterns of the groundwater and the hydraulic conductivities of the soil-waste/fill and surrounding soils. The data would be used to model groundwater flow and the effects from constructing the cap and the sheet piling wall.

Site Restoration

Once cap construction is complete, restoration activities would include repaving Shore Road and the parking area at the north end of the Study Area, reseeding lawn areas, re-landscaping, restoring gravel surfaces, re-installing a chain-link fence around the Housatonic Boat Club, rebuilding sidewalks, and reinstalling the utilities at the boathouse. A 12-foot wide sliding gate would be installed at the entrance of the Boat Club for automobile access, and a 3-foot wide swinging gate installed for individual access. The piling/rope fence that bounds the driveway and some other paved areas would also be replaced with an equivalent structure.

Approximately 1,350 linear feet of Shore Road and 6,400 square feet of pavement would be replaced under Alternative 4. For the purpose of cost-estimation, reconstruction of Shore Road includes a 12-inch crushed stone base and 3-inch binder course topped by a 1-inch thick wearing course. Actual reconstruction will be consistent with Town of Stratford

specifications. All other paved areas would be restored to a 6-inch stone base and 2-inch binder course with a 1-inch topping.

Landscaped areas would be returned to their pre-construction state whenever possible. Lawn areas would be reseeded and neatly landscaped, although trees or shrubs would be replaced with plant varieties that have root systems that would not affect the integrity of the cap. The hard-packed gravel surfaces that make up the driveway and parking lot at the center of the Study Area would be restored and covered with a 6-inch layer of ¾-inch stone. All sidewalks would be rebuilt with a 6-inch stone base and 2-inch thick layer of concrete.

Utilities Replacement

The existing underground utilities would be abandoned in place and new utilities put in service above the low-permeability layer. Also, the septic system and leaching field from the Housatonic Boat Club would be abandoned in place, and the Boat Club would be connected to the sewer system located to the southwest of the Study Area. The line would be approximately 1,100 feet long and would be powered by an Environment One model GP 2014-129 grinder pump discharging into a 1½-inch diameter PVC pipe. Water pipes are expected to be 3-inch PVC lines. A clean soil utility corridor would be used for the relocated utilities so that any future service would not include penetration of the flexible liner or intrusion into soil-waste/fill materials. Any contaminated materials excavated during the construction of the clean utility corridor would be deposited under the proposed cap. Trenching would extend to 2-3 feet below ground surface to ensure enough clean cover above the new utilities to protect them from freezing.

Above-ground utilities are also present in the Study Area. It is assumed that 10 power poles would be removed during cap construction and re-set on the property of the Shakespeare Theater outside of the area to be capped.

Institutional Controls

Institutional controls would be implemented for this alternative to restrict future activities and limit human contact with contaminants left in place. These controls would be Environmental Land Use Restrictions (ELURs) prohibiting disturbance of the cap, limiting future excavation at the Study Area, and prohibiting the use of the groundwater as a drinking water supply.

As a precaution to protect the cap, a warning barrier layer will be placed within the cap cover to alert persons to the fact that a cap is present and that digging should cease (unless approval has been given by the controlling regulatory agency).

Operation & Maintenance (O&M)

O&M activities for this alternative consist primarily of inspections and monitoring. The cap will be inspected quarterly and after flooding events for its integrity and any surface erosion. The sheet piling headwall will also require inspection quarterly and after flooding events and should always be inspected during low tides. Groundwater levels will be monitored quarterly, and vegetation growth will be inspected to ensure that roots from trees and large shrubs will not penetrate the cap. It is assumed that some maintenance for the cap[, sheetpiles, and/or other site structures will be performed annually to ensure performance. The cost estimate assumes that the sheet piles will need to be replaced once over a 25 year period.

4.3.1.2 Detailed Analysis of Alternative 4

This section provides the detailed evaluation of Alternative 4 using the criteria described in Section 3.2 of the Draft Final EE/CA.

Effectiveness

Alternative 4 would meet the overall goals of the NTCRA since removal objectives would be met.

Overall Protection of Human Health and the Environment – A risk assessment has been performed to identify the areas of the Study Area that provide the greatest current and potential risks to human health and the environment. The multi-media low-permeability capping of the contaminated soil-waste/fill under Alternative 4 would reduce the potential human health and ecological risks from direct contact, incidental ingestion, and inhalation of the COCs, as well as decrease the potential for leaching into the groundwater or Housatonic River.

Compliance with ARARs – The proposed ARARs, which must be complied with during this removal action, are shown on Tables 4-2a, b, and c in the Draft Final EE/CA. Final ARARs are subject to agreement between EPA and CTDEP.

This discussion focuses on CTDEP's remediation standard regulations, Section 22a-133. The remediation standard regulations require polluted soil to be remediated to a concentration that meets direct exposure criteria and the pollutant mobility criteria or that an engineered control be used. Based on contaminant concentrations at the Study Area, the direct exposure criteria require a 4-foot barrier if the surface is unpaved or a 2-foot barrier if the surface is paved. These criteria are applicable when land use restrictions are implemented to limit access to the subsurface soils. Without land use restrictions, polluted soil must be 15 feet bgs to be considered inaccessible. Alternative 4 would comply with the direct exposure criteria because an engineered control would be used.

The objective of pollutant mobility criteria is to eliminate the source of continued groundwater contamination. These criteria require an engineered control (such as the low-permeability cap) or remediation/removal of soil to the mean high water table (assumed to be 5.5 feet bgs) since the Study Area is located in a GB groundwater area. Since a low-

permeability cap would be put in place, Alternative 4 would meet the pollutant mobility criteria.

Other known applicable ARARs include wetland and floodplain restrictions. Based on the 100-year flood elevation presented in the Flood Insurance Rate map, the top of cap will be at or below the 100-year flood level.

Reduction of Toxicity, Mobility, or Volume Through Treatment - Alternative 4 would not satisfy the NCP preference for treatment since the contaminated soil-waste/fill would remain on site. There would be no treatment or destruction of hazardous materials in Alternative 4.

Short-Term Effectiveness – Implementation of Alternative 4 would not pose significant risks to the local community or to workers. During cap construction and site restoration activities, engineering controls would be instituted to minimize noise and fugitive dust concerns. Workers would be protected from risks (exposure to lead, asbestos, PCBs, dioxins, and other contaminants) through the use of appropriate personal protective equipment (PPE) and implementation of proper safety practices.

No adverse impact to the environment is anticipated during implementation of this alternative. The installation of sheet piles as a barrier along the shoreline of the Housatonic River would prevent impacts to the river and the wetlands adjacent to Study Area. The impact of driving the sheet piling around the foundation of the boat club and the impact on shoreline slopes will need to be assessed as part of the geotechnical investigation.

Some increase in heavy vehicle (dump trucks, excavator) traffic into and out of the Study Area would be expected during construction. Vehicular access into the Study Area would be along Shore Road, which might cause some inconvenience to local residents, members of the Housatonic Boat Club, or patrons of the Shakespeare Theater. Traffic controls would be implemented as needed to minimize inconvenience. The Housatonic Boat Club

would be shut down, with boats removed and stored off site, for the duration of the construction period.

An increase in noise levels during the construction process would be anticipated. Efforts would be made to minimize the potential impact to the local community by working during regular hours and coordinating with the nearby residents.

Long-Term Effectiveness – Capping of the contaminated soil-waste/fill would not reduce the volume of contaminants at the Study Area. All contamination that is present at the Study Area would remain after the cap installation and could pose risks in the long term if the cap is not properly maintained or impacted by erosion or flood events; however, the cap significantly decreases direct exposure and the potential to leach as a result of infiltration.

As discussed above, Alternative 4 would comply with the direct exposure criteria as well and the pollutant mobility criteria. It is assumed that that Alternative 4 would be effective in the long term because the cap would effectively prevent human contact and effectively minimize migration of contaminants in the unsaturated zone into the groundwater.

The reliability of this alternative is high, provided that proper O&M is maintained, institutional controls are implemented to restrict future excavation at the Study Area, and no natural disasters occur. Any residual contamination would remain "inaccessible" as long as the clean fill overlying it remained undisturbed. This may be somewhat limited if a fence is not installed around the Study Area.

The sheet piling along the shoreline is assumed to have a 25-year life and may have to be replaced within that period of time.

Implementability

Alternative 4 is implementable, but as with the other three alternatives, some uncertainties exist. The Alternative 4 uncertainties are sheet piling installation, groundwater flow issues, the final elevation of the cap and the vapor collection layer. Each of these is discussed below.

Sheet Piling Installation - It is assumed that the sheet piling would be installed by driving only, but if subsurface rock or obstructions are present, excavation or alternative anchoring or bracing of the sheet piles may be required.

Groundwater Flow Pattern - If groundwater flow is towards the Housatonic River, groundwater may "back up" behind the sheet piling wall, potentially raising the groundwater table. The RCRA-type cap is not designed to accommodate the upward hydrostatic pressure on the low-permeability liner, and the pressure on the cap could compromise its integrity. The sheet piling is not designed to be a groundwater cut-off wall in this alternative, so the design may require accommodating the flow using another engineered drainage layer or weep holes through the sheeting to equalize the hydraulic head on both sides of the wall. These drainage options may require placement of filtering to prevent plugging. The geotechnical and groundwater studies must address these concerns before design of the sheet pile system.

Final Study Area Elevations – The final elevation of the top of the cap will be approximately 12 feet, which is at or below the 100-year flood elevation of 12 or 13 feet for the site (elevation varies over the four acres). This could mean that the entire cap could be under water. Also, current Study Area activities will need to be adjusted to the new site grades. The finished floor elevation of the Housatonic Boat Club is 8.84 feet, which is below the final grade of the proposed cap (approximately 12 feet). Building ingress and egress requirements will have to be included in the design of the cap.

Vapor Collection Layer – This will be examined during the design phase of the project.

Many companies exist with the trained personnel, equipment, and materials to perform the proposed removal action. The technologies are proven and are available for full-scale application. All necessary approvals and permits should be able to be obtained from the appropriate agencies.

Cost

The costs for Alternative 4 are presented on Revised Table 4-1 and detailed in Attachment A.

4.4 Comparative Analysis of Removal Action Alternatives

As part of the alternatives analysis, the three excavation alternatives were compared in the Draft Final EE/CA to identify differences between the alternatives and how site contaminant threats would be addressed; the fourth alternative will also be compared in this Addendum. Alternatives 1 and 2 are similar in that they provide equivalent degrees of protection from contamination left in place after the excavation. Both address the entire Study Area that has been identified by the risk assessment and propose a depth of excavation and surface restoration design that would satisfy the direct exposure criteria outlined by CTDEP regulations. However, Alternative 3 adds compliance with the pollutant mobility criteria regulations set forth in the CTDEP regulations. Either disposal option in the excavation alternatives (in-town storage or out-of-town disposal) is equally protective of the Study Area. Alternative 4, the low-permeability capping alternative, also satisfies both the direct exposure criteria and the pollutant mobility criteria regulations, but in order to comply with floodplain requirements, the cap "must be designed, constructed, operated, and maintained to prevent washout...by a 100-year flood...." The cost difference between the options is significant for all three excavation alternatives; the cost for the capping alternatives is similar to excavation Alternative 3 with the in-town disposal options. The implementation of Alternative 4 requires additional studies for geotechnical analysis and groundwater modeling and contains uncertainties regarding the change in groundwater flow patterns as a result of using sheet piling along the shoreline.

4.5 EPA-Recommended Alternative

Based on the detailed analysis presented in the preceding sections and in the Draft Final EE/CA, the EPA-recommended alternative remains Alternative 3 – Excavation to 5.5-Foot Depth and Site Restoration with in-town storage. As described above, this alternative addresses all of the Connecticut state regulations for leaving contamination in place, complies with floodplain requirements, has a lower degree of uncertainty, and less O&M activities. Despite the extra costs that would be incurred due to the greater excavation depth, Alternative 3 has been recommended because it is the most protective of human health and the environment in the long term. For off-site disposal, Option 1, in-town storage, is more cost effective than out-of-town disposal and is therefore the recommended option.

ATTACHMENT A
DETAILED COST ESTIMATE

COST ASSUMPTIONS
ALTERNATIVE NO. 4 - LOW-PERMEABILITY CAPPING
RAYMARK - SHORE ROAD
STRATFORD, CONNECTICUT

Project Duration

* Sheet Piling: 40,000 SF / 960 SF/day = 42 days (021-614-1500)
* Cap Construction:
    * Subgrade: 6,325 CY / 600 CY/day = 11 days (022-262-0190)
    * Geosynthetic Clay Layer: 18,974 SY / 1000 SY/day = 19 days
    * Flexible Membrane Liner: 18,974 SY / 1000 SY/day = 19 days
    * Filter Fabric: 18,974 SY / 10000 SY/day = 2 days
    * Drainage Layer: 6,325 CY / 600 CY/day = 11 days
    * Cover Layer: 12,652 CY / 600 CY/day = 21 days
* Site Preparation and Restoration: 40 days allotted for prep. and restoration
* Total Project Duration: 165 days / 5 working days/week = 33 weeks

Site Preparation

* $50,000 allotted to prepare site for excavation
* Site preparation activities include but may not be limited to:
    * Shutting off electricity to site and removing power and light poles
    * Pumping out septic tank and abandon in place
    * Dismantling and moving boat crane to temporary storage site
    * Moving and storing boat ramp
    * Taking down and replacing signs along Shore Road
    * Consolidating small amounts of excavated contaminated materials from site prep. to other areas to be capped

Quantity Takeoffs

CAP CONSTRUCTION
* Cap - Total area of cap = 170,769 ft2
* Subgrade of 12" sand = 170,769 ft2 * 1 ft = 170,769 ft3 = 6,325 CY
* Geosynthetic clay layer = 170,769 ft2 = 18,974 SY
* Flexible membrane liner = 170,769 ft2 = 18,974 SY
* Gravel drainage layer = 170,769 ft2 * 1 ft = 170,769 ft3 = 6,325 CY
* Geotextile filter fabric = 170,769 ft2 = 18,974 SY
* Cover layer = 170,769 ft2 * 2 ft = 341,538 ft3 = 12,650 CY

STEEL SHEET PILING
* Approx. 2000 linear feet of piling
* Required height: 4 feet bank + 5 feet above grade + at least half below grade = 18 feet (assume 20 feet)
* Total square footage = 2000 ft * 20 ft = 40,000 SF

SITE RESTORATION
* Boat Club lot repaving - 6,400 ft2; 160 ft of curbing
* Shore Road repaving - 1,350 ft. * 15 ft wide = 20,250 ft2 = 2,250 SY
* Revegetation - 70,000 SF; 25 shrubs
* Reinstall gravel - 4,500 SY
* Fencing - 800 ft
* Gates - one 12' sliding; one 3' swinging

ATTACHMENT A

COST ASSUMPTIONS
ALTERNATIVE NO. 4 - LOW-PERMEABILITY CAPPING
RAYMARK - SHORE ROAD
STRATFORD, CONNECTICUT

* Sidewalks - 300 ft. * 5 ft wide = 1,500 SF

UTILITIES
* Utilities trenching
1,100 ft for sewer and water lines * 5 ft deep * 2 ft wide = 11,000 ft3 = 407 CY
1,100 ft for sewer and water lines * 5 ft deep * 2 ft wide = 11,000 ft3 = 407 CY

Unit Costs

SHEET PILING
* 20' piling installed and left in place = $15.12/SF (021-614-1500)
* Assume 20% add-on for sheets treated for intertidal environments
  $15.12/SF + 20% = $18.14/SF

CAP CONSTRUCTION
* Subgrade: $13.51/CY sand
* Geosynthetic Clay Layer: $6.75/SY
* Flexible Membrane Liner: $4.68/SY
* Drainage Layer: $17.01/CY
* Geotextile Fabric: $2.52/SY
* Cover Layer: $27.21/CY

SITE RESTORATION
* Repave lot: asphaltic concrete, 6" stone base, 2" binder course, 1" topping @ $1.51/SF (025-124-0020). Curbs: asphaltic berm, 12" width @ $1.27/LF (025-254-0200)
* Shore Rd.: 12" crushed stone base @ $17.16/SY (022-308-0300), 3" binder course @ $4.65/SY (025-104-0160), 1" wearing course @ $1.93/SY (025-104-0300)
* Lawns: Seed mix, push spreader @ $41.20/MSF (029-308-0010)
* Trees and Shrubs: 15" diameter bagged and burlapped @ $42.50/each (029-521-0752)
* Stone, gravel surface: Crushed 3/4" stone, compacted, 6" deep @ $8.76/SY
* Chain link fence: 3 strands barb wire, 2" post @ 10' OC, set in concrete, 6' high @ $14.98/LF (028-308-0500)
* Sliding gate: 6' high, 12 ' wide @ $113.95/LF (028-308-3100)
* Swinging gate: 6' high, 3' wide @ $194.00 each (028-308-1400)
* Rope fence: 4' high wood posts set in concrete @ $16.50 each. (028-324-6040)
  400' rope @ $3/LF
* Sidewalks: 6" stone base @ $8.76/SY (022-308-0100), 4" thick concrete @ $1.93/SF (025-128-0310)

UTILITIES
* Grinder pump: Environment One model GP 2014-129 @ $7,075 including tax and delivery
* Alarm/Disconnect panel: model MOD 260 @ $1,000 including tax and delivery
* Power poles: wood, set in earth @ $1,457/pole
* Trenching: 1/2 CY backhoe, 24" wide, 5' deep, @ $3.37/CY (022-254-0090)
* Sewer pipe: 1.5" PVC @ $2.81/LF (026-678-2100) - fittings @ 10% of pipe cost
* Water pipe: 3" PVC @ $4.89/LF (026-678-2160) - fittings @ 10% of pipe cost

PRELIMINARY CAPITAL COSTS
ALTERNATIVE NO. 4 - LOW PERMEABILITY CAPPING
ENVIRONMENTAL MEDIA: SOILS
RAYMARK - SHORE ROAD
STRATFORD, CONNECTICUT

			Unit Cost ($)				Total Cost ($)				Total Direct Cost, 1999 ($) [1]
Item	Qty	Unit	Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	(Total Cost x 1.1)
MOBILIZATION/DEMOBILIZATION											
1) Office trailer (2)	9	MO	1,000				9,000				9,900
2) Storage trailer (1)	9	MO	500				4,500				4,950
3) Construction survey	1	LS	20,000				20,000				22,000
4) Portable communication equipment	4	SETS	1,500				6,000				6,600
5) Equipment mobilization/demobilization	1	LS	30,000				30,000				33,000
6) Site utilities	9	MO	4,000				36,000				39,600
7) Security	9	MO	10,000				90,000				99,000
8) Decontamination trailer	9	MO	1,500				13,500				14,850
DECONTAMINATION FACILITIES AND SERVICES											
1) Laundry service	33	WKS	250				8,250				9,075
2) Truck decon pad (2)											
a) Concrete pad - 8"	80	CY		70	125	5.00		5,600	10,000	400	17,600
b) Gravel base 6"	60	CY		7.50	3.33	8.00		450	200	480	1,243
c) Curb	240	LF		3.07	1.99	0.05		737	478	12	1,349
d) Collection sump	2	EA		1,450	500	220		2,900	1,000	440	4,774
e) Splash guard	1,560	SF		1.25	1.00			1,950	1,560		3,861
3) Decontamination services	9	MO	1,200				10,800				11,880
4) Decon water	118,800	GAL	0.20				23,760				26,136
5) Personnel decon pad (2)											
a) Concrete pad 4"	4	CY		70	125	5.00		280	500	20	880
b) Gravel base 4"	4	CY		7.50	3.33	8.00		30	13	32	83
c) Curb	160	LF		3.07	1.99	0.05		491	318	8	899
6) Clean water storage tank (3000 gals)	2	EA		3,000	300			6,000	600		7,260
7) Spent water storage tank (5000 gals)	2	EA		5,000	400			10,000	800		11,880
LEGAL FEES											
1) Activity use limitations	1	DEED			2,500				2,500		2,500 [2]
SITE PREPARATION											
1) Prepare site for excavation	1	LS	50,000				50,000				50,000 [2]
HEADWALL CONSTRUCTION											
1) Groundwater flow study and modeling	1	LS	50,000				50,000				50,000 [2]
2) Sheet piling, treated for intertidal environment	40,000	SF	18.14				725,600				725,600 [2]
CAP CONSTRUCTION											
1) Geotechnical study	1	LS	50,000				50,000				50,000 [2]
2) Subgrade - average thickness 12" - sand	6,325	CY		10	0.84	2.67		63,250	5,313	16,888	93,996
3) Geosynthetic clay liner	18,974	SY	6.75				128,075				140,882
4) Flexible Membrane Liner 40 mil HDPE	18,974	SY	4.68				88,798				97,678
5) Gravel drainage layer - 12"	6,325	CY	17.01				107,588				118,347
6) Geotextile filter fabric	18,974	SY	2.52				47,814				52,596
7) Soil layer 24" place, spread, and compact	12,650	CY		6.75	5.31	15.15		85,388	67,172	191,648	378,627
8) Surface drain	1	LS	100,000				100,000				110,000
SITE RESTORATION											
1) Repave Lot	6,400	SF		1.14	0.20	0.17		7,296	1,280	1,088	10,630

PRELIMINARY CAPITAL COSTS
ALTERNATIVE NO. 4 - LOW PERMEABILITY CAPPING
ENVIRONMENTAL MEDIA: SOILS
RAYMARK - SHORE ROAD
STRATFORD, CONNECTICUT

			Unit Cost ($)				Total Cost ($)				Total Direct Cost, 1999 ($) [1]
Item	Qty	Unit	Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	(Total Cost x 1.1)
2) Parking lot curbs	160	LF		0.47	0.80			75	128		224
3) Repave Shore Rd.											
a) 12" stone base	2,250	SY		15.40	0.58	1.18		34,650	1,305	2,655	42,471
b) 3" binder course	2,250	SY		3.89	0.41	0.35		8,753	923	788	11,509
c) 1" wearing course	2,250	SY		1.53	0.21	0.19		3,443	473	428	4,777
4) Revegetation (Lawns)	70	MSF		18.00	16.50	6.70		1,260	1,155	469	3,172
5) Revegetation (Trees and Shrubs)	25	EA			42.50				1,063		1,169
6) Restore stone/gravel surfaces (4 inch layer)	4500	SY		7.70	0.35	0.71		34,650	1,575	3,195	43,362
7) Replace fence	800	LF		10.20	2.91	1.87		8,160	2,328	1,496	13,182
8) Sliding gate	12	LF		82.50	19.15	12.30		990	230	148	1,504
9) Swinging gate (3' wide)	1	EA		75.00	72.50	46.50		75	73	47	213
10) Rope fence											
a) 4' posts set in concrete	21	EA		6.25	10.25			131	215		381
b) rope	400	LF		3.00				1,200			1,320
11) Replace sidewalks											
a) 6" stone base	1,500	SF		7.70	0.35	0.71		11,550	525	1,065	14,454
b) 4" thick concrete	1,500	SF		0.96	0.97			1,440	1,455	0	3,185
UTILITIES											
1) Grinder pump (Environment One model GP 2014 129)	1	EA		7,075.00				7,075			7,783
2) Alarm/Disconnect Panel (Environment One model MOD 260)	1	EA		1,000.00				1,000			1,100
3) Replace power pole	10	EA	1,457				14,570				16,027
4) Trenching	814	CY			1.93	1.44			1,571	1,172	3,017
5) Sewer pipe (force main, 1.5" PVC)	1,100	LF		0.93	1.88			1,023	2,068		3,400
6) Sewer Pipe Fittings (10% of cost of pipe)	1	LS		340.01				340			374
7) Water Pipe	1,100	LF		2.07	2.82			2,277	3,102		5,917
8) Water Pipe Fittings (10% of cost of pipe)	1	LS		591.69				592			651
INTERIM CONSTRUCTION MONITORING											
1) Stormwater Sampling	70	HR			25				1,750		1,925
2) Stormwater Analysis	7	EA	2,270				15,890				17,479
3) Air Monitoring (10 hr/wk x 33 weeks)	330	HR			25.00				8,250		9,075
4) Air Sample Analysis (6 @ 33 weeks)	198	EA	350				69,300				76,230
5) Sample Shipping	33	WK	100				3,300				3,630
6) ODCs/M&IE	33	WK				375				12,375	13,613
WELL REPLACEMENT/INSTALLATION											
1) Install 1 monitoring well	1	EA	6,000				6,000				6,600
2) Drilling Oversight	20	HR			25				500		550
3) Oversight ODCs/M&IE	1	LS				800				800	880
4) Construction Survey	1	LS	200				200				220
Subtotal of Total Direct Costs							1,708,946	303,055	120,421	235,652	2,517,070
Safety Level (C) Multiplier (30% of labor & equipment)									35,376	70,695	106,072
Total with Safety Multiplier							1,708,946	303,055	155,797	306,347	2,721,558

PRELIMINARY CAPITAL COSTS
ALTERNATIVE NO. 4 - LOW PERMEABILITY CAPPING
ENVIRONMENTAL MEDIA: SOILS
RAYMARK - SHORE ROAD
STRATFORD, CONNECTICUT

			Unit Cost ($)				Total Cost ($)				Total Direct Cost, 1999 ($)[1]
Item	Qty	Unit	Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	(Total Cost x 1.1)
Burden @ 30% of Labor Cost									46,739		51,413
Labor @ 10% of Labor Cost									15,580		17,138
Material @ 10% of Material Cost								30,305			33,336
Subcontract @ 5% of Sub. Cost							85,447				93,992
Total Direct Cost							1,794,393	333,360	218,116	306,347	2,917,437
Indirect @ 75% of Total Direct Labor Cost									163,587		179,945
Profit @ 5% of Total Direct Cost											145,872
Sub Total: Direct, Indirect, Profit											3,243,254
Health & Safety Monitoring @ 2%											64,865
Total Field Cost											3,308,119
Contingency @ 20% of Total Field Cost											661,624
Engineering @ 6% of Total Field Cost											198,487
Total Cost											4,168,231

Notes:
1. Total costs are based on 1995 values used for Raymark Facility FS plus ten percent for inflation.
2. The source of the cost basis is NOT the Raymark Facility FS and the 10% inflation factor has not been applied.

ANNUAL OPERATIONS AND MAINTENANCE COSTS
ALTERNATIVE NO. 4 - LOW-PERMEABILITY CAPPING
RAYMARK - SHORE ROAD
STRATFORD, CONNECTICUT

			Unit Cost ($)				Total Cost ($)				Total Direct Cost, 1999 ($) [1]
Item	Qty	Unit	Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	(Total Cost x 1.1)
SITE MAINTENANCE											
1) Landscaping/Site Cleanup	2	EA		1,000	704	350		2,000	1,408	700	4,519
2) Pavement Inspection/Repair	1	EA		1,500	2,048	350		1,500	2,048	350	4,288
2) Cap Maintenance and Repair	1	EA		3,000	2,048	350		3,000	2,048	350	5,938
HEADWALL AND CAP INSPECTION											
1) Inspect Cap Quarterly	4	EA			800	250		0	3,200	1,000	4,620
1) Inspect Sheet Piling Quarterly	4	EA			800	250		0	3,200	1,000	4,620
1) Measure Groundwater Levels Quarterly	4	EA			800	250		0	3,200	1,000	4,620
Subtotal of Total Direct Costs								6,500	8,704	2,400	19,364
Burden @ 30% of Labor Cost									2,611		2,872
Labor @ 10% of Labor Cost									870		957
Material @ 10% of Material Cost								650			715
Subcontract @ 5% of Sub. Cost							NA				
Total Direct Cost								7,150	12,186	2,400	23,909
Indirect @ 75% of Total Direct Labor Cost									9,139		10,053
Profit @ 5% of Total Direct Cost											1,195
Sub Total: Direct, Indirect, Profit											35,158
Health & Safety Monitoring @ 6%											2,109
Total Field Cost											37,267
Contingency @ 20% of Total Field Cost										NA	
Engineering @ 4% of Total Field Cost										NA	
Total Cost											**37,267**

Notes:
1. Total costs are based on 1995 values used for Raymark Facility FS plus ten percent for inflation.

PRELIMINARY CAPITAL COSTS - YEAR 25
ALTERNATIVE NO. 4 - LOW PERMEABILITY CAPPING
ENVIRONMENTAL MEDIA: SOILS
RAYMARK - SHORE ROAD
STRATFORD, CONNECTICUT

Item	Qty	Unit	Unit Cost ($) Sub.	Mat.	Labor	Equip.	Total Cost ($) Sub.	Mat.	Labor	Equip.	Total Direct Cost, 1999 ($) [1] (Total Cost x 1.1)
MOBILIZATION/DEMOBILIZATION											
1) Office trailer (2)	2	MO	1,000				2,000				2,200
2) Storage trailer (1)	2	MO	500				1,000				1,100
3) Construction survey	1	LS	20,000				20,000				22,000
4) Portable communication equipment	4	SETS	1,500				6,000				6,600
5) Equipment mobilization/demobilization	1	LS	30,000				30,000				33,000
6) Site utilities	2	MO	4,000				8,000				8,800
7) Security	2	MO	10,000				20,000				22,000
8) Decontamination trailer	2	MO	1,500				3,000				3,300
DECONTAMINATION FACILITIES AND SERVICES											
1) Laundry service	8	WKS	250				2,000				2,200
2) Truck decon pad (2)											
a) Concrete pad - 8"	80	CY		70	125	5.00		5,600	10,000	400	17,600
b) Gravel base 6"	60	CY		7.50	3.33	8.00		450	200	480	1,243
c) Curb	240	LF		3.07	1.99	0.05		737	478	12	1,349
d) Collection sump	2	EA		1,450	500	220		2,900	1,000	440	4,774
e) Splash guard	1,560	SF		1.25	1.00			1,950	1,560		3,861
3) Decontamination services	2	MO	1,200				2,400				2,640
4) Decon water	26,400	GAL	0.20				5,280				5,808
5) Personnel decon pad (2)											
a) Concrete pad - 4"	4	CY		70	125	5.00		280	500	20	880
b) Gravel base - 4"	4	CY		7.50	3.33	8.00		30	13	32	83
c) Curb	160	LF		3.07	1.99	0.05		491	318	8	899
6) Clean water storage tank (3000 gals)	2	EA		3,000	300			6,000	600		7,260
7) Spent water storage tank (5000 gals)	2	EA		5,000	400			10,000	800		11,880
HEADWALL CONSTRUCTION											
1) Sheet piling, treated for intertidal environment	40,000	SF	18.14				725,600				725,600 [2]
INTERIM CONSTRUCTION MONITORING											
1) Stormwater Sampling	20	HR			25				500		550
2) Stormwater Analysis	2	EA	2,270				4,540				4,994
3) Air Monitoring (10 hr/wk x 8 weeks)	80	HR			25.00				2,000		2,200
4) Air Sample Analysis (6 @ 8 weeks)	48	EA	350				16,800				18,480
5) Sample Shipping	8	WK	100				800				880
6) ODCs/M&IE	8	WK				375				3,000	3,300
Subtotal of Total Direct Costs							847,420	28,438	17,969	4,392	915,481
Safety Level (C) Multiplier (30% of labor & equipment)									5,391	1,318	6,708
Total with Safety Multiplier							847,420	28,438	23,360	5,710	995,420
Burden @ 30% of Labor Cost									7,008		7,709

ATTACHMENT A

PRELIMINARY CAPITAL COSTS - YEAR 25
ALTERNATIVE NO. 4 - LOW PERMEABILITY CAPPING
ENVIRONMENTAL MEDIA: SOILS
RAYMARK - SHORE ROAD
STRATFORD, CONNECTICUT

Item	Qty	Unit	Unit Cost ($)				Total Cost ($)				Total Direct Cost, 1999 ($) [1]
			Sub.	Mat.	Labor	Equip.	Sub.	Mat.	Labor	Equip.	(Total Cost x 1.1)
Labor @ 10% of Labor Cost									2,338		2,570
Material @ 10% of Material Cost								2,844			3,128
Subcontract @ 5% of Sub. Cost							42,371				46,608
Total Direct Cost							889,791	31,282	32,704	5,710	1,055,435
Indirect @ 75% of Total Direct Labor Cost									24,528		26,981
Profit @ 5% of Total Direct Cost											52,772
Sub Total: Direct, Indirect, Profit											1,135,187
Health & Safety Monitoring @ 2%											22,704
Total Field Cost											1,157,891
Contingency @ 20% of Total Field Cost											231,578
Engineering @ 6% of Total Field Cost											69,473
Total Cost											**1,458,943**

Notes:

1. Total costs are based on 1995 values used for Raymark Facility FS plus ten percent for inflation.
2. The source of the cost basis is NOT the Raymark Facility FS and the 10% inflation factor has not been applied.

CALCULATION WORKSHEET

CLIENT: EPA JOB NUMBER: N0162

SUBJECT: Present Worth Analysis of Alternative No. 4 - Low-Permeability Capping

BY: JJD DATE: Jul-99

YEAR	PW FACTOR	CAPITAL COSTS	O&M COSTS	PRESENT WORH
0	1.0000	4,168,231		$4,168,231
1	0.9346		37,267	$34,829
2	0.8734		37,267	$32,551
3	0.8163		37,267	$30,421
4	0.7629		37,267	$28,431
5	0.7130		37,267	$26,571
6	0.6663		37,267	$24,833
7	0.6227		37,267	$23,208
8	0.5820		37,267	$21,690
9	0.5439		37,267	$20,271
10	0.5083		37,267	$18,945
11	0.4751		37,267	$17,705
12	0.4440		37,267	$16,547
13	0.4150		37,267	$15,465
14	0.3878		37,267	$14,453
15	0.3624		37,267	$13,507
16	0.3387		37,267	$12,624
17	0.3166		37,267	$11,798
18	0.2959		37,267	$11,026
19	0.2765		37,267	$10,305
20	0.2584		37,267	$9,631
21	0.2415		37,267	$9,001
22	0.2257		37,267	$8,412
23	0.2109		37,267	$7,861
24	0.1971		37,267	$7,347
25	0.1842	1,458,943	37,267	$275,675
26	0.1722		37,267	$6,417
27	0.1609		37,267	$5,997
28	0.1504		37,267	$5,605
29	0.1406		37,267	$5,238
30	0.1314		37,267	$4,896
				$4,899,490

Based on a discount rate of: 7.00%

ATTACHMENT A