Final

Feasibility Study Addendum

Operable Unit V

Peconic River

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PREPARED BY

ENVIRONMENTAL MANAGEMENT DIRECTORATE

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REGISTERED TO ISO 14001

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) and the Brookhaven National Laboratory (BNL) have submitted this addendum to the Feasibility Study (FS) as an evaluation of alternatives for cleanup of the Peconic River both on Laboratory property and off of Laboratory property (west of Schultz Road). This FS Addendum provides an evaluation of alternatives that involve the removal of contaminated sediment using standard mechanical removal followed by restoration activities.

The FS Addendum is intended to provide sufficient detail to select a remedial alternative that will protect human health and the environment. The DOE has proposed an alternative in this FS Addendum based on the evaluation of alternatives. A summary of this alternative and the other alternatives considered will also be provided in the Proposed Remedial Action Plan (PRAP). These documents are presented to the public for formal comment. The actual remedy will be selected only after the formal public comment period has ended and the information submitted during this time has been considered. The DOE, with agreement from the U.S. Environmental Protection Agency and concurrence of the New York State Department of Environmental Conservation, will select the final remedy. The final remedy will be detailed in a Record of Decision.

DOE and BNL have conducted extensive environmental investigations of the Peconic River sediment, surface water, fish, and plants over the past several years. It has been determined that some areas of the Peconic River on the BNL site and some off-site areas will be cleaned up to further reduce the potential for both human and ecological health risks. This decision is based on the results of the investigations, as well as open discussion with the regulatory agencies and community members. The most significant basis for the cleanup is the presence of mercury and polychlorinated biphenyls (PCBs) that are bioaccumulating in fish living in the portions on the Laboratory property, and mercury that is bioaccumulating in fish in portions of the Peconic River off of the Laboratory property. The bioaccumulation of these contaminants in fish present potential human health and environmental risks. Other contaminants of concern include heavy metals and radionuclides. BNL maintains a proactive waste minimization program that reduces the generation of waste at the source to further minimize environmental impacts associated with operations. Several actions and programs have been implemented that directly aid the reduction or removal of sources to Peconic River sediment. These actions also focus on ensuring sediment does not become re-contaminated once the cleanup is complete.

This document considers the results of numerous investigations and actions taken, specifies the objectives in conducting a cleanup of Peconic River sediment, details the alternatives for cleaning up, and compares the alternatives against the criteria required for selecting a remedy. The intent of this FS Addendum is to provide sufficient information to enable members of the public to understand this cleanup project sufficiently to provide comments to the DOE before final cleanup decisions are agreed to with the regulatory agencies.

The on-site sections of the Peconic River are scheduled for remediation during the winter and spring of 2004 as a non-time critical removal action performed under *Action Memorandum: Peconic River Removal Action for Sediment on BNL Property*, dated January 23, 2004. The Action Memorandum cleanup plan implements the preferred alternative discussed in this document and the PRAP. It was shared with the

public in two information sessions in October 2003 and was placed in the Administrative Record on January 30, 2004. The removal action will also be reviewed as part of this FS Addendum and the concurrent PRAP. The on-site and the off-site cleanup goals will be documented in a Record of Decision following review of the FS Addendum and the PRAP by the public and regulatory agencies.

The three principal remediation goals for the Peconic River are to remove sediment with elevated mercury levels, remove contaminated sediment from areas that preferentially methylate mercury, and to minimize the potential for contaminated sediment to migrate downstream.

Four alternatives are discussed in this FS Addendum. It should be noted that the first alternative is a "No Action" alternative. The "No Action" alternative provides a basis against which other alternatives are compared.

Three proposed remedial actions were developed as the cleanup alternatives based on the remedial action objectives. All remedial alternatives involve removal of sediment, usually six to 12 inches deep, from selected areas by excavation using conventional earth moving equipment. Consequently all three sediment removal alternatives remove substantial proportions of all of the contaminants present in the upstream section of the Peconic River. They differ primarily in the target cleanup goals and the resulting areas proposed for cleanup. Figure 1, Cleanup and Temporary Access Path Area by Cleanup Alternative, depicts the remediation and road area for each of the three action alternatives. Although sediment removal activities would temporarily disturb some wetland areas, initial results of pilot studies conducted on the Peconic River have indicated that these areas can be restored and can recover successfully. The preliminary results of the wetland restoration pilot studies have indicated that areas previously dominated by an invasive species can be restored with native species of wetland plants. The temporary sediment trap installed near gauging station HQ will be removed because potential migration of sediment contributing to bioaccumulation and toxicity of mercury will be reduced once sediment removal is completed and demonstrated to be effective in controlling contaminant migration, fate, and transport. Sediments trapped behind and within the trap will be analyzed and removed, if applicable, prior to removal of the sediment trap.

Alternatives Two, Three, and Four are designed to remove sediment above a specific level (or levels) of contamination. Sediment removal will both reduce exposure of the aquatic community to contaminants in sediment, and also reduce the extent of mercury bioaccumulation in fish. Thus, these alternatives would reduce the potential for bioaccumulation of mercury in fish, thereby further reducing the potential health hazards to people consuming fish from the Peconic River upstream of Schultz Road.

Alternatives Two and Three, respectively, represent upper bound and lower bound values for the extent of sediment removal. Evaluation of these two alternatives provides a comparison of the range of benefit versus impact if cleanup were to be based strictly on sediment contamination levels.

Alternative Four lies within this range and targets wetland depositional areas that may be significant sources for mercury bioaccumulation as well as other areas that may contribute to future migration of contaminants or future bioaccumulation. Alternative Four uses both average sediment goals specific to the Peconic River and maximum sediment goals within cleaned up deposition areas as its targets.

Alternative Four is proposed as the alternative that best addresses the CERCLA evaluation criteria based on the results of the comparative analysis performed in Section 4 of this FS Addendum. It removes sediment from Laboratory property that may pose a risk to aquatic organisms living in the sediment and represent significant sources of methyl mercury that may bioaccumulate in fish. The alternative will also remove sediment from off of Laboratory property that may contribute to the bioaccumulation of mercury in fish and the potential risks to human health and the environment. This includes sediment in the riverbed as well as adjacent wetlands where the potential for bioaccumulation may be greatest. It removes a substantial amount of contamination to protect the ecosystem, and minimizes - to the extent possible - the impact to upland and wetland areas. Target goals are used for sediment on the Laboratory property that result in protection of the aquatic community, fish, and wildlife. Lower target goals are established for beyond Laboratory property in County parkland to allow the most flexibility in its uses or other future development.

The unconsolidated sediment would be removed from selected areas where significant methyl mercury sources are likely to occur and where contaminant concentrations are highest under Alternative Four. This would remove the mercury-contaminated sediment that has the greatest potential to bioaccumulate in fish. Consequently, the human health risk from consuming fish will be substantially reduced. Monitoring fish tissue concentrations after cleanup will verify that human health is protected by this action. Removal would be accomplished using conventional earth-moving equipment.

Contaminant mass removal efficiencies are presented in Figure 2. Based on average concentrations measured in the surface sediment (top six inches), 92 percent of the mass of mercury in the area from the BNL Sewage Treatment Plant to Schultz Road would be removed. Additionally, it would be expected that 93 percent of the mass of PCBs (measured as aroclor-1254) would be removed from the sediment as well as 91 percent of the mass of cesium-137.

Contaminant concentration removal efficiencies, as opposed to the mass removal efficiencies discussed above, are presented in Figure 3. The concentrations of mercury would be reduced by an estimated 87 percent, of PCBs by 70 percent, and of cesium-137 by 88 percent.

In summary, this FS Addendum details the alternatives considered to address potential ecological and human health risks related to contamination associated with BNL in the upstream portions of the Peconic River. Alternative Four is proposed as the cleanup alternative. Alternative Four will provide significant removal of contaminants and, focuses on protecting the ecosystem, and would reduce the bioaccumulation of mercury and PCBs in fish. It would be protective of human health and provides the best balance between contamination removal and impact to upland and wetland areas.

The implementation of this remedy is taking place in two phases. The first phase will address sediment on Laboratory property under an Action Memorandum. The second phase will address sediment that extends beyond the Laboratory boundary and upstream of Schultz Road plus an additional three sections of the river near Manor Road. This phased approach will provide the best means for accelerating cleanup while ensuring that cleanup of the County parkland is as effective as possible.

The aforementioned "Action Memorandum" was issued for public review in the fall of 2003 and is scheduled for implementation in the winter and spring of 2004. An Action Memorandum is an authorization by DOE to start work under its Superfund response authority, and authorizes work called a

removal action. This process is commonly used to accelerate and/or complete discrete portions of a larger response action.

Comparison of Alternatives

	Baseline Net Cost	Total Area of Remediated Streambed	Stream bed to be remediated (Linear feet)	Percent Mercury Removal	Volume of sediment removed (Cubic yards)
Alternative 1 No Action	$197,600	0		0	0
Alternative 2 Remove sediment containing mercury concentrations greater than 1.06 parts per million (ppm) from the Sewage Treatment Plant to Schultz Road	$12,150,000	20.4 acres	18,500	96	24,700
Alternative 3 Remove sediment containing mercury concentrations greater than 9.8 ppm from the Sewage Treatment Plant to Schultz Road	$5,821,000	7.6 acres	7,070	66	9,250
Alternative 4 Remove the sediment layer down to sand from depositional areas and from areas identified as preferential methylmercury sources. Achieve average mercury concentrations of less than 1.0 ppm on BNL property and less than 0.75 ppm off BNL property to Schultz Road. This alternative also includes an additional 2.4 acres in the Manor Road area with a mercury concentration goal of less than 2 ppm following the cleanup.	$11,461,000	19.8 acres	14,720	92	24,018

Note: To compare alternatives, the percent mercury removal is from the Sewage Treatment Plant to Schultz Road

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Acronyms, Abbreviations, and Units of Measure

AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
BNL	Brookhaven National Laboratory
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act* of 1980
CFR	Code of Federal Regulations
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FDA	U.S. Food and Drug Administration
FS	Feasibility Study
ft^3/yr	cubic feet per year
FY04	fiscal year 2004
g/day	grams per day
gpm	gallons per minute
LF	linear feet
LGP	low ground pressure
LS	lump sum
mg/kg	milligram per kilogram
mg/l	milligrams per liter
mgd	million gallons per day
ND	non-detect
NYCRR	New York Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
OU V	Operable Unit V
PCBs	polychlorinated biphenyls
pCi/g	picoCuries per gram
ppm	parts per million
ppt	parts per trillion
PEC	probable effect concentrations
psi	pounds per square inch
RA	Risk Assessment
RAOs	Remedial Action Objectives
RI	Remedial Investigation
SF	square feet
SPDES	State Pollution Discharge Elimination System
SQG	sediment quality guidelines
STP	Sewage Treatment Plant
TAGM	Technical and Administrative Guidance Memorandum
TBC	to be considered
TCLP	Toxic Characteristic Leaching Procedure
TEC	threshold effect concentrations
YR	year
µCi/g	microCuries per gram
µg/kg	micrograms per kilogram

1.0 INTRODUCTION

1.1 Purpose

The U. S. Department of Energy (DOE) and the Brookhaven National Laboratory (BNL) have submitted this addendum to the Feasibility Study (FS) as an evaluation of alternatives for cleanup of the Peconic River on the Laboratory property and off the Laboratory property west of Schultz Road. One Alternative also includes cleanup of three sections of the river near Manor Road. This FS Addendum addresses alternatives for the removal of Peconic River contaminated sediment using technologies that were successfully deployed in pilot studies. The technologies incorporated in the evaluated alternatives include standard mechanical removal followed by restoration activities as well as vacuum guzzler technology. Both techniques were evaluated in a pilot study initiated in the spring of 2002. The FS Addendum is intended to provide sufficient detail about the available remedial alternatives to select one that will protect human health and the environment. The DOE proposes Alternative Four, evaluated in this FS Addendum, as the cleanup remedy based on the evaluation of alternatives. The Proposed Remedial Action Plan (PRAP) will provide a summary of this document, including the recommendation to implement Alternative Four. The final remedy will be selected only after the formal public comment period has ended and the information submitted during this time has been considered. The DOE, with agreement from the U.S. Environmental Protection Agency (EPA) and concurrence of the New York State Department of Environmental Conservation (NYSDEC), will select the final remedy. The final remedy will be documented in a Record of Decision.

DOE and BNL have conducted extensive environmental investigations of the Peconic River sediment, surface water, fish, and plants over the past several years. Some areas of the Peconic River on the Laboratory property and some areas just off of the Laboratory property plus three sections of the river near Manor Road will be cleaned up to further reduce the potential for both human and ecological health risks based on the results of these investigations and some underlying assumptions, as well as discussion with the regulatory agencies and community members.

This document considers the results of the numerous investigations conducted, specifies the objectives in conducting a cleanup, details the alternatives for cleaning up, and compares the alternatives against the *Comprehensive Environmental Remediation, Compensation, Liability Act* (CERCLA) criteria. The intent of this FS Addendum is to provide detailed descriptions and comparison of the alternatives being considered to facilitate evaluation of the considered remedies before final cleanup decisions are agreed to with the regulatory agencies.

BNL has a total of 30 Areas of Concern (AOC). These areas were grouped into six distinct Operable Units in order to more effectively manage them. The Peconic River sediment, which is addressed by this document, is part of Operable Unit (OU) V and has

been designated AOC 30. Operable Unit V consists of four AOCs: the Sewage Treatment Plant (STP) (AOC 4), Capped and Retired Formerly Leaking Sewers within the Operable Unit (AOC 21), the Former Eastern Tritium Plume (AOC 23), and the Peconic River (AOC 30). The STP AOC includes Peconic River sediment and surface water, the soils in the area of the sand filter beds, hold-up ponds, and the satellite disposal area. In the spring of 2000, a proposed plan for OU V was presented for public comment. All of the cleanup decisions associated with OU V were commented upon by the public and, with the exception of the Peconic River sediment cleanup, all were agreed to by the regulatory agencies. The decisions were finalized in a Record of Decision issued in January 2002. Cleanup activities associated with those areas have been completed. Thus, this FS Addendum only addresses the cleanup of the Peconic River sediment.

The decision about how to clean up the Peconic River sediment was deferred as the result of public input during the 2000 public comment period. Concerns submitted by members of the public focused on reducing wetland damage. Other principal interests of the community members included minimizing the potential for downstream migration of contaminants during the cleanup and either increasing or decreasing the cleanup area. The initial Feasibility Study and Proposed Remedial Action Plan identified depositional areas in the river where sediment would be removed, followed by a full restoration of the wetland areas. These areas contained elevated levels of mercury in surface sediment, but often also contained elevated levels of other metals, PCBs, and radionuclides. Inherent in the comments was the need to further evaluate technologies that might be able to clean the sediment with less disruption to the wetlands and to conduct additional sediment, surface water, fish, and vegetation sampling to provide better definition of the areas requiring cleanup. This information was considered necessary before public acceptance of a remedy could be achieved and thus a final decision could be made.

The DOE and BNL, in close cooperation with the regulatory agencies and many members of the public, completed numerous activities related to the initial public concerns about cleaning up the Peconic River areas. In December 2000, a workshop involving national and international remediation and environmental restoration companies was convened at BNL. The workshop, attended by regulatory agency staff, BNL and DOE project staff, other vendors, and community members, focused on the identification of alternative technologies that might be capable of reducing wetland damage while achieving the necessary cleanup. Four technologies with promise emerged from this workshop as determined by the project staff with input from community participants in the workshop. The technologies warranting further investigation included electrochemical remediation, phytoremediation with native plant species, vacuum guzzling, and sediment removal with subsequent wetland restoration. Considerable detail about all of these technologies and the pilot testing is available on the BNL website at the following address: http://www.bnl.gov/erd/Peconic/factsheets.html.

Each of the four technologies identified in the December 2000 workshops was evaluated in further detail. A summary of these evaluations are provided below:

- The electrochemical remediation was deemed to be inadequate, in its current state of development, to meet Peconic River cleanup objectives. The process is limited by soil moisture content, contaminant properties, pH-related mineral deposition, subsurface debris, and premature precipitation of species at the electrodes. In fact, cesium-137 may not plate on the electrodes but may be mobilized and concentrated in the sediment at higher concentrations.

- Phytoextraction with native species was eliminated after the analysis of plant samples obtained from the Peconic River. The time required to achieve cleanup was too long to be feasible based on the concentrations measured in the plants compared to the sediment, and based on the expected biomass available for harvesting. Use of non-native species or harvesting belowground portions of native plants was not considered feasible since it would result in the same disruption of the environment as excavation, which is why phytoextraction was initially considered.

- The last two, vacuum guzzling and sediment removal followed by restoration, were pilot tested to verify their capabilities under Peconic River conditions. Both of these technologies are now part of the cleanup alternatives presented herein.

In 2001 and 2002, many additional sediment samples were collected and analyzed to provide greater certainty of the extent of contaminants. In 2003, additional sediment samples were collected to support the design of the cleanup. Additional fish were collected from off of the Laboratory property but near BNL. These fish were prepared as edible fish tissue samples to provide a better measurement of the concentrations to which people who eat fish might be exposed. The on-site fish and off-site fish from previous collections had been analyzed as whole fish samples (i.e., head, scales, skin, fins, and internal organs included).

Finally, all available sediment, surface water, ground water and fish characterization data was consolidated to conduct a revised assessment of human health risk (BNL 2003). The prior risk assessment identified that, if sufficient fish were available on the Laboratory property and fishing were to occur, humans consuming these fish could be subject to an excess health risk. However, given that access to the BNL site is limited, fishing on the Laboratory property is prohibited, and the river is often incapable of supporting significant fish populations, cleanup was proposed based upon the potential ecological risk that was also present.

The conclusion of the fish characterization data was that bioaccumulation of contaminants in fish does occur, and people may be exposed to contaminants in fish in the Peconic River off of the Laboratory property or in the accessible areas on Laboratory property. The more recent risk assessment made assumptions that fish could be consumed at significant levels. The results indicated a potential human health risk due to mercury and PCBs on Laboratory property and mercury off of Laboratory property. Each of the three sediment removal alternatives differs in the amount of sediment to be

removed from the Peconic River. Any cleanup action should be based on reducing this bioaccumulation. This, in fact, forms the basis for the cleanup alternatives evaluated in this *Feasibility Study Addendum*.

1.2 Report Organization

Section 1 of this report describes the site background, summarizes the remedial investigation and associated studies, and summarizes the recently conducted sediment removal pilot studies. Section 2 of this report describes the development of the Remedial Action Objectives based on the findings of the Remedial Investigation, the risk assessments, and additional studies. The alternatives that were developed to meet the Remedial Action Objectives are also described in Section 2. Section 3 provides a detailed evaluation of each of the four alternatives and evaluates each of them against the nine CERCLA criteria. Section 4 is a comparative analysis of the alternatives, and Section 5 presents the proposed alternative.

1.3 Site Background

Brookhaven National Laboratory is a DOE laboratory conducting research in physical, biomedical, and environmental sciences, as well as in selected energy technologies. Brookhaven Science Associates, a not-for-profit research management organization, operates BNL under a contract with DOE.

The Laboratory is located 60 miles east of New York City, close to the geographic center of Suffolk County on Long Island, New York. It is bordered on the west by the William Floyd Parkway, on the east by residential areas and parkland, on the north by residential areas, and on the south by the Long Island Expressway.

In 1980, the BNL site was placed on the New York State Department of Environmental Conservation (NYSDEC) list of Inactive Hazardous Waste Disposal Sites. In 1989, it was included on the Environmental Protection Agency's (EPA) National Priorities List of Superfund sites. The Laboratory's inclusion on the Superfund and NYSDEC lists was primarily due to the effects of discontinued past operations, which could impact Long Island's sole-source aquifer, the Island's sole primary drinking water source.

Past operations and practices at BNL resulted in wastewater containing chemical and radiological contaminants being processed at the BNL STP. Treated waste from the STP is discharged into the Peconic River from which it may deposit in the sediment. The discharges into the Peconic River and the contaminants adsorbed to the STP sand filter beds have been a source of contamination to the Peconic River sediment. Additional details regarding the operations of the STP and the potential as a source of Peconic River contamination are discussed in Section 1.2.3 of the 1998 FS Report. Releases from the STP to the Peconic River are monitored for compliance with a State issued permit, and the Laboratory has discontinued past practices that led to this contamination.

Excavation and off-site disposal of radiological and chemical contaminated sand and soil at the STP above the agreed-upon cleanup goals were performed to eliminate continuing sources of contamination to the Peconic River as part of the OU V STP Record of Decision (issued in January 2002). BNL maintains a proactive Pollution Prevention/Waste Minimization program to further minimize environmental impacts associated with operations conducted at BNL. The program strives to reduce the generation of wastes at the source, thereby minimizing the amount of wastes requiring disposal or treatment. Many of these projects specifically address sources of sanitary sewer contaminants. Implementing this source reduction program is eliminating contribution of contaminants to the BNL sanitary sewer and ultimately the Peconic River. In particular, the following actions related to source removal have been, or are being, conducted (see Section 1.2.4 of the 1998 FS Report and Appendix B of this FS Addendum for further details).

- Conversion to Digital Photographic Processing in the Photography Arts Division – This reduced the amount of wet photographic processes that generate silver (Ag) contaminated hazardous waste and consume large volumes of rinse water, which becomes slightly contaminated with processing chemicals.

- Substitution of non-mercury thermometers for mercury thermometers - Thermometers are accidentally dropped or bumped against a hard surface, resulting in the release of the mercury contents sometimes in laboratory sinks. This was identified as a source of mercury spills. Suitable non-mercury thermometers have replaced many of the mercury thermometers in use at the BNL.

- Replacement of mercury manometers with digital instrumentation - Replacement of mercury manometers with non-mercury digital flow monitoring instrumentation was conducted in order to upgrade existing monitoring capability, while eliminating a source of mercury.

- PCB ballast replacement and low-mercury bulb relamping for Building 902 - PCB ballasts in old lighting equipment are prone to failure, which often results in leakage of PCB contaminated materials requiring costly spill clean up and disposal. Electronic ballasts are more reliable, contain no PCBs and are more energy efficient. Bulbs will also be replaced with the low mercury fluorescent bulbs, eliminating another source of hazardous waste.

- Low-mercury bulb replacement across BNL – Approximately 30,000 low-mercury bulbs have been obtained to replace mercury-bearing bulbs.

- Inclusion of mercury in the BNL New York State Pollution Discharge Elimination System (SPDES) permit - Mercury has been added to the BNL SPDES Permit in 1998 to monitor the STP effluent for levels of mercury that may contaminate the Peconic River sediment and potentially harm fish.

- A STP SPDES evaluation – The individual research facilities' effluents were sampled for characterization purposes. Facilities with high levels of contaminants were targeted for pollution prevention activities and source removal.

- STP and sewer upgrades including relining of pipes that may contain residual contaminants – The STP has undergone a series of three upgrade phases from 1992 to 2002 and significant quantities of wastes were removed under these projects and shipped off-site.

- Removal of mercury from contaminated plumbing – Mercury was removed from contaminated piping, traps and other plumbing components in Medical Clinic/Hospital (Bldg 490), Chemistry (Bldg 555), Energy Science & Technology (Bldg 815) and Hot Laboratory (Bldg 801).

- The Process Evaluation Project - All 145 industrial processes, such as machining, electronics manufacture and painting, and all 1,821 research experiments were reviewed during 1998 to 2000. This allowed BNL to better identify waste streams with potential to impact the Sewage Treatment Plant and subsequently the Peconic River.

- The BNL Facility Review Project - In 1998, a comprehensive examination of site facilities was conducted to identify any past or current activities that have the potential to degrade the environment. Among the more than 900 processes, storage areas, past practices, pits and tanks identified in the building reviews, 76 have been categorized as Significant and Lesser issues and have been or are being tracked to closure.

- Achievement of ISO 14001 certification - BNL achieved ISO 14001 Certification in 2001 and has implemented environmental management systems that will help reduce BNL's impact to the environment. BNL has been successfully recertified annually since.

These actions, projects, and upgrades are expected to reduce any future impacts of the treated effluent being released to the Peconic River by further reducing or eliminating existing contaminant concentrations.

1.4 Remedial Investigation Summary

An OU V Remedial Investigation (IT 1998) was conducted to identify the nature and extent of soil, sediment, groundwater, and surface water contamination. The investigation included geophysical and biological surveys, sampling of soil, groundwater, surface water, and sediment, chemical and radiological analyses, benthic invertebrate toxicity testing, fish bioaccumulation studies, data validation, and preparation of the Remedial Investigation and Risk Assessment Report.

This feasibility study addendum addresses the results of those studies pertinent to the Peconic River sediment. BNL conducted a more comprehensive sampling of soils, sediment, and water for plutonium, uranium, and other radionuclides subsequent to the final Remedial Investigation report. The results of this study are reported in the *Plutonium Contamination Characterization and Radiological Dose and Risk Assessment Report* (IT 2000).

Additional sediment sampling was undertaken to better delineate the extent of contamination in the sediment on the Laboratory property and off of the Laboratory to Connecticut Avenue based on regulatory and community comments received during the public comment period for the original proposed plan in 2000. Additional fish tissue sampling was also conducted to determine edible fish tissue concentrations in areas outside off of the Laboratory and included areas that were previously dry at the time of sampling.

State and Federal standards, criteria, and guidance were reviewed to evaluate the nature and extent of contamination in soil, sediment, groundwater and surface water. Screening criteria used to identify contamination were derived from these requirements. These screening criteria are given in the Operable Unit V Remedial Investigation Report and Risk Assessment Report, completed in May 1998.

Elevated levels of metals and PCBs, and low levels of pesticides and radionuclides were detected in Peconic River sediment. Concentrations were highest in on-site surface sediment and most prominent in the depositional areas on the Laboratory property located approximately 0.5 mile, 1 mile, and 1.5 miles downstream of the STP.

The following sections provide a summary of the range of contaminants found in the Peconic River sediment and fish.

Peconic River Sediment

Mercury (maximum 39.7 milligrams per kilogram [mg/kg]), silver (maximum 380 mg/kg), and copper (maximum 1490 mg/kg) were detected most often, and at the highest concentrations above the screening level. Another contaminant of concern was the PCB aroclor-1254 (maximum 1.5 mg/kg) contamination was highest in surface sediment and was most prominent in depositional areas approximately 1 mile and 1.5 miles downstream of the STP. The distribution of mercury in Peconic River sediment on laboratory property is mapped in Appendix D, Sheets 1A to 7A. Off of the Laboratory property, contamination was generally higher in the depositional areas just downstream of BNL near North Street, in two small ponded areas midway between North Street and Schultz Road, and at Schultz Road where the restricted flow due to the culvert also promotes deposition. The distribution of mercury in Peconic River sediment between the BNL Boundary and Connecticut Avenue is mapped in Appendix D, Sheets 1B to 6B. Sampling conducted in 2003 confirmed the decreasing trend of concentrations of contaminants (e.g. mercury, silver, copper silver PCBs) downstream of Schultz Road.

The distribution of PCB and Cesium-137 in sediment on laboratory property and between the laboratory and Schultz Road are mapped in Appendix D, PCBs and Cesium-137 Sheets 1A-7A and 1B-6B, respectively.

An investigation into the distribution of site related radionuclides in the Peconic River was also conducted. Although it was determined in the human health risk assessment (BNL 2003) that radionuclides were present at levels that would not result in radiation doses above the levels requiring cleanup (EPA's level of 15 millirem per year [mrem/year] and NYSDEC's Technical and Administrative Guidance Memorandum [TAGM] level of 10 mrem/year), the distribution of the site-related radionuclides is useful for interpreting the likely distribution of other site-related contaminants that may be collocated with these radionuclides. Cesium-137, americium-241, and plutonium 239/240 are present at higher concentrations in the upstream Peconic River sediment than in the Connetquot River, a river with similar characteristics that is outside the influence of the BNL site. The maximum cesium-137 concentration in sediment on-site was 44.1 picoCuries per gram (pCi/g). The maximum americium-241 and plutonium-239/240 concentrations were also found on-site at 1.91 pCi/g and 0.158 pCi/g, respectively.

Similar to the inorganic contaminants, the low-level radionuclides detected were highest in the surface sediment and were most prominent in the depositional areas. Concentrations of these three radionuclides were also statistically greater than the background levels in the Peconic River in the off-site area upstream of Schultz Road. The maximum concentrations of cesium-137, americium-241, and plutonium-239/240 off-site but upstream of Schultz Road were 24.1 pCi/g, 0.62 pCi/g, and 0.15 pCi/g. In the Peconic River downstream of Schultz Road, the maximum detected concentrations of cesium-137, americium-241, and plutonium-239/240 were only 11 1 pCi/g, 0.057 pCi/g, and 0.13 pCi/g, respectively. Downstream of Schultz Road only the cesium-137 concentrations are statistically greater than the background concentrations. The less mobile radionuclides such as americium-241 and plutonium-239/240 concentrations downstream of Schultz Road are indistinguishable from background levels. Although the radionuclides are at levels not requiring cleanup, a large percentage of these and other site-related contaminants will be removed with the other contaminants.

Based on the low levels of most site-related radionuclides downstream of Schultz Road, the low levels of other chemicals (e.g., mercury, PCBs, and copper) downstream of Schultz Road, the increase of mercury in depositional areas near Manor Road, and potential risks and health hazards posed by these contaminants downstream of Schultz Road being below acceptable risk levels, this Feasibility Study will focus on the sediment in the Peconic River on Laboratory property and off of Laboratory property to Schultz Road. One Alternative also includes three sections of the river near Manor Road.

Peconic River Fish

Fish collected from the Peconic River headwaters had bioaccumulated mercury and PCBs. The majority of the fish collected from the Peconic River for analysis were

pickerel, creek chubsuckers, and bullhead catfish; some sunfish and bass were also present. The average concentrations measured in edible fish tissue samples off of the Laboratory property were 0.62 mg/kg mercury and 0.023 mg/kg aroclor-1254. Fish collected on the Laboratory property were analyzed as whole body samples (skin, bones, head, and internal organs were included). The average concentrations in these samples were 0.68 mg/kg mercury and 1.77 mg/kg aroclor-1254. The naturally occurring radionuclides uranium-234 and uranium-238 were detected in some of the fish samples, with highest activities in the inedible portions of the fish.

The radionuclide cesium-137 was detected in all of the fish samples for which it was analyzed (34 of 34). It was found in higher concentrations in fish collected on Laboratory property, and generally in slightly higher concentrations in the flesh and skin than in the bone and viscera. The highest activity of cesium-137 in fish was in a whole-body sample of pickerel taken on the Laboratory property (2.712 pCi/g).

1.5 Sediment Removal Pilot Studies

Pilot studies were conducted during the spring of 2002 to evaluate two sediment removal technologies for use in the remediation of the Peconic River. A high-capacity vacuum guzzler was used in the river and within an adjacent wetland located downstream of the STP discharge outfall and immediately upstream of a stream gauging station identified as HQ (see photograph 1). Water in the river was diverted downstream of the gauging station prior to the use of the guzzler within the streambed. The adjacent wetland, which receives water from the river during periods of high flow and/or from groundwater, was dry during the period that the vacuum guzzler was operating. Sediment was removed to depth of approximately six to 12 inches, or when a sand layer was encountered. A total of 750 cubic yards was removed from both areas. Results of post-excavation sampling revealed that the vacuum guzzler was more effective in removing contaminated sediment from the dry backwater area than from the riverbed. This was conducted without disturbing the surrounding wetland vegetation, nor was any topsoil or fill material placed in the excavated areas.

Photograph 1. Sediment removal using a vacuum guzzler

Photograph 2. Sediment removal using a long-arm excavator

A second pilot study was conducted in an area immediately downstream of the stream gauging station HQ located along North Street near the southeast boundary of the Laboratory property. This study evaluated the use of standard construction equipment in the Peconic River habitat and demonstrated the effectiveness of restoring a wetland habitat under Peconic River site-specific conditions. Approximately 400 feet of a wetland meadow was removed using a long-arm excavator (see photograph 2).

Photograph 3. Planting of four wetland species in April 2002

Photograph 4. Growth of restored wetland after four months (August 2002)

Contaminated sediment was removed to a depth of approximately six to 12 inches or when a sand layer was encountered, and transported to specially constructed drying beds for removal of excess moisture. Results of post-excavation sampling indicated that contaminants were substantially removed. Following excavation of 730 cubic yards of material, topsoil was backfilled and graded to create a streambed and adjacent areas for replanting of native wetland plants. For the pilot test, a temporary sediment trap was installed to limit the migration of contaminated sediment during high flow events. Following sediment removal, four species of native wetland plants were planted and monitored for several months as to their survivability and growth (see photographs 3 and 4). The initial results indicate that the wetland restoration was successful as evidenced by the extensive growth and high rate of survival (greater than 90%) observed after four months of monitoring. Additional wetland species have also appeared, suggesting that the remaining sediment contained a viable seed bank for recruitment.

The pilot study areas will be re-evaluated to verify compliance with the selected cleanup goals following the selection of a remedy.

2.0 REMEDIAL ACTION OBJECTIVE AND REMEDIAL ALTERNATIVES

This section describes the development of the remedial action objectives (RAOs) based on the findings of the Remedial Investigation (RI), risk assessments, and additional studies as well as a description of the remedial alternatives and the areas proposed for remediation based on the remedial alternatives.

2.1 Development of Remedial Action Objectives

Remedial action objectives define goals for the protection of human health and the environment. The RAOs specify the contaminants of interest, exposure pathways and exposure receptors, and the acceptable contaminant levels.

Based on the results of the OU V RI, the supplemental reports, and the various studies and risk assessments, it was determined that:

- Concentrations of contaminants in fish pose a potential health hazard to people consuming fish caught upstream of Schultz Road
- Concentrations of contaminants in fish pose a potential a risk to wildlife that may eat these fish, and a risk to the fish themselves
- Contamination in sediment located in the depositional areas of the Peconic River headwaters may have adverse effects on other aquatic life living in the sediment

The primary exposure pathways that represent the potential risks are the following:

- Exposure of people and fish-eating wildlife to potentially contaminated fish
- Exposure of aquatic communities to contaminated sediment

The baseline risk assessment evaluated the health effects that could result from exposure to contamination as a result of dermal contact, inhalation, and ingestion, as well as direct exposure to emissions from radionuclides associated with current and potential future land use.

Two categories of human health risks were addressed in the risk assessment for OU V and the Peconic River: risk of cancer, and non-carcinogenic toxicity. Current Federal guidelines for acceptable risks are generally an individual lifetime excess carcinogenic risk in the range of one-in-ten thousand (1×10^{-4}) to one-in-one million (1×10^{-6}) and a non-carcinogenic maximum Hazard Index equal to one. A Hazard Index greater than one indicates a potential for non-carcinogenic health effects.

The baseline human health risk assessment concluded that a potential health hazard exists for people who consume fish from either the on-site or the off-site (upstream of Schultz Road) section of the Peconic River. This potential for risk is due to bioaccumulation of mercury in the edible portion of the fish tissue. A potential cancer risk to future on-site residents was also determined due to PCBs in fish in the portions of the Peconic River on the Laboratory property, based on the same conservative assumptions. Because this was based on whole-body chemical analysis and not on analysis of edible fish tissue, it is expected to be a conservative estimate of cancer risk. Where sufficient edible-size fish tissue was analyzed (off of the Laboratory property in the upstream section), potential cancer risks were within the acceptable levels established by the EPA. The majority of the fish collected from the Peconic River for analysis were pickerel, creek chubsuckers,

and bullhead catfish; some sunfish and bass were also present. Human health risks from direct exposure to sediment were found to be within the EPA recommended target range.

Mercury in sediment was significantly higher in the Peconic River on the Laboratory property and closer to the BNL site. Concentrations of mercury measured downstream of Schultz Road (further from the site) were much lower. Mercury concentrations in fish had also been measured in other water bodies on Long Island as part of BNL's annual monitoring program and as part of the Remedial Investigation. Mercury concentrations in fish tissue in these reference locations were significantly less than the concentrations measured on Laboratory property or near the Laboratory property. Fish collected from Swan Pond in 1997 as part of the Remedial Investigation had average mercury concentrations of 0.14 mg/kg and a maximum concentration of 0.23 mg/kg whereas fish tissue concentrations from fish collected on Laboratory property during that period averaged 0.46 mg/kg of mercury with a maximum of 1.3 mg/kg. The 2000 Site Environmental Report (BNL 2001) reported no detectable mercury in fish from Swan Pond and Carman's River but average concentrations near the STP on Laboratory property of about 2 mg/kg.

The ecological risk assessment established a potential risk to aquatic communities, due primarily to elevated concentrations of mercury, silver, and copper. Though site-specific factors (for example, natural organic compounds, sulfide concentrations, and clays) may limit the bioavailability of the sediment contaminants, contaminants were sufficiently bioavailable to affect aquatic communities and bioaccumulate in fish and other aquatic organisms. Elevated levels of mercury, silver, and copper were generally detected at locations exhibiting depositional characteristics, such as where the Peconic River widens. Off-site migration of site-related contaminants was observed, with concentrations generally decreasing with distance downstream from the BNL boundary. Samples taken between the BNL boundary and Connecticut Avenue were obtained and verify the extent of cleanup that is being proposed.

Mercury detected in fish tissue was assumed to be entirely methyl mercury. While some inorganic mercury is likely to be present, assuming all as methyl mercury provides a conservative estimate that is likely to overestimate the risk.

The presence of radionuclides in Peconic River sediment, fish, deer, soil and water was also assessed. Though levels of radionuclides are also evaluated, the annual radiation dose from these sources was determined in the human health risk assessment (BNL 2003) to be present at levels that would not result in radiation doses above the levels requiring cleanup (EPA's level of 15 mrem/year and NYSDEC's TAGM level of 10 mrem/year) and the increased lifetime cancer risk from radionuclide exposure (up to 1.2×10^{-4}) is essentially equivalent to the presumptively safe level of 1×10^{-4}. The annual dose from eating deer meat with elevated cesium-137 was found to contribute most to the total radiation dose; cesium-137 levels in deer are part of a long-term monitoring plan and on-site sources of the cesium-137 contamination are being reduced through actions with other OUs. Although cleanup due to radionuclides is not necessary, co-located cesium-

137, the greatest contributor to radiological dose and risk, will be removed as part of the cleanup.

The following RAOs have been identified for sediment based on the results of the risk assessments:

- Reduce site-related contaminants (e.g., mercury) in fish to levels protective of human health.
- Reduce or mitigate, to the extent practicable, existing and potential adverse ecological effects of contaminants in the Peconic River.
- Prevent, or reduce to the extent practicable, the migration of contaminants off of the BNL facility or to areas where risk may become unacceptable.

2.2 Contaminants of Interest

During the RI process, constituents were identified as potential contaminants of interest based on either potential human health or ecological concerns. Mercury, silver, and copper were detected with the greatest frequency and at the highest concentrations relative to the screening level and were demonstrated in laboratory studies to pose a health risk to aquatic wildlife living in the sediment. In general, the elevated concentrations of inorganics were detected in surface sediment. Another contaminant of concern was the PCB aroclor-1254. The highest concentrations on the Laboratory property of organic compounds generally corresponded to the locations where the highest levels of inorganics were detected. Cesium-137 was also detected at elevated levels within these same areas. Based on the results of the risk assessments, and the co-occurrence of contaminants in the sediment, mercury was selected as the indicator contaminant to evaluate remedial action areas. Though mercury was selected as the indicator contaminant, remedial alternatives will also be evaluated with respect to aroclor-1254 and cesium-137.

2.3 Proposed Cleanup Alternatives

Four alternatives will be discussed in this FS Addendum. It should be noted that the first alternative is a "No Action" alternative as required by law as a basis for comparison. Based on the RAOs, three cleanup alternatives are defined that form the basis of the area evaluated for cleanup. The second and third alternatives seek to remove sediments containing contaminants exceeding specific values to protect the aquatic community and also significantly reduce the extent of mercury available for bioaccumulation, thereby further protecting human health. The fourth alternative identifies and cleans up the depositional areas likely to contribute most to the bioaccumulation in fish, and also addresses other areas of elevated concentrations such that average concentrations remaining are below the target goals. However, in order to allow the County greater flexibility in the use of the areas off the Laboratory property as park land or for any future development, different values are used for areas on the Laboratory property and off

of the property, and the extent of cleanup is intermediate to the second and third alternative.

Alternative One (No Action) will be discussed in Section 2.6.1.

2.3.1 Alternative Two

The EPA or NYSDEC has not promulgated sediment cleanup criteria. The NYSDEC has developed sediment-screening levels to identify contaminated sediment. These screening levels are presented in the NYSDEC "Technical Guidance for Screening Contaminated Sediment" (NYSDEC 1999). In addition to the NYSDEC sediment guidance, screening values have been developed through modeling, laboratory studies, and field studies. For instance, ranges of sediment guidance values (effects range-low and effects range-medium) were developed by Long et al. (1995). Their methodology was used as a basis to develop some of the NYSDEC screening levels.

MacDonald et al. (2000) developed consensus-based sediment quality guidelines (SQG) for freshwater sediment for both threshold effect concentrations (TEC), levels below which adverse effects are not expected to occur, and probable effect concentrations (PEC), levels above which adverse effects to benthic invertebrates are expected to frequently occur. Consensus-based SQGs were based on the geometric mean of published SQGs developed using a variety of approaches. The consensus-based PEC for mercury was determined to be 1.06 mg/kg. Ingersoll et al. (2000) examined the predictive ability of the consensus-based SQGs, and a consensus-based SQG was considered reliable if the incidence of false positives (samples incorrectly classified as toxic) and false negatives (samples incorrectly classified as not toxic) was 25 percent or less. However, the consensus-based SQG for mercury was not found to be reliable. This is most likely due to the speciation of mercury in the sediment, as well as the ability of methyl mercury to bioaccumulate in organisms. The consensus-based SQGs address only direct toxic effects on benthic invertebrates and do not address bioaccumulation in the food chain. For this lower bound alternative for sediment removal, a lower limit sediment target level of 1.06 mg/kg mercury is chosen.

The section of the Peconic River between the STP and Schultz Road that would be cleaned up under Alternative Two are shown in Figure 4. Cleanup based on this value will reduce the risk to the ecosystem and also reduce the availability of mercury for bioaccumulation in fish and thus reduce the potential health hazards to people consuming fish from the Peconic River upstream of Schultz Road. As the lower bound alternative, this represents the most extreme impact to the upland and wetland communities. It also represents the highest ratio of cost to percent mass removal of contaminants.

2.3.2 Alternative Three

A site-specific toxicity study was conducted as part of the OU V RI. Concentrations of contaminants in the sediment exceeded screening levels that indicated potential toxicity to organisms living in the sediment. The toxicity study was conducted in order to

determine if site-specific conditions might reduce the bioavailability of the contaminants in such a way that they were not as toxic as the screening criteria would indicate. In the toxicity study, toxicity was observed in all samples with 14.6 mg/kg mercury or 143 mg/kg silver or greater; however, toxicity was observed in some samples at lower concentrations. Through discussions with the regulatory agencies, and based on the data reported in the toxicity study, 9.8 mg/kg mercury, 88.9 mg/kg silver, and 310 mg/kg copper were determined to represent a level beneath which toxicity to benthic organisms in the Peconic River sediment is not likely. These values were derived as the median concentrations in the samples where toxicity was observed. Since mercury serves as the indicator contaminant for defining remedial areas, the upper limit sediment target level of 9.8 mg/kg mercury is used for this upper bound alternative. The sections of the Peconic River between the STP and Schultz Road that would be cleaned up are shown in Figure 5. The use of this level will also significantly reduce the availability of mercury for potential bioaccumulation in fish and thus will also reduce the potential health risks to people consuming fish caught from the Peconic River upstream of Schultz Road. As the upper bound alternative, this represents the lowest impact to the upland and wetland communities. It also represents the lowest ratio of cost to percent mass removal of contaminants. While this alternative is likely to achieve reduced bioaccumulation of contaminants in fish, it is less certain than the lower bound Alternative Two, and it does not specifically incorporate areas where fishing may occur such as those included in Alternatives Four.

2.3.3 Alternative Four

Alternative Four identifies and cleans up areas where sediment has historically been deposited leading to higher concentrations of contaminants, where wetland methylation of mercury occurs, areas above the cleanup goals that may sustain fish populations that could be consumed by human receptors or wildlife, and areas that contain contaminants that may be transported to areas where they may pose an unacceptable risk. Separate sediment goals are used for on Laboratory property and off Laboratory property.

On Laboratory property sediment would be removed in the wetland depositional areas most likely to result in significant bioaccumulation in fish. The average concentrations in the Peconic River sediment across the entire section of the river on the laboratory property would be reduced to about 1mg/kg. There is also a goal of all levels of mercury in the sediment being below 2 mg/kg following remediation for the areas being cleaned up. The reduction to a 1 mg/kg average is similar to sediment screening levels. It should be noted that on-site work is scheduled during the spring of 2004, under an Action Memorandum (BNL 2004) issued by DOE using its removal authority. The Action Memorandum is part of the Administrative Record and may be found in the repository libraries.

Although these levels are protective of public health and the environment, it is reasonable to propose a lower cleanup goal for areas off of the Laboratory property to provide the greatest flexibility in its use as County parkland or for any future development. Off the Laboratory property and upstream of Schultz Road and in an additional three sections of

the river near Manor Road, sediment would be removed from ponded areas that may be sources of bioaccumulation, as well as other areas with elevated concentrations. The average concentration of mercury within the sediment off of the Laboratory property would be reduced to about 0.75 mg/kg. There is also a goal of all levels of mercury in sediment to be below 2 mg/kg following remediation for the areas being cleaned up. The sections of the Peconic River between the STP and Schultz Road that would be cleaned up under Alternative Four are shown in Figure 6a.

Additionally, after extensive discussions with the regulatory agencies, 2.4 acres near Manor Road with slightly elevated levels of mercury will also be remediated. This area also has the goal that all levels of mercury in sediment will be below 2 mg/kg following remediation. The three additional sections near Manor Road that are proposed for cleanup under Alternative 4 are shown in Figure 6b.

2.4 Areas and Volumes Requiring Remedial Action

Each of the three sediment removal alternatives differs in the amount of sediment to be removed from the Peconic River. Though each alternative removes substantial portions of all of the contaminants present, the actual amounts differ based on the remedial target levels. The areas and volumes requiring remediation under each alternative are presented in this section.

2.4.1 Alternatives Two and Three

The areas of the Peconic River requiring remedial action were determined, for Alternatives Two and Three, by comparing the mercury results from the sediment samples collected during the RI and subsequent studies to the sediment target levels (i.e., lower bound of 1.06 mg/kg for Alternative Two and upper bound of 9.8 mg/kg for Alternative Three). The contaminants in sediment were generally found at much higher concentrations in the surface sediment (i.e., zero to six inches). Contaminants in the subsurface sediment are not readily bioavailable. Areas where concentrations greater than the cleanup levels have been found deeper than six inches are also selected for remediation since the surface sediment there is also at concentrations above the cleanup levels. Based on post-removal measurements of the vacuum guzzler pilot study area, additional remediation will be necessary in Area A. The section of Area D immediately downstream of gauging station HQ in which the sediment removal/wetland restoration pilot study was performed does not require additional cleanup.

A combination of existing sample data, knowledge of the stream flow characteristics, contaminant concentration trends, and sediment depositional characteristics was used to estimate the areal boundary of each stream segment requiring remediation. The widthwise areal extent of each section requiring remediation was based on the width of each stream segment as depicted on existing BNL site maps, knowledge of marsh or swamp land bordering the Peconic River, and the contaminant concentrations in those surrounding areas. For instance, much of the area off of the Laboratory property appears as a well-defined stream corridor on the maps. Marsh surrounds this apparent corridor

through much of its length. The additional sampling results obtained over the past two years, including the pre remedial design and sampling data, provide a robust database to evaluate the extent of cleanup necessary. In addition, confirmatory samples will be collected to verify achievement of the cleanup goals.

2.4.2 Alternative Two

The area projected for cleanup based on the sediment lower bound value of 1.06 mg/kg mercury is presented in Figure 4. The area extends from the Sewage Treatment Plant (STP) discharge down to an area just upstream of Schultz Road. Concentrations of mercury immediately upstream and downstream of Schultz Road were less than one mg/kg. The approximate area of the Peconic River that contains sediment with concentrations greater than 1.06 mg/kg of mercury is estimated to be 890,000 square feet (approximately 20.4 acres). Removal of sediment to the streambed is expected to require removal of six to 12 inches of sediment. Based on an average removal of nine inches of sediment, the excavated sediment volume requiring remediation is approximately 24,700 cubic yards.

2.4.3 Alternative Three

The area projected for cleanup based on the sediment upper bound value of 9.8 mg/kg mercury is presented in Figure 5. This includes portions of the following areas: the channel and wetland areas downstream of the STP outfall and upstream of gauging station HM and the eastern firebreak road, the wetlands east of the eastern firebreak road, the wetlands near North Street and extending past the gauging station HQ onto the off-site area behind the residences on North Street, the ponded area known as the Ice Pond plus a smaller pond area upstream of that, and a small marsh area in the Suffolk County park lands. The approximate area of the Peconic River that contains sediment with concentrations greater than 9.8 mg/kg of mercury is estimated to be 333,000 square feet (approximately 7.6 acres). Removal of sediment to the streambed is expected to require removal of six to 12 inches of sediment. Based on an average removal of nine inches of sediment, the excavated sediment volume requiring remediation is approximately 9,250 cubic yards.

2.4.4 Alternative Four

The areas projected for cleanup based on Alternative Four are presented in Figure 6. This includes the areas identified in Alternative Three and Four as well as portions of the following areas:

- the channel upstream of the wetland area west of gauging station HM and the eastern firebreak road,

- the channel upstream of the wetlands east of the eastern firebreak road,

- a small stretch of the river between the residences and the Ice Pond, and

- a few additional areas in the Suffolk County park lands downstream of the Ice Pond and upstream of Schultz Road,

- three sections of the river in the vicinity of Manor Road.

Other areas may be identified during the design process in order to achieve the remedial goals.

The approximate area of the Peconic River proposed for remediation under Alternative Four is estimated to be 19.8 acres. Removal of sediment to the streambed is expected to require removal of six to 12 inches of sediment. Based on an average removal of nine inches of sediment, the excavated sediment volume requiring remediation is approximately 24,000 cubic yards.

2.5 Description of Remedial Alternatives

This section provides a description of the remedial alternatives that are being evaluated by this FS Addendum to address the presence of contamination within the Peconic River.

For each alternative, it is assumed that source reduction or source removal for Peconic River sediment contamination has taken place or is occurring. The source removal actions were discussed in Section 1.3 of this FS Addendum and detailed in Appendix B.

The major components of Alternatives Two, Three, and Four are similar to the alternative from the FS prepared for OU V that DOE proposed to the public in 2000, involving sediment excavation and dewatering using drying beds, off-site sediment disposal, wetland restoration, and removal of the temporary sediment trap installed near gauging station HQ. However, the revised alternatives incorporate sediment removal methods that minimize damage to the Peconic River wetland habitat. This responds to the community's desire to minimize potential impacts to the wetland environment of the Peconic River that may result during cleanup activities. The development of remedial Alternatives Two, Three, and Four also considers the results of the pilot studies that were conducted on the Peconic River during the spring of 2002. These pilot studies were performed to investigate the effectiveness of vacuum dredging as a high precision sediment removal technique, and the use of standard construction equipment for sediment removal with subsequent wetland restoration. The pilot studies also gave an opportunity to evaluate the operational aspects of deploying the respective technologies. Each remedial alternative assumes that the STP does not act as a continuing source of contamination.

2.5.1 Alternative One

Alternative One is the "no action" alternative and will not include the implementation of any remedial action. Monitoring of surface water and sediment would be conducted for a minimum of five years to establish that contaminant deposition is not recurring and that contamination is not migrating downstream. Annually, surface water and sediment samples would be collected and analyzed for the constituents of concern (mercury, PCBs, and cesium-137). It is assumed that samples would be collected at approximately 500-foot intervals over the length of the Peconic River from the STP discharge point to Schultz Road. The no action alternative is used as the baseline against which the other alternatives are evaluated, and it is required to be considered under CERCLA.

2.5.2 Alternatives Two, Three, and Four

Some similar methods and technologies would be used for Alternatives Two, Three, and Four, and are discussed together. Following this section, the specific differences between the four alternatives are discussed. The cleanup will be conducted in two phases - Phase 1 for on-laboratory property and Phase 2 for the section of the river between the lab boundary and Schultz Road.

These Phase 1 and Phase 2 alternatives involve the removal of the unconsolidated sediment layer (approximately six to 12 inches) down to sand from sections of the Peconic River known to contain mercury at concentrations that exceed the cleanup goals. The major features of these methods include stream dewatering, the excavation/removal of the sediment layer utilizing conventional earth moving equipment, dewatering of removed sediment with drying beds, off-site disposal of sediment and wetland restoration.

The temporary haul paths will be installed with the goal of minimizing the amount and type of disturbance that takes place in/around the work area. It will not be necessary to grade the ground surface or place any materials that are difficult to remove after use. For on-site operation, (Phase 1), a temporary haul road along the river was constructed using aggregate stone. From the newly constructed haul road temporary haul paths will be installed at the transit points from the haul road to the river. The haul path will be placed over the existing ground without excavation and be covered with temporary composite mats to create minimal disturbance. The temporary mat path will be approximately 14-feet wide and will therefore require minimal removal of trees, shrubs, and roots.

For the off-site operations (Phase 2) the existing fire road (Z path) located to the west of the Phase 2 excavation area, may be used to gain access to the cleanup areas. Offsite temporary access path locations will be proposed in the remedial action work plans. Water from the Sewage Treatment Plan outfall will be pumped around the cleanup area and be discharged into the river through a series of hay bales to control turbidity, silting and erosion.

Prior to sediment removal, existing elevations of the riverbed would be obtained and cut stakes installed within the excavation boundary. Sediment removal will be accomplished by isolating and dewatering sections of the stream by the placement of temporary water bladder dams upstream and downstream of the section being worked on. The upstream dam would serve to prevent upstream flow from entering the work area, and the downstream dam would prevent backflow into the work area. Isolated sections would then be dewatered using a system of sumps, submersible dewatering pumps, and discharge piping. Flow from the upstream side would be captured by a sump and pumped to the downstream side of the downstream dam in order to by-pass the isolated section. These pumps would pump water at a flow rate that exceeds the normal STP effluent flow of 0.8 million gallons per day (MGD) or approximately 550 gallons per minute (gpm).

Appropriate erosion control measures will be provided at the discharge end of the dewatering pumps due to the increase in flow velocity at the pump discharge. Water within the isolated area will also be captured by a strategically placed sump and pumped to the downstream side of the downstream dam. The sump(s) required to capture flow will be large enough in diameter and of sufficient depth to accommodate the suction line of the dewatering pump and form an adequate depression in the streambed to capture water.

At the completion of the excavation and placement of the topsoil the pump around from the outfall will be removed, the bladders will be drained, and the flow will be restored to the river.

The anticipated length of the dewatered sections will depend upon stream topography and hydrology. Advantages of dewatering the stream in sections prior to sediment removal include: 1) enhanced streambed grade control, 2) complete access to all areas of the streambed, 3) increased ease and accuracy with confirmatory sampling, and 4) reduction in sediment resuspension. More effective dewatering within the isolated section will be promoted by trenching temporary channels (6-inch maximum depth) that direct water to flow towards the sump. In order to minimize turbidity downstream at the discharge point, silt screens will be utilized as necessary.

Within most of the areas of the Peconic River, sediment removal will be accomplished using conventional construction equipment such as excavators. Much of the equipment will be ground pressure (LGP) equipment that minimizes impact to the streambed. Using a front-end loader or excavator, the excavated sediment will be loaded into vehicles with 4-wheel off road capability, and then hauled to the staging/drying bed. The rate of excavation and staging is assumed to be approximately 200 cubic yards per day (cy/day).

Post-excavation sampling of the riverbed will be conducted to confirm that the design depth of the cut for sediment removal has achieved the cleanup target.

Drying beds will be constructed adjacent to the on-site rail spur. As determined through previous pilot studies, a bulking factor of 1.47 will be applied to the *in-situ* volume of sediment removed for the purpose of sizing the drying bed(s). The bulking factor adjusts the *in-situ* sediment volume to account for expansion of the removed sediment due to non-compactive handling. The area will be lined, bermed, and provided with drainage features (i.e., gravel drainage layer, geomembrane, and sump) to facilitate the collection of free liquids from stockpiled excavated sediment. The drying beds and staging area design will be detailed in the project work plans. As sediment is removed, it will be transported to the drying beds where it will be turned and mounded intermittently using backhoes or excavators to enhance the drying process. The stockpile will be covered at the end of each workday or when precipitation is anticipated. Free liquids generated from the drying bed stockpile will be transferred to a large storage tank for settling and testing. The water will be filtered and tested for compliance with the BNL New York State Pollution Discharge Elimination System (SPDES) permit. Only after analytical results indicate that the water meets all BNL SPDES limits will the water be returned to the Peconic River. The filtrate residue will then be returned to the sediment drying bed(s). Additional dewatering may be achieved through the addition of drying agents, if warranted, depending on sediment moisture content, time constraints or other disposal considerations.

The volume of debris, such as fallen trees or brush that provides wildlife habitat, to be removed during the clearing/grubbing activities will be minimized.

An equipment decontamination pad will be provided to clean equipment before exiting the site. A 60-mil liner draped and anchored over the berm will underlie the entire pad. Timber mats will be placed over the liner to provide a firm base for trucks to be driven over. Another 60-mil liner will be placed beneath the timber mats to act as a rub sheet. Water will be collected in the sump and pumped to a holding tank for reuse or treatment. Soil and dirt removed during the decontamination process will be either manually cleaned off the pad or recovered by mucking out the bottom of the sump. This material will be transferred to the sediment waste stream for subsequent transport to the disposal facility with the excavated sediment.

As confirmed through laboratory testing and the results of pilot studies, dewatering the sediment by means of a gravity drain drying bed is expected to yield a solids content of approximately 40 to 50 percent by weight given adequate drying time and the proper ambient field/weather conditions. The drying time is assumed to be approximately four weeks. The resulting dewatered material must pass the EPA Paint Filter Test, which evaluates the presence or absence of free liquids in materials, and is required prior to disposal in a landfill. The actual sediment characteristics will vary in different areas of the river due to heterogeneities caused by the river's location-specific depositional hydrologic characteristics. The dewatered material is also expected to exhibit an unconfined compressive strength that meets the requirement of most disposal facilities. A minimum unconfined compressive strength of 20 pounds per square inch (psi) is generally acceptable. However, specific requirements for unconfined compressive strength testing will vary according to the particular disposal facility, and may not be

required at all. Disposal facilities typically require materials to pass the Paint Filter Test and be greater than 20 percent solids by weight. Certain facilities also require that, in addition to passing the Paint Filter Test and containing greater that 20 percent solids by weight, the material must exhibit a sufficient unconfined compressive strength.

After sufficient drying, sediment will be characterized in accordance with the Waste Management Plan and transported and disposed in a licensed off-site waste landfill facility that will accept the waste. An appropriate landfill facility will be chosen following the characterization of the wastes and the evaluation of candidate landfills.

Wetland and upland restoration will be performed following sediment removal. All restoration activities and monitoring of established wetland and upland plots will be completed in accordance with project-specific work plans utilizing the results of the wetland restoration pilot study. Wetlands will be evaluated twice annually during the first two years following restoration, with annual monitoring occurring thereafter, for a total monitoring period of five years. Results of the monitoring program will be summarized in the five-year CERCLA evaluation report.

The temporary sediment trap installed near gauging station HQ will be removed at the completion of the cleanup. Sediments trapped within and downstream of the trap will be analyzed and removed, if applicable, prior to removal of the sediment trap. On achievement of the cleanup goals vacuum guzzling may be used to remove: the temporary on-site haul road bluestone aggregate.

2.5.3 Alternative Two

This alternative involves the removal of the unconsolidated sediment layer (approximately six to 12 inches) down to sand from the Peconic River known to contain mercury at concentrations that exceed the lower bound sediment cleanup target of 1.06 mg/kg upstream of Schultz Road. The surface area of the river requiring remediation under this alternative is 890,000 square feet (approximately 20.4 acres) for the 1.06 mg/kg cleanup target. Based on an average removal depth of nine inches, the volume of sediment to be removed is estimated to be approximately 24,700 cubic yards. The estimated length of stream to be remediated is 18,500 linear feet.

To accomplish this remedial activity, 15-foot-wide temporary access paths will be constructed as appropriate to access those areas requiring remediation. The total length of temporary access paths required to accomplish the remedial activities for the 1.06 mg/kg target cleanup level will be approximately 18,000 linear feet. The total estimated area required for the drying beds is estimated to be 120,000 square feet.

Post-remedial monitoring of surface water and sediment will also be conducted for a minimum of five years to determine the effectiveness of the remedial effort, and to ensure that the deposition and downstream migration of contaminated sediment is not recurring. Annually, surface water and sediment samples will be collected and analyzed for the constituents of concern (mercury, methyl mercury, PCBs, and cesium-137). The need to

continue sampling will be evaluated in the CERCLA Five Year Review and thereafter on an annual basis. Preliminary estimates assume that samples will be collected at approximately 500-foot intervals over the length of the remediated area. Additionally, following sediment removal, monitoring of both edible fish tissue and whole body fish tissue samples for mercury and PCBs will be performed to evaluate any remaining risks to human health or wildlife. Samples will also be collected in both remediated and non-remediated areas for methyl mercury to assess the effectiveness in removing the sources of methyl mercury than may bioaccumulate in fish.

2.5.4 Alternative Three

This alternative involves the removal of the unconsolidated sediment layer (approximately six to 12 inches) down to sand from the Peconic River known to contain mercury at concentrations that exceed the upper bound sediment cleanup target of 9.8 mg/kg upstream of Schultz Road. The surface area of the river projected for remediation under this alternative is 333,000 square feet (approximately 7.6 acres) for the 9.8 mg/kg cleanup target. Based on an average removal depth of nine inches, the volume of sediment to be removed is estimated to be approximately 9,250 cubic yards for the 9.8 mg/kg cleanup target. The estimated length of stream to be remediated is 7,070 linear feet for the 9.8 mg/kg target.

To accomplish this remedial activity, 15-foot-wide temporary access paths would be constructed as appropriate to access those areas requiring remediation. The total length of temporary access paths required to accomplish the remedial activities for the 9.8 mg/kg cleanup level will be approximately 7,200 linear feet. The total estimated area required for the drying beds is estimated to be 120,000 square feet.

Post-remedial monitoring of surface water and sediment will also be conducted for a minimum of five years to determine the effectiveness of the remedial effort, and to ensure that the deposition and downstream migration of contaminated sediment is not recurring. Annually, surface water and sediment samples will be collected and analyzed for the constituents of concern (mercury, methyl mercury, PCBs, and cesium-137). The need to continue sampling will be evaluated in the CERCLA Five Year Review and thereafter on an annual basis. Preliminary estimates assume that samples will be collected at approximately 500-foot intervals over the length of the remediated area. Additionally, following sediment removal, monitoring of both edible fish tissue and whole body fish tissue samples for mercury and PCBs will be performed to evaluate any remaining risks to human health or wildlife. Samples will also be collected in both remediated and non-remediated areas for methyl mercury to assess the effectiveness in removing the sources of methyl mercury than may bioaccumulate in fish.

2.5.5 Alternative Four

Alternative Four involves the removal of the 6-12 inch unconsolidated sediment layer down to sand from the wetland depositional areas of the Peconic River that are most likely to contribute to the bioaccumulation of mercury in fish, as well as other areas with

elevated concentrations of mercury that should be removed to prevent their migration down stream or because of their elevated contribution to the methylation of mercury. Selected areas were selected for removal based on location, mercury level, and regulatory input. Areas typically are contiguous to targeted depositional areas and have mercury levels sufficiently elevated to increase average mercury levels. It should be noted that on-site work is scheduled for the spring of 2004, under an Action Memorandum (BNL 2004) issued by DOE using its removal authority. The Action Memorandum is part of the Administrative Record and may be found in the repository libraries. Sediment will be removed such that the average sediment concentration on the Laboratory property is about 1 mg/kg mercury and would be removed such that the average sediment concentration off of the Laboratory property is about 0.75 mg/kg mercury. The surface area of the river projected for remediation under this alternative is approximately 19.8 acres. The volume of sediment to be removed is estimated to be approximately 24,000 cubic yards, based on an average removal depth of nine inches. The estimated length of stream to be remediated is 14,720 linear feet.

Fifteen foot-wide temporary access paths would be constructed as appropriate to access those areas requiring remediation to accomplish this remedial activity. The total length of temporary access paths required to accomplish the remedial activities for these cleanup levels will be approximately 14,510 linear feet. The total estimated area required for the drying beds is estimated to be 120,000 square feet.

Post-remedial monitoring of surface water and sediment will also be conducted for a minimum of five years to determine the effectiveness of the remedial effort, and to ensure that the deposition and downstream migration of contaminated sediment is not recurring. Annually, surface water and sediment samples will be collected and analyzed for the constituents of concern (mercury, methyl mercury, PCBs, and cesium-137). The need to continue sampling will be evaluated in the CERCLA Five Year Review and thereafter on an annual basis. Preliminary estimates assume that samples will be collected at approximately 500-foot intervals over the length of the remediated area. Additionally, following sediment removal, monitoring of both edible fish tissue and whole body fish tissue samples for mercury and PCBs will be performed to evaluate any remaining risks to human health or wildlife. Samples will also be collected in both remediated and non-remediated areas for methyl mercury to assess the effectiveness in removing the sources of methyl mercury than may bioaccumulate in fish.

3.0 DETAILED EVALUATION OF ALTERNATIVES

This section provides a detailed analysis of the remedial alternatives that form the basis for selecting the most appropriate alternative to address the Peconic River sediment contamination. These remedial alternatives are individually evaluated against nine evaluation criteria per CERCLA; however, the "State Acceptance" and "Community Acceptance" criteria will not be evaluated until comments from regulatory agencies and the public have been received on the final FS Addendum and the Proposed Remedial Action Plan. A brief summary of each of the evaluation criteria is provided below.

- **Overall Protection of Human Health and the Environment.** This criterion is used to assess the degree of protection to human health and the environment provided by an alternative. The evaluation should determine whether the alternative achieves RAOs and explain how the alternative reduces, eliminates, and/or controls risks posed by each of the potential exposure pathways identified for the site.
- **Compliance with Applicable or Relevant and Appropriate Requirements (ARARs).** This evaluation criterion is used to determine if an alternative complies with Federal and State ARARs and to be considered (TBC) requirements. If an alternative does not comply with ARARs, justification for a waiver should be provided. Under CERCLA, an ARAR may be waived if one of the following conditions is met: (1) the action is an interim action and the ARAR will be met upon project completion, (2) compliance with the ARAR would pose a greater risk to human health and the environment, (3) it is technically impractical to meet the ARAR, (4) the standard performance of an ARAR can be met by an equivalent method, (5) a State ARAR has not been consistently applied, and (6) ARAR compliance would not provide a balance between the protection achieved at one site and the demands on Superfund for other sites. ARARs and TBC requirements applicable to this FS Addendum are presented in Appendix C.
- **Long-term Effectiveness and Permanence.** This evaluation criterion is used to evaluate the long-term ability of an alternative to protect human health and the environment after remedial response levels have been achieved. The primary consideration under this criterion is the effectiveness of controls that are necessary to manage the risks posed by treatment residuals or untreated wastes.
- **Reduction of Toxicity, Mobility, and Volume.** This evaluation criterion is used to address EPA's statutory preference for remedial alternatives that (1) permanently and significantly reduce the toxicity, mobility, and volume of the compounds of concern and (2) utilize treatment as a principal element. This criterion focuses on the following factors:

    - the amount of hazardous materials treated or destroyed
    - the degree of reduction in toxicity, mobility, and volume of contaminated material
    - the degree the treatment method can be reversed
    - the characteristics and quantity of residual material that will remain

- **Short-term Effectiveness.** This evaluation criterion is used to assess the potential effects the construction and implementation of the alternative may have on human health and the environment (e.g., the risks to worker health and safety). Factors to be evaluated include protection of the workers and the community during the implementation of remedial actions, environmental impacts resulting from the implementation of the remedial actions, and the time required to achieve protection.
- **Implementability.** This evaluation criterion is used to assess the technical and administrative feasibility of implementing an alternative. Technical feasibility addresses the difficulties and unknowns associated with a technology, the reliability

of a technology, the ease of undertaking future remedial actions, and the ability to monitor the effectiveness of the system. Administrative feasibility refers to the activities required to coordinate with regulatory agencies and the availability of equipment and services.

- **Cost.** This criterion is used to evaluate the capital and operations and maintenance costs associated with an alternative. These cost estimates are conceptual, and will be refined during the design phase of the project. Present worth analysis is used to evaluate expenditures that occur over multiple years.
- **State Acceptance.** The BNL site is being remediated under an Interagency Agreement between DOE, EPA and NYSDEC. Therefore, the selected remedy will be reviewed and accepted by all parties to the agreement. State and regulatory acceptance will be based on the review of this FS Addendum and the Proposed Plan by the regulatory agencies, and will be formally documented as part of the ROD.
- **Community Acceptance.** The selected remedy will be presented to the public in the Proposed Plan. Community comments and acceptance will then be addressed in the Responsiveness Summary of the ROD, which will respond to public comments, questions, and concerns about the FS Addendum and the Proposed Plan. Informal public roundtables to answer community questions will be conducted during the public comment period of the FS Addendum and Proposed Plan.

CERCLA requires that, to the maximum extent practical, remedial action alternatives must (1) be protective of human health and the environment, (2) attain ARARs, (3) be cost effective, (4) utilize permanent solutions and alternative treatment technologies, and (5) reduce toxicity, mobility, or volume (40 Code of Federal Regulations [CFR] 300.430).

3.1 Alternative 1 - No Action

The evaluation of this alternative against the seven evaluation criteria is presented in the following sections.

3.1.1 Overall Protection of Human Health and the Environment

Based on the results of the human health risk assessment, a potential health risk exists to people consuming fish from the Peconic River either on or immediately off of the Laboratory property due to mercury accumulated in the edible portions of fish tissue. Potential risks were also identified from PCBs in fish from the on-site areas. Since the no action alternative will not reduce the bioaccumulation of contaminants into fish, any potential human health hazards would remain under the no action alternative.

The ecological risk assessment reported a potential risk to aquatic life, particularly benthic invertebrates, due to exposure to metals (e.g., mercury) in sediment. Analyses conducted using sequential extractions indicated that the bioavailability of the metals is limited, but not absent. The site-specific toxicity tests indicated that effects to benthic

organisms could be expected if concentrations are greater than 9.8 mg/kg mercury, 88.9 mg/kg silver, or 310 mg/kg copper. Since this alternative will not remove sediment that contains concentrations above these levels, impacts to aquatic life are still expected under the no action alternative.

The ecological risk assessment also indicated that wildlife consuming fish only from the on-site Peconic River could be at risk based on the levels of mercury and PCBs measured in whole fish samples. Since, the bioaccumulation of these contaminants is not expected to be reduced under the no action alternative, the potential risks to wildlife are expected to remain.

3.1.2 Compliance with ARARs

There are no promulgated Federal or State standards for the cleanup of contaminated sediment. The NYSDEC has developed screening levels, which are prescribed for use in identifying potentially contaminated sediment (NYSDEC 1999). Mercury and PCBs, as well as other contaminants, were found at concentrations above the NYSDEC sediment screening levels along the length of the OU V Peconic River study area. For constituents that are found to exceed the screening levels, the NYSDEC recommends considering the volume and location of the sediment, the persistence of the contaminant, the uncertainty about the criteria, the rate of sedimentation, and the results of site-specific sediment tests. In general, if volumes of sediment are large or difficult to remove because of the accessibility and sensitivity of the habitat or if the sediment is located in a depositional zone where natural sedimentation is likely to occur, remediation may not be warranted. Natural sedimentation assumes that the redeposition of clean sediment from upstream would cover the existing contaminated sediment and therefore minimize exposure to aquatic life.

The location-specific ARARs that may restrict certain activities associated with the Peconic River are summarized on Table C-2 of Appendix C within the OU V FS Report. In general, this alternative will comply with location-specific ARARs (e.g. Federal requirements outlined in 40 CFR 6.302 [a, b, g] [Protection of Wetlands, Floodplain Management, Area Affecting Stream or River] and State requirements such as Protection of Wetlands, 6 New York Codes, Rules, and Regulations [NYCRR] 663 and the Wild and Scenic Rivers Act, 6 NYCRR 666) because no impacts to the wetlands or to the Peconic River are involved under this alternative.

Since no action is considered under Alternative One, no action-specific requirements are applicable.

3.1.3 Long-term Effectiveness and Permanence

Under the no action alternative, the contaminants of interest will remain in place and rely on the occurrence of natural sedimentation to minimize the exposure of aquatic life to contaminated sediment and bioaccumulation of mercury in fish. Natural sedimentation rates have been estimated to be approximately 0.014 to 0.025 inches per year. The flow

rate from STP effluent (approximately 0.8 MGD) times the average Total Suspended Solids (approximately 15 milligrams per liter [mg/l]) yields a sedimentation loading rate of 580 ft^3/year. Under low water and draught conditions (approximately 38% of the time), the Peconic River flow on-site is totally recharged to groundwater prior to leaving the site boundary. Under these conditions, all suspended particulates are assumed to be deposited within on-site depositional wetland areas. The analytical data and river hydrology suggest that the most significant deposition is primarily occurring in three wetland depositional areas that are designated for remediation in each of the three alternatives: the area just west of the eastern firebreak road, the wetland area east of the eastern firebreak road, and the area at North Street. If the sedimentation loading rate at 580 ft^3/year is assumed to be deposited over these depositional wetland areas, a sedimentation rate of 0.025 inches per year results. Even if sedimentation is assumed to be constant throughout the stream area on the Laboratory property, a sedimentation rate of 0.014 inches per year results.

This method of calculating sedimentation rates assumes that over land flow from surface runoff is minimal since the majority of flow in the Peconic River is from the STP discharge. This method does not account for decaying vegetation that would also add to the creation of a protective barrier for the environment.

BNL's Pollution Prevention/Waste Minimization program has implemented many steps that minimize the contribution of contaminants to the BNL sanitary sewer and the Peconic River including STP and sewer upgrades and reduction of potential mercury sources.

Assuming that the STP does not act as a continuing source of contamination, approximately 40 to 70 years will be required to develop a one-inch layer of clean sediment. Thus, natural sedimentation is a long-term process and a substantial amount of time will be required to create a protective barrier for the environment by natural sedimentation. Based on the foregoing and assuming that a minimum of six inches of sediment is required to act as a barrier, it would be 240 to 420 years before sedimentation could be considered effective. No long-term monitoring of sedimentation rates will be conducted; however, for a period of five years, surface water and sediment samples will be collected and analyzed annually for the constituents of concern (mercury, PCBs, and cesium-137) to establish that contaminant deposition is not recurring.

3.1.4 Reduction of Toxicity, Mobility, or Volume

The no action alternative will not reduce the volume or toxicity of the contaminants contained in the Peconic River sediment or the fish, and the no action alternative does not meet the EPA statutory preference for treatment as a principal element. The potential for mobilization of the contaminated sediment will not be eliminated, but it is anticipated to be reduced due to the natural burying of contaminants with clean sediment (e.g., deposition of clean sediment from upstream areas). Natural sedimentation assumes the redeposition of clean sediment, and that the potential discharge of contaminants via the STP effluent is controlled.

3.1.5 Short-term Effectiveness

The short-term effectiveness of this alternative is low since natural sedimentation requires a substantial amount of time to develop a protective barrier. Any construction activities conducted along the Peconic River will result in the disturbance of the wetlands and associated community. The no action alternative will not result in the implementation of any construction and will not result in the disturbance of the sensitive ecosystem (e.g., wetlands). There will be no short-term risks to worker health and safety and the community that are commonly associated with construction activities (e.g., slip/trip hazards).

3.1.6 Implementability

There are no factors that will limit the technical feasibility of the no action alternative. Administratively, this alternative requires no coordination with regulatory agencies and will not require the submittal of permit applications.

3.1.7 Cost

Costs associated with this alternative are limited to those involving the long term monitoring of surface water and sediment. The detailed cost estimate is provided in Appendix A. The costs are estimated to be $197,600. The annual cost associated with surface water and sediment monitoring ($39,517) was carried forward for five years and will be reviewed at the end of the five-year period in accordance with CERCLA. The annual monitoring cost is based on the collection of water and sediment samples from every 500 feet of the river beginning below the Sewage Treatment Plant outfall and extending to Schultz Road. Samples will be analyzed for mercury, PCBs, and cesium-137.

3.2 Alternative Two

The evaluation of this alternative against the seven evaluation criteria is presented in the following sections.

3.2.1 Overall Protection of Human Health and the Environment

Alternative Two involves the removal of the unconsolidated sediment (approximately six to 12 inches) from selected locations by excavation using conventional earth moving equipment. The baseline human health risk assessment concluded that a potential health hazard exists for people who eat fish from the Peconic River either on or off of the Laboratory property in the upstream section. This risk is due to mercury in the edible portion of the fish tissue off Laboratory property and mercury and PCBs in whole body collections of fish on the Laboratory property. Although there is a significant amount of uncertainty regarding the bioaccumulation factors relating sediment concentrations to edible fish tissue concentrations, the sediment removal as part of Alternative Two is expected to reduce the potential for bioaccumulation in fish substantially, and to further

reduce the potential health hazards for people consuming fish caught in the upstream portions of the Peconic River.

The removal of the sediment layer to the 1.06 mg/kg mercury cleanup level will result in significant improvement in overall protection of human health, based on very conservative assumptions, because contaminated sediment that is believed to be the source of mercury bioaccumulation in fish would be substantially removed. More than 96 percent of the mass of mercury in the surface sediment in the area from the STP to Schultz Road would be removed at the 1.06 mg/kg mercury level based on average concentrations measured in the surface sediment (top six inches). Additionally, it would be expected that more than 95 percent of the mass of PCBs (measured as aroclor-1254) would be removed from the sediment as well as more than 97 percent of the mass of cesium-137. The concentrations of mercury would be reduced by an estimated 91 percent, of PCBs by 69 percent, and of cesium-137 by 94 percent.

Removal of contaminated sediment to the 1.06 mg/kg mercury level will reduce the potential for effects to the aquatic community by reduction of exposure concentrations to levels below the toxicity-based target levels.

The execution of this remedial activity will also result in the temporary disturbance of the wetland community although removal of the contaminated sediment to cleanup levels will reduce the exposure of the aquatic community to sediment contaminants that are deemed to be toxic to aquatic life. The removal of sediment to the 1.06 mg/kg target level would result in a greater degree of wetland disturbance because a larger portion of the river would be remediated. Pilot studies conducted on the Peconic River have substantiated that the sediment removal and wetland reconstruction techniques described for this alternative are effective at restoring sensitive wetland environments. Common to Alternatives Two, Three, and Four, wetland damage and upland temporary access path construction affects will be minimized. Detailed planning and surveys will minimize the number and length of temporary access paths to the wetlands through the upland areas. Prior to initiating construction potential routes will be surveyed to select the shortest routes and routes that minimize the impacts to forest vegetation. The route is next marked and then inspected and approved by NYSDEC as part of the equivalency permit process. As part of the construction process a silt screen will be staked along the full downgrade length of the haul paths to prevent the spread of sediment in the eventuality of a potential spill. Within the wetlands, serial handling of sediment by multiple excavators to move the sediment from the actual excavation location to the truck loading station will further reduce the length and number of temporary access paths needed. Within the wetlands, long arm excavators (e.g. 60 foot reach) will allow sediment removal from approximately a 7500 square-foot area, thus reducing impacts of placement of construction equipment within the wetlands. Furthermore, the results of the wetland restoration pilot studies have demonstrated that areas previously dominated by an invasive species can be restored with native species of wetland plants.

3.2.2. Compliance with ARARs

There are no promulgated Federal or State standards for the cleanup of contaminated sediment. The NYSDEC has developed screening levels that are prescribed for use in identifying potentially contaminated sediment (NYSDEC 1999). A consensus-based level of 1.06 mg/kg mercury was developed (Ingersoll et al. 2000) based on average values from literature sources at which toxic effects might be expected to be observed. These values were derived from generic conditions and do not represent site-specific attributes. Use of the target level of 1.06 mg/kg mercury will result in removal of sediment with concentrations above this level.

Alternative Two may not comply with location-specific ARARs because this alternative involves the temporary disturbance of wetland areas. Specifically, Federal and State regulations require that impacts to wetlands be minimized unless no other viable option exists. However, pilot studies conducted on the Peconic River have substantiated that the sediment removal techniques described for this alternative are effective at minimizing disturbance to sensitive wetland environments. Wetland restoration techniques have also been demonstrated to be effective through a pilot study.

There are also a number of action-specific requirements that must be met before implementing this alternative. These include requirements for Dredge and Fill Operations (33 CFR 320.2), the National Pollution Discharge Elimination System (40 CFR 122), Discharge of Storm Water Runoff (40 CFR 122.26), and others.

3.2.3 Long-term Effectiveness and Permanence

This alternative involves the removal and disposal of contaminated sediment, which pose a potential risk to the aquatic community, and therefore provides a permanent remedy for the contaminants of interest that exist at concentrations that are deemed to be toxic to aquatic life.

This alternative assumes that natural re-deposition of clean sediment would occur after remediation has been completed.

The effectiveness of the wetland restoration pilot study conducted in 2002 demonstrates that long-term impacts of sediment removal will be mitigated.

3.2.4 Reduction of Toxicity, Mobility, or Volume

Alternative Two does not meet the EPA's statutory preference for treatment as a principle component. Although the sediment that is removed will be dewatered in a drying bed, no treatment to reduce the toxicity, mobility, or volume of the contaminants of interest will be conducted. Therefore, the removed sediment will have essentially the same characteristics after excavation as it had in the stream. Failure to reduce the toxicity and mobility of the contaminants of interest may not be a concern since the removed sediment

is anticipated to be characteristically non-hazardous. It will be disposed of in an appropriately permitted facility.

However, because this alternative involves the removal and disposal of contaminated sediment that pose a potential risk to the aquatic community and consequently, to humans, Alternative Two will significantly reduce the volume, mobility and the toxicity of the sediment to which the aquatic community may be exposed. The contaminated sediment potentially available to aquatic organisms would be removed. The sediment that remains after remediation and that are thereafter re-deposited as a result of natural sedimentation are expected to pose an acceptable risk to humans and to the aquatic community.

3.2.5 Short-term Effectiveness

The execution of this alternative will involve the implementation of removal activities (e.g., dewatering, excavation, material stockpiling, and material load-out) and may pose minor short-term risks to worker health and safety. Potential risks to workers include those generally associated with construction activities (e.g. slip/trip/fall and equipment operation hazards). The extensive handling and processing of contaminated sediment involved with this alternative increases the potential for workers to be exposed to contaminants through either ingestion or inhalation of the sediment. Inhalation risks may increase during the sediment drying process because the finer particles in the dried sediment may become airborne. The use of engineering controls, to reduce airborne dust, and the use of personal protective equipment and monitoring will minimize such risks. This activity is not expected to present significant risk to workers or the local community.

The execution of this alternative will also result in the short-term disturbance of wetlands and the associated aquatic community along the stream. However, pilot studies conducted on the Peconic River have substantiated that the sediment removal techniques described for this alternative are effective at minimizing disturbance to sensitive wetland environments. Wetland restoration techniques have also been demonstrated to be effective through a pilot study. Some contaminant redistribution could occur as a result of sediment resuspension during removal activities. However, redistribution of large amounts of contaminants is considered unlikely, as monitoring and mitigative measures such as silt curtains would be used to reduce such impacts. The above impacts will be further minimized by conducting the sediment removal during the winter and early spring when water levels are lowest and the wildlife are either dominant or not resident in the river during that period.

The time required to execute this alternative is expected to be approximately 124 working days.

3.2.6 Implementability

Alternative Two involves stream/wetlands dewatering using damming methods, sediment excavation, sediment dewatering with drying beds, and off-site disposal. Minor

uncertainties may exist due to site-specific conditions (e.g., topography, stream flows, land area, and access), variability of excavated sediment material characteristics (e.g., solid content, wet density, moisture content, particle types and size distribution, and free liquid yield), and variability in ambient weather conditions that may affect the efficiency and duration of the drying bed process. It was assumed that a drying time of four weeks would be required for each load of sediment placed on the bed in order to achieve appropriate percent solids by weight sufficient for disposal.

The expected reliability associated with the use of the methods outlined for this alternative is expected to be high because the contaminated sediment, which poses a potential risk to the aquatic community, is removed and placed in a controlled disposal facility. In addition, the means by which contaminated sediment removal is achieved (i.e., by dewatering sections and removal through the use of conventional construction equipment) has been demonstrated by pilot testing to be both reliable and implementable.

Post-remedial monitoring of surface water and sediment will need to be conducted for a minimum of five years to determine the effectiveness of the removal action effort. Annually, surface water and sediment samples will be collected and analyzed for the constituents of concern (mercury, PCBs, and cesium-137). Preliminary estimates are that samples will be collected at approximately 500-foot intervals over the length of the remediated area. The effectiveness of this alternative will also be evaluated through the monitoring of both edible fish tissue and whole body fish tissue concentrations from off the Laboratory property and the areas on the Laboratory property near North Street. Additionally samples will also be collected in both remediated and non-remediated areas for evaluation of methyl mercury.

Administratively, this alternative will require a significant level of coordination with regulatory agencies and the disposal facilities. Confirmatory post-excavation samples will be taken as each section of the stream is remediated and the results reported to the appropriate regulatory agency. Water samples will be taken from the filtrate treatment system effluent to ensure the BNL SPDES permit discharge limitations are met. Intermittent sampling and testing of the dewatered sediment will be required prior to disposal as required by the disposal facility. Equipment and material availability should not pose a problem because all equipment is conventionally used.

3.2.7 Cost

The approximate cost of this alternative is $12,150,000. The total volume of sediment that will be removed is 24,700 cubic yards from a surface area of 890,000 square feet, approximately 20.4 acres. Approximately 1,059 cubic yards of sediment representing a surface area of 40,700 square feet have already been removed based on findings from the pilot studies conducted in the spring of 2002.

A summary of the cost components associated with implementation of this alternative is provided in Table 3.1. The detailed cost estimate is provided in Appendix A.

Table 3.1
Cost Estimate For Alternative 2

Remediation Activities	Quantity	Units	Unit Cost	Total Cost
Temporary Access Path Clearing	283,575	SF	$0.95	$269,056
Temporary Access Path Construction	18,905	LF	$41.51	$784,747
Drying Bed Construction	120,000	SF	$3.30	$396,598
Drying Bed Operation	1	LS	$392,822	$392,822
Dewatering River Bed	1	LS	$222,369	$222,369
Sediment Excavation and Transport	1	LS	$2,294,047	$2,294,047
Samples for Disposal	37	Samples	$1612.00	$59,644
Post-Excavation Samples	1424	Samples	$455.47	$648,583
Wetland Restoration	1	LS	$1,459,077	$1,459,077
Load Rail Cars	1	LS	$585,802	$585,802
Waste Transport and Disposal	1	LS	$3,516,418	$3,516,418
A. Subtotal				**$10,629,164**
B. Post Remediation Monitoring	5	YR	$85,000	**$609,900**
C. Total (A +B)				**$11,239,064**
D. Management and Oversight				**$911,102**
E. Total (C +D)				**$12,150,165**

Note: LF = linear foot; LS = lump sum; SF = square feet; YR = year

The following assumptions were used to develop the cost estimate:

- The surface area was calculated from the area dimensions of the stream channel and adjacent wetland areas that were determined from the sediment investigations to contain elevated concentrations of mercury greater than 1.06 mg/kg (see Figure 4). The volume for removal was calculated using the depth for which elevated concentrations of mercury were detected; this is approximately nine inches in depth.

- Based on results of the pilot study for conventional excavation, a production rate of 200 cubic yards per day was assumed.

- Based on results of the pilot studies, a bulking factor of 1.47 was applied to the estimated volume of sediment to be removed to determine volume of excavated material to be handled.

- Sediment is estimated to weigh 1.5 tons per cu yd of excavated sediment after drying.

- Based on the results of the preliminary Toxic Characteristic Leaching Procedure (TCLP) analysis of stream sediment and the removal of contaminated sediment during the pilot studies, the excavated sediment is assumed to be classified as non-hazardous waste. Mercury levels in the sediment do not appear to exceed waste acceptance criteria for subtitle D landfills. The level of radioactive material in the sediment is also assumed to comply with DOE authorized limits for release in accordance with DOE Order 5400.5.

- It was assumed that the wetland restoration activities would include backfilling to grade the excavated areas to a width of approximately 15 feet on either side of the stream at the edge of the excavation. This will provide the appropriate hydrologic regime restoration of the wetland plant communities.

- The length of time required to dewater the sediment in the drying beds sufficiently to meet disposal requirements was assumed to be four weeks. This assumes a total surface area of 120,000 square feet with a depth of 2.5 feet for the drying beds.

- The final solids content and weight of the excavated and dewatered sediment were determined as part of a treatability study conducted prior to the pilot studies.

- Confirmatory samples will be analyzed for mercury, PCBs, and cesium-137.

- Post-remediation monitoring assumes annual sampling and analysis of surface water and sediment at 500-foot intervals and collection. Analyses will include

mercury, PCBs, and cesium-137. Restored wetlands will be monitored for replanting success at least twice a year.

- It was assumed the waste characterization samples for disposal would be collected at a frequency of one per 1000 cubic yards of dewatered sediment.

- Personal protection levels will be no greater than level C.

- The estimate does not contain provisions for sheeting, shoring, or compressive strength.

- The estimate does not contain any provision for depressing the groundwater table below existing conditions.

- The constructed roadways and temporary access paths were assumed to be restored following remedial activities.

- The transportation and disposal cost of waste assumes that the landfill facility has a rail spur and is within a 500-mile distance to BNL.

- Rail cars are assumed to have a payload capacity of 67 cubic yards.

- Rail transport rate and broker fee are based on vendor quote.

3.3 Alternative Three

The evaluation of this alternative against the seven evaluation criteria is presented in the following sections.

3.3.1 Overall Protection of Human Health and the Environment

This alternative involves the removal of the unconsolidated sediment (approximately six to 12 inches) from selected locations by excavation using conventional earth moving. The baseline human health risk assessment concluded, based on conservative assumptions, that a potential health hazard exists for people who eat significant quantities of fish caught from the Peconic River either on the Laboratory property or in the area off the Laboratory property in the upstream section. This risk is due to mercury in the edible portion of the fish tissue off of the Laboratory property and mercury and PCBs on the Laboratory property. Based on the uncertainty regarding the bioaccumulation factors relating sediment concentrations to edible fish tissue concentrations, and the remaining potential sources for bioaccumulation (though a reduction in bioaccumulation in fish due to removal of contaminants is expected), the ability of Alternative Three to reduce the edible fish tissue concentrations is less certain than Alternative Two.

The removal of sediment under the Alternative three benthic wildlife protection cleanup goal to only 9.8 mg/kg of mercury is substantially less than either the Alternative Two cleanup goal of 1.06 mg/kg or the Alternative Four 1.0 ppm on Laboratory property average and 0.75 off laboratory property average. Substantial additional contaminated sediment within some of the wetland areas, especially in section of the river between the site perimeter and Schultz Road, would not be cleaned up. Under Alternative Two an additional 12.8 acres would be cleaned up and under Alternative Four an additional 9.9 acres would be cleaned up. Some of these areas are known or suspected to be able to provide a habitat for fish and may act as a continuing source of bioaccumulation. Approximately 66 percent of the mass of mercury in surface sediment in the area from the STP to Schultz Road would be removed based on the 9.8 mg/kg target level based on average concentrations measured in the surface sediment (top six inches). In areas not selected for cleanup, mercury concentrations at levels up to 9.8 mg/kg would remain in place creating additional potential for increased bioaccumulation by fish. This bioaccumulation would raise the potential human health risk. Additionally, it is estimated that 76 percent of the mass of PCBs (measured as aroclor-1254) would be removed from the sediment as well as 77 percent of the mass of cesium-137. The concentrations of mercury would be reduced by an estimated 64 percent, of PCBs by 59 percent, and of cesium-137 by 75 percent. It should be noted that the percent mass removals and percent reductions discussed with regard to these alternatives are totals, and include the sediment already removed during the pilot studies.

The principal difference between Alternative Three and the two more substantial cleanup Alternatives, Two and Four, is in the percent removal of contaminants, as shown in Table 4.2, and average contaminant concentration remaining after remediation is completed as shown in Table 4.1. The percent removal of mercury and PCB, the principal health drivers for cleanup, in Alternative Three is about 20-30% lower than for Alternative Two and about 15-25% lower than Alternative 4. Although the post remediation concentration are similar among Alternative Two and Four, the post remediation mercury levels for Alternative 3 is approximately 3-4 times the levels after cleanup of Alternatives Four and Two respectively.

Contaminants in the sediment have the potential to pose a risk to aquatic communities exposed to the sediment. Removal of contaminated sediment to the 9.8 mg/kg target level will reduce the contaminant concentration to levels below which effects are expected to be frequently observed, based on the site-specific toxicity tests. However, some effects may still occur at lower levels. This alternative will provide increased protection of aquatic life. However, targeting sediment contaminant levels for cleanup does not provide direct assurance that potential health risks will be reduced.

Although removal of the contaminated sediment to cleanup levels will reduce the exposure of the aquatic community to sediment contaminants that are deemed to be toxic to aquatic life, the execution of this remedial activity will also result in the temporary disturbance of the wetland community. Although sediment removal activities would temporarily disturb wetland areas, pilot studies conducted on the Peconic River have substantiated that the sediment removal techniques described for this alternative are

effective at minimizing disturbance to sensitive wetland environments. Wetland restoration techniques have also been demonstrated to be effective through a pilot study. Furthermore, the results of the wetland restoration pilot studies have demonstrated that areas previously dominated by an invasive species can be restored with native species of wetland plants.

3.3.2 Compliance with ARARs

There are no promulgated Federal or State standards for the cleanup of contaminated sediment. The NYSDEC has developed screening levels that are prescribed for use in identifying potentially contaminated sediment (NYSDEC 1999). The results of the Toxicity Testing Study of the Peconic River Sediment (IT 1996) indicate that mercury concentrations above 9.8 mg/kg are expected to frequently result in observable impacts to aquatic communities living in the sediment. Additionally, concentrations of copper above 310 mg/kg and silver above 88.9 mg/kg are also related to frequently observed impacts, based on the site-specific toxicity tests. Use of the target level of 9.8 mg/kg mercury will result in removal of sediment with concentrations above this level.

Because this alternative involves the temporary disturbance of wetland areas, it may not comply with location-specific ARARs. Specifically, Federal and State regulations require that impacts to wetlands be minimized unless no other viable option exists. However, pilot studies conducted on the Peconic River have substantiated that the sediment removal techniques described for this alternative are effective at minimizing disturbance to sensitive wetland environments. Wetland restoration techniques have also been demonstrated to be effective through a pilot study.

There are also a number of action-specific requirements that must be met before implementing this alternative. These include requirements for Dredge and Fill Operations (33 CFR 320.2), the National Pollution Discharge Elimination System (40 CFR 122), Discharge of Storm Water Runoff (40 CFR 122.26), and others.

3.3.3 Long-term Effectiveness and Permanence

For both sediment target cleanup levels, this alternative involves the removal and disposal of contaminated sediment, which pose a potential risk to the aquatic community, and therefore provides a permanent remedy for the contaminants of interest that exist at concentrations that are deemed to be toxic to aquatic life. However, the removal of sediment to the 9.8 mg/kg target level will be less effective and permanent from the standpoint of human health protection because contaminated sediment within the wetland area east of the eastern firebreak and the wetland and open water areas at North Street would remain in place that could continue to provide a mercury source for potential fish bioaccumulation.

The effectiveness of the wetland restoration pilot study conducted in 2002 demonstrates that long-term impacts of sediment removal will be mitigated.

This alternative assumes that natural re-deposition of clean sediment would occur after remediation has been completed.

3.3.4 Reduction of Toxicity, Mobility, or Volume

This alternative does not meet the EPA's statutory preference for treatment as a principal component. Although the sediment that is removed will be dewatered in a drying bed, no treatment to reduce the toxicity, mobility, or volume of the contaminants of interest will be conducted. Therefore, the removed sediment will have essentially the same characteristics after excavation as it had in the stream. Failure to reduce the toxicity and mobility of the contaminants of interest may not be a concern since the removed sediment is anticipated to be characteristically non-hazardous.

Alternative Three will significantly reduce the volume, mobility and the toxicity of the sediment to which the aquatic community may be exposed. The sediments that remain after remediation and that are re-deposited as a result of natural sedimentation are expected to pose an acceptable risk to humans and to the aquatic community.

The removal of sediment to the 9.8 mg/kg mercury level will result in a substantially lesser degree of reduction than that for either Alternative Two or Alternative Four (Table 4-1). Contaminated sediment within the wetland area east of the eastern firebreak and most of the wetland and open water areas at North Street would remain in place. Some of these areas are known or suspected to provide habitat for fish.

3.3.5 Short-term Effectiveness

The execution of this alternative will involve the implementation of removal activities (e.g., dewatering, excavation, material stockpiling, and material load-out) and may pose minor short-term risks to worker health and safety. Potential risks to workers include those generally associated with construction activities (e.g. slip/trip/fall and equipment operation hazards). The extensive handling and processing of contaminated sediment involved with this alternative increases the potential for workers to be exposed to contaminants through either ingestion or inhalation of the sediment. Inhalation risks may increase during the sediment drying process because the finer particles in the dried sediment may become airborne. The use of engineering controls to minimize dust production and personal protective equipment and monitoring will minimize such risks. This activity is not expected to present significant risk to workers or the local community.

The execution of this alternative will also result in the short-term disturbance of wetlands and the associated aquatic community along the stream. However, pilot studies conducted on the Peconic River have substantiated that the sediment removal techniques described for this alternative are effective at minimizing disturbance to sensitive wetland environments. Wetland restoration techniques have also been demonstrated to be effective through a pilot study. Some contaminant redistribution could occur as a result of sediment resuspension during removal activities. However, redistribution of large

amounts of contaminants is considered unlikely, as monitoring and mitigative measures such as silt curtains would be used to reduce such impacts.

The above impacts will be further minimized by conducting the sediment removal during the winter and early spring when water levels are lowest and the wildlife are either dominant or not resident in the river during that period.

The time required to execute this alternative is expected to be approximately 150 working days.

3.3.6 Implementability

This alternative involves stream/wetlands dewatering using damming methods, sediment excavation, sediment dewatering with drying beds, and off-site disposal. Although these methods are conventionally used and well proven, uncertainties may exist due to site specific conditions (e.g., topography, stream flows, land area, and access), variability of excavated sediment material characteristics (e.g., solid content, wet density, moisture content, particle types and size distribution, and free liquid yield), and variability in ambient weather conditions which may affect the efficiency and duration of the drying bed process. It was assumed that a drying time of four weeks would be required for each load of sediment placed on the bed in order to achieve appropriate percent solids by weight sufficient for disposal.

The expected reliability associated with the use of the methods outlined for this alternative is expected to be high because the contaminated sediment, which pose a potential risk to the aquatic community, are removed and placed in a controlled disposal facility. In addition, the means by which contaminated sediment removal is achieved (i.e., by dewatering sections and removal through the use of conventional construction equipment) has been demonstrated by pilot testing to be both reliable and implementable.

Post-remedial monitoring of surface water and sediment will need to be conducted for a minimum of five years to determine the effectiveness of the remedial effort. Surface water and sediment samples will be collected annually and analyzed for the constituents of concern (mercury, PCBs, and cesium-137). Current assumptions are that samples will be collected at approximately 500-foot intervals over the length of the remediated area. The effectiveness of this alternative will also be evaluated through the monitoring of both edible fish tissue and whole body fish tissue concentrations from the off-site area near BNL and the areas on the Laboratory property near North Street. Additionally samples will also be collected in both remediated and non-remediated areas for evaluation of methyl mercury.

Administratively, this alternative will require a significant level of coordination with regulatory agencies and the disposal facilities. Confirmatory post-excavation samples will be taken as each section of the stream is remediated and the results reported to the appropriate regulatory agency. Water samples will be taken from the filtrate treatment system effluent to ensure the BNL SPDES permit discharge limitations are met.

Intermittent sampling and testing of the dewatered sediment will be required prior to disposal as required by the disposal facility. Equipment and material availability should not pose a problem because all equipment is conventionally used.

3.3.7 Cost

The cost of this alternative is expected to be approximately $5,821,000. The total volume of sediment that will be removed is 9,250 cubic yards from a surface area of 333,000 square feet (approximately 7.6 acres). This assumes that the pilot studies have previously removed 1059 cubic yards of sediment representing a surface area of 40,700 square feet.

A summary of the cost components associated with implementation of this alternative is provided in Table 3.2. A detailed cost estimate is provided in Appendix A.

Table 3.2
Cost Estimate For Alternative 3

Remediation Activities	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Temporary Access Path Clearing	132,525	SF	$0.95	$125,525
Temporary Access Path Construction	8,835	LF	$41.51	$366,741
Drying Bed Construction	120,000	SF	$3.30	$396,598
Drying Bed Operation	1	LS	$162,895	$162,895
Dewatering River Bed	1	LS	$126,482	$126,482
Sediment Excavation and Transport	1	LS	$881,160	$881,160
Samples for Disposal	14	Samples	$1,612	$22,568
Post-Excavation Samples	533	Samples	$455.58	$242,828
Wetland Restoration	1	LS	$492,030	$492,030
Load Rail Cars	1	LS	$273,534	$273,534
Waste Transport and Disposal	1	LS	$1,315,694	$1,315,694
A. Subtotal				**$4,406,269**
B. Post Remediation Monitoring	5	YR	$85,000	**$504,050**
C. Total (A +B)				**$4,910,319**
D. Management and Oversight				**$911,102**
E. Total (C +D)				**$5,821,421**

Note: LF = linear foot; LS = lump sum; SF = square feet; YR = year

Assumptions used to develop the cost estimate are:

- The surface areas were calculated from the area dimensions of the stream channel and adjacent wetland areas that were determined from the sediment investigations to contain elevated concentrations of mercury greater than 9.8 mg/kg (see Figure 5). The volume for removal was calculated using the depth for which elevated concentrations of mercury were detected; this is approximately nine inches in depth.

- Based on results of the pilot study for conventional excavation, a production rate of 200 cubic yards per day was assumed.

- Based on results of the pilot studies, a bulking factor of 1.47 was applied to the estimated volume of sediment removed to determine volume of excavated material to be handled.

- Sediment is estimated to weigh 1.5 tons per cu yd of excavated sediment after drying.

- Based on the results of the preliminary TCLP analysis of stream sediment and the removal of contaminated sediment during the pilot studies, the excavated sediment are assumed to be classified as non-hazardous waste. Mercury levels in the sediment do not exceed waste acceptance criteria for subtitle D landfill. The level of radioactive material in the sediment is also assumed to comply with DOE authorized with limits for release in accordance with DOE Order 5400.5.

- It was assumed that the wetland restoration activities would include backfilling to grade the excavated areas to a width of approximately 15 feet on either side of the stream at the edge of the excavation in order to restore the wetland plant communities.

- The length of time required to dewater the sediment in the drying beds sufficiently to meet disposal requirements was assumed to be four weeks. This assumes a total surface area of 120,000 square feet with a depth of 2.5 feet for the drying beds.

- The final solids content and weight of the excavated and dewatered sediment were determined as part of a treatability study conducted prior to the pilot studies.

- Confirmatory samples will be analyzed for mercury, PCBs, and cesium-137.

- Post-remediation monitoring assumes annual sampling and analysis of surface water and sediment at 500 foot intervals. Analyses will include mercury, PCBs, and cesium-137. Restored wetlands will be monitored for replanting success at least twice a year.

- It was assumed the waste characterization samples for disposal would be collected at a frequency of one per 1000 cubic yards of dewatered sediment.

- Personal protection levels will be no greater than level C.

- The estimate does not contain provisions for sheeting, shoring, or compressive strength.

- The estimate does not contain provisions for depressing the groundwater table below existing conditions.

- The roadways constructed were assumed to be restored following remedial activities.

- The transportation and disposal cost of waste assumes that the landfill facility has a rail spur and is within a 500-mile distance to BNL.

- Rail cars are assumed to have a payload capacity of 67 cubic yards.

- Rail transport rate and broker fee are based on vendor quote.

3.4 Alternative Four

The assessment of this alternative against the seven evaluation criteria is presented in the following sections. During discussion with the regulators in the summer of 2003, DOE decided to accelerate the portion of the on Laboratory property Peconic River cleanup under a non-time critical removal action by implementing Alternative 4. A draft Action Memorandum was prepared and shared with the regulators. The on-site Laboratory portion of the cleanup was also discussed with the community on October 7 and October 15, 2004. Community comments were considered and the document was subsequently finalized and placed in the Administrative Record on January 30, 2004.

The Peconic River cleanup on Laboratory property under the action Memorandum is also described in the Proposed Remedial Action Plan and in this section of the Feasibility Study Addendum. Both the community and the regulators are encouraged to comment again on the on-site portion of the cleanup between the STP and the Lab boundary as well as the section of the cleanup between the Lab boundary and Schultz Road in either or both the Proposed Remedial Action Plan and this Feasibility Study Addendum.

The Action Memorandum of January 20, 2004 is part of the Administrative Record and may be found in the repository libraries.

3.4.1 Overall Protection of Human Health and the Environment

This alternative involves the removal of the unconsolidated sediment (approximately six to 12 inches) from selected locations by excavation using conventional earth moving equipment. The baseline human health risk assessment concluded, based on conservative assumptions, that a potential health hazard exists for people who eat a significant amount fish caught from the Peconic River either on-site or in the off-site area in the upstream section. This potential risk is due to mercury in the edible portion of the fish tissue off-site and mercury and PCBs on site. This alternative targets all of the depositional areas and is expected to significantly reduce the contaminants available for bioaccumulation into fish to which people may be exposed.

Approximately 92 percent of the mass of mercury in the surface sediment in the area from the STP to Schultz Road would be removed based on average concentrations measured in the surface sediment (top six inches). Additionally, it is estimated that 93 percent of the mass of PCBs (measured as aroclor-1254) would be removed from the sediment as well as 91 percent of the mass of cesium-137. It should be noted that the percent mass removals and percent reductions in concentration discussed with regard to these alternatives are totals, and include the sediment already removed during the pilot studies.

Contaminants in the sediment have the potential to pose a risk to aquatic communities exposed to the sediment. Removal of contaminated sediments identified in this alternative should reduce the contaminant concentration to levels below which effects are expected to be frequently observed, based on the site-specific toxicity tests, though some effects may still occur at lower levels, and will reduce average concentrations to about or below the consensus-based screening level, and should provide increased protection of aquatic life.

The execution of this remedial activity will also result in the temporary disturbance of the wetland community. Pilot studies conducted on the Peconic River have shown that the sediment removal techniques described for this alternative are effective at minimizing disturbance to sensitive wetland environments although sediment removal activities would temporarily disturb wetland areas. Wetland restoration techniques have also been demonstrated to be effective through a pilot study. Furthermore, the results of the wetland restoration pilot studies have demonstrated that areas previously dominated by an invasive species can be restored with native species of wetland plants.

3.4.2 Compliance with ARARs

There are no promulgated Federal or State standards for the cleanup of contaminated sediment. The NYSDEC has developed screening levels that are prescribed for use in identifying potentially contaminated sediment (NYSDEC 1999). The results of the Toxicity Testing Study of the Peconic River Sediment (IT 1996) indicate that mercury concentrations above 9.8 mg/kg are expected to frequently result in observable impacts to aquatic communities living in the sediment. Additionally, concentrations of copper

above 310 mg/kg and silver above 88.9 mg/kg are also related to frequently observed impacts, based on the site-specific toxicity tests. The areas identified by this alternative are expected to remove most sediment above these levels.

Because this alternative involves the temporary disturbance of wetland areas, it may not comply with location-specific ARARs. Specifically, Federal and State regulations require that impacts to wetlands be minimized unless no other viable option exists. However, pilot studies conducted on the Peconic River have substantiated that the sediment removal techniques described for this alternative are effective at minimizing disturbance to sensitive wetland environments. Wetland restoration techniques have also been demonstrated to be effective through a pilot study.

There are also a number of action-specific requirements that must be met before implementing this alternative. These include requirements for Dredge and Fill Operations (33 CFR 320.2), the National Pollution Discharge Elimination System (40 CFR 122), Discharge of Storm Water Runoff (40 CFR 122.26), and others.

3.4.3 Long-term Effectiveness and Permanence

This alternative involves the removal and disposal of contaminated sediment. The contaminated sediment poses a potential risk to the aquatic community. Alternative Four provides a permanent remedy for the contaminants of interest that exist at concentrations that are deemed to be toxic to aquatic life. Additionally, this alternative removes contaminated sediment from the depositional areas most likely to contribute significantly to the methylation of mercury, minimizes the potential for downstream migration of contaminated sediment and should be effective and permanent from the standpoint of human health.

This alternative assumes that natural re-deposition of clean sediment would occur after remediation has been completed.

3.4.4 Reduction of Toxicity, Mobility, or Volume

This alternative does not meet the EPA's statutory preference for treatment as a principle component. Although the sediment that is removed will be dewatered in a drying bed, no treatment to reduce the toxicity, mobility, or volume of the contaminants of interest will be conducted. Therefore, the removed sediment will have essentially the same characteristics after excavation as it had in the stream. Failure to reduce the toxicity and mobility of the contaminants of interest may not be a concern since the removed sediment is anticipated to be characteristically non-hazardous.

The effectiveness of the wetland restoration pilot study conducted in 2002 demonstrates that long-term impacts of sediment removal will be mitigated.

Alternative Four significantly reduce the volume, mobility and the toxicity of the sediment to which the aquatic community may be exposed. The sediments that remain

after remediation and that are thereafter re-deposited as a result of natural sedimentation are expected to pose an acceptable risk to humans and to the aquatic community.

The removal of sediment under this alternative will result in a close but lesser degree of contaminant reduction than that for the 1.06 mg/kg cleanup level (Table 4-1).

3.4.5 Short-term Effectiveness

The execution of this alternative will involve the implementation of removal activities (e.g., dewatering, excavation, material stockpiling, and material load-out) and may pose minor short-term risks to worker health and safety. Potential risks to workers include those generally associated with construction activities (e.g. slip/trip/fall and equipment operation hazards). The extensive handling and processing of contaminated sediment involved with this alternative increases the potential for workers to be exposed to contaminants through either ingestion or inhalation of the sediment. Inhalation risks may increase during the sediment drying process because the finer particles in the dried sediment may become airborne. The use of engineering controls to minimize dust production and personal protective equipment and monitoring will minimize such risks. This activity is not expected to present significant risk to workers or the local community.

The execution of this alternative will also result in the short-term disturbance of wetlands and the associated aquatic community along the stream. However, pilot studies conducted on the Peconic River have shown that the sediment removal techniques described for this alternative are effective at minimizing disturbance to sensitive wetland environments. Wetland restoration techniques have also been demonstrated to be effective through a pilot study. Some contaminant redistribution could occur as a result of sediment resuspension during removal activities. However, redistribution of large amounts of contaminants is considered unlikely, as monitoring and mitigative measures such as silt curtains would be used to reduce such impacts.

The time required to execute this alternative is expected to be approximately 100 working days.

3.4.6 Implementability

This alternative involves stream/wetlands dewatering using damming methods, sediment excavation, sediment dewatering with drying beds, and off-site disposal. Although these methods are conventionally used and well proven, uncertainties may exist due to site specific conditions (e.g., topography, stream flows, land area, and access), variability of excavated sediment material characteristics (e.g., solid content, wet density, moisture content, particle types and size distribution, and free liquid yield), and variability in ambient weather conditions which may affect the efficiency and duration of the drying bed process. It was assumed that a drying time of four weeks would be required for each load of sediment placed on the bed in order to achieve appropriate percent solids by weight sufficient for disposal.

The expected reliability associated with the use of the methods outlined for this alternative is expected to be high because the contaminated sediment, which pose a potential risk to the aquatic community, are removed and placed in a controlled disposal facility. In addition, the means by which contaminated sediment removal is achieved (i.e., by dewatering sections and removal through the use of conventional construction equipment) has been demonstrated by pilot testing to be both reliable and implementable.

Post-remedial monitoring of surface water and sediment will need to be conducted for a minimum of five years to determine the effectiveness of the remedial effort. Annually, surface water and sediment samples will be collected and analyzed for the constituents of concern (mercury, PCBs, and cesium-137). Samples will be collected at approximately 500-foot intervals over the length of the remediated area. The effectiveness of this alternative will also be evaluated through the monitoring of both edible fish tissue and whole body fish tissue concentrations from the off-site area near BNL and the areas on the Laboratory property near North Street. Additionally samples will be collected in both remediated and non-remediated areas for evaluation of methyl mercury.

Administratively, this alternative will require a significant level of coordination with regulatory agencies and the disposal facilities. Confirmatory post-excavation samples will be taken as each section of the stream is remediated and the results reported to the appropriate regulatory agency. Water samples will be taken from the filtrate treatment system effluent to ensure the BNL SPDES permit discharge limitations are met. Intermittent sampling and testing of the dewatered sediment will be required prior to disposal as required by the disposal facility. Equipment and material availability should not pose a problem because all equipment is conventionally used.

3.4.7 Cost

The cost of this alternative is expected to be approximately $11,461,000. The total volume of sediment that will be removed is approximately 24,000 cubic yards. This assumes that the pilot studies have previously removed 1059 cubic yards of sediment representing a surface area of 40,700 square feet.

A summary of the cost components associated with implementation of this alternative is provided in Table 3.3. The detailed cost estimate is provided in Appendix A.

Table 3.3
Cost Estimate For Alternative 4

Remediation Activities	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Temporary Access Path Clearing	201,450	SF	$0.95	$191,136
Temporary Access Path Construction	13,430	LF	$41.51	$557,479
Drying Bed Construction	120,000	SF	$3.30	$396,598
Drying Bed Operation	1	LS	$326,985	$326,985
Dewatering River Bed	1	LS	$194,860	$194,860
Sediment Excavation and Transport	1	LS	$1,997,522	$1,984,553
Samples for Disposal	32	Samples	$1,612.00	$51,584
Post-Excavation Samples	1217	Samples	$445.80	$553,413
Wetland Restoration	1	LS	$1,070,847	$1,069,943
Load Rail Cars	1	LS	$504,373	$504,373
Waste Transport and Disposal	1	LS	$2,938,451	$2,934,918
Additional Manor Road Area				$1,138,000
A. Subtotal				**$9,903,841**
B. Post Remediation Monitoring	5	YR	$90,000	**$645,777**
C. Total (A +B)				**$10,549,618**
D. Management and Oversight				**$911,102**
E. Total (C +D)				**$11,460,720**

Note: LF = linear foot; LS = lump sum; SF = square feet; YR = year

Assumptions used to develop the cost estimate are:

- The surface areas were calculated from the area dimensions of the stream channel, adjacent wetland areas, and depositional areas that were determined from the sediment investigations to contain elevated concentrations of mercury (see Figure 6). The volume for removal was calculated using the depth for which elevated concentrations of mercury were detected; this is approximately nine inches in depth.

- A production rate of 200 cubic yards per day was assumed Based on results of the pilot study for conventional excavation.

- A bulking factor of 1.47 was applied to the estimated volume of sediment to be removed to determine volume of excavated material to be handled based on results of the pilot studies.

- Sediment is estimated to weigh 1.5 tons per cu yd of excavated sediment after drying.

- Based on the results of the preliminary TCLP analysis of stream sediment and the removal of contaminated sediment during the pilot studies, the excavated sediment are assumed to be classified as non-hazardous waste. Mercury levels in the sediment do not exceed waste acceptance criteria for subtitle D landfill. The level of radioactive material in the sediment is also assumed to comply with DOE authorized with limits for release in accordance with DOE Order 5400.5.

- It was assumed that the wetland restoration activities would include backfilling to grade the excavated areas to a width of approximately 15 feet on either side of the stream at the edge of the excavation in order to restore the wetland plant communities.

- The length of time required to dewater the sediment in the drying beds sufficiently to meet disposal requirements was assumed to be four weeks. This assumes a total surface area of 120,000 square feet with a depth of 2.5 feet for the drying beds.

- The final solids content and weight of the excavated and dewatered sediment were determined as part of a treatability study conducted prior to the pilot studies.

- Confirmatory samples will be analyzed for mercury, PCBs, and cesium-137.

- Post-remediation monitoring assumes annual sampling and analysis of surface water and sediment at 500-foot intervals. Analyses will include mercury, PCBs, and cesium-137. Restored wetlands will be monitored for replanting success at least twice a year.

- It was assumed the waste characterization samples for disposal would be collected at a frequency of one per 1000 cubic yards of dewatered sediment.

- Personal protection levels will be no greater than level C.

- The estimate does not contain provisions for sheeting, shoring, or compressive strength.

- The estimate does not contain any provision for depressing the groundwater table below existing conditions.

- The roadways constructed were assumed to be restored following remedial activities.

- The transportation and disposal cost of waste assumes that the landfill facility has a rail spur and is within a 500-mile distance to BNL.

- Rail cars are assumed to have a payload capacity of 67 cubic yards.

- Rail transport rate and broker fee are based on vendor quote.

4.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The purpose of the comparative analysis of alternatives is to evaluate the relative performance of each alternative with respect to the evaluation criteria. This analysis compares the relative advantages and disadvantages of each alternative, and provides the rationale for selecting a preferred alternative.

4.1 Overall Protection of Human Health and the Environment

Sediment in the Peconic River on Laboratory property contains contaminants (particularly mercury and PCBs) that tend to bioaccumulate in fish. Sediment in the section of the river between the BNL border and Schultz Road contain elevated levels of mercury also preferentially convert mercury into methyl mercury. Sediment in the section of the river near has elevated levels of mercury. Because the onsite, and offsite sections of the river contain contaminants that are or have the potential to bioaccumulate in fish, consumption of these fish have a potential health hazard. The approximate areas projected for remediation by each of the cleanup alternatives are compared in Figure 1. This figure also shows the estimated area of roads required for each alternative for comparison of ancillary environmental impacts.

Alternative One requires no disruption of the wetlands, forested areas, or biota. Alternative One does not reduce the levels of the contaminants present. The contaminants will continue to be a source for bioaccumulation in fish. These fish may potentially be consumed by people or wildlife and will continue to impact ecological receptors. Contaminants that remain may be subject to transport to other areas where they may pose additional unacceptable risks.

Alternatives Two, Three and Four remove different amounts of the sediment that contain elevated levels of the contaminants. This cleanup reduces the potential for bioaccumulation in fish that may potentially be consumed by humans or wildlife. Each Alternative will have some short-term disturbance to the wetlands. Alternative Two, Three, and Four use sediment cleanup levels as metrics for the actual remediation goals (i.e., reduced fish tissue contaminant concentrations) to achieve reduction in human health and ecological risk. Additionally, the effectiveness of the remedies would be

evaluated through direct measurements of fish tissue contaminant concentrations to ensure that risk reduction goals are met.

Alternative Two is expected to remove over 96 percent of the mass of mercury, PCBs, and cesium-137 contained in the surface sediment between the STP and Schultz Road, with a reduction in concentrations of 91 percent for mercury and 69 percent for PCBs and 94 percent for cesium-137. It is expected that this would result in greater certainty in reducing bioaccumulation in fish to levels and reducing sediment concentrations to levels that will not be toxic to aquatic organisms.

Alternative Three is expected to remove about 66 percent of the mass of mercury, 76 percent of the mass of PCBs, and 77 percent of the mass of cesium-137 contained in the surface sediment between the STP and Schultz Road with a reduction in concentrations of 64 percent for mercury, 59 percent for PCBs, and 75 percent for cesium-137. However, mercury concentrations may remain at levels up to but less than 9.8 mg/kg in sections of the wetlands not selected for remediation and may continue to act as a source for bioaccumulation in fish. Because potentially significant source areas may remain under Alternative Three, and due to the uncertainty related to the bioaccumulation factors related to mercury in sediment, it is less certain that the bioaccumulation will be reduced.

Alternative Four is expected to remove about 92 percent of the mass of mercury, 93 percent of the mass of PCBs, and 91 percent of the mass of cesium-137 contained in the surface sediment of the Peconic River between the STP and Schultz Road, with a reduction in concentrations of 87 percent for mercury, 70 percent for PCBs, and 88 percent for cesium-137. Based on available data, the maximum value measured among the areas not requiring remediation is less than 3.3 mg/kg in the Laboratory property and 2.9 mg/kg in the Peconic River off of the Laboratory property. Because significant source areas will be removed, it is expected that Alternative Four will result in reducing bioaccumulation to levels that are protective of human health.

Alternative One does not reduce the average concentrations of contaminants in the sediment. Mercury, PCB and cesium-137 average concentrations on-site would remain at 5.7 mg/kg, 110 micrograms per kilogram (µg/kg), and 8.0 pCi/g and average concentrations off-site would remain at 1.8 mg/kg, less than 30 µg/kg, and 5.4 pCi/g (based on current sediment analytical data) respectively. Average concentrations would be significantly reduced under Alternatives Two, Three, and Four. The average levels of contaminants that would be expected to remain in the surface sediments (top six inches), of both the remediated and non-remediated areas, for each of these alternatives are compared in Table 4.1.

Table 4.1 Average Levels Of Contaminants Expected To Remain In The Surface Sediments (Top Six Inches)*

	Alternative One	Alternative Two	Alternative Three	Alternative Four
Mercury (mg/kg)	3.6	0.3	1.3	0.5
PCB (mg/kg)	0.09	ND-0.03	ND-0.03	ND-0.03
Cs-137 (pCi/g)	7.0	0.4	2.0	0.8

Note: Average PCB concentrations are difficult to estimate due to the presence of numerous samples with non-detectable (ND) levels.
*For comparability between all cleanup alternatives, Alternative Four numbers only represent the area being cleaned up between The Sewage treatment Plant and Schultz Road.

The average concentrations presented in Table 4.1 are area weighted average concentrations of the surface sediments (zero to six inches) and conservatively assume that average concentrations in remediated areas are 0.33 mg/kg mercury (the average concentration of mercury from the Area D pilot study), 0.24 pCi/g cesium-137 (the average background concentration measured in the Connetquot River), and 0.025 mg/kg (essentially the average detection limits since remediated areas should result in non-detectable levels of PCBs). In order to determine area-weighted averages, the river was divided into segments based on hydrology, sample clusters, or river lengths between sample points. When more than one sample was present within a segment, the average of those samples was used to represent that segment. When only one sample was present in a segment, that concentration was used to represent that segment. The area-weighted average was the ratio of the sum of the products of the segment area times the segment concentration divided by the total area.

Based on site-specific toxicity tests, concentrations of metals (i.e., copper, mercury, and silver) are present in the Peconic River sediment at concentrations that are toxic to aquatic life living in the sediment. Alternative One does not reduce the levels of these contaminants, so toxic effects would still be expected. Alternative Two will reduce concentration of these metals to levels well below those at which toxic effects are expected to be frequently observed, and unnecessarily disturb approximately five to six acres of additional wetlands. Alternative Three will reduce the concentration of these metals to levels just below those at which toxic effects are expected to be frequently observed. Alternative Four will also reduce the concentration of these metals to levels between those of Alternative Two and Alternative Three, at which toxic effects would not be likely.

4.2 Compliance with ARARs

Federal or State standards for the cleanup of contaminated sediment have not been promulgated. There are no applicable or relevant and appropriate requirements for the

cleanup of the Peconic River sediment. Compliance with chemical-specific ARARs does not apply to any of the alternatives. Even though there are no specifically applicable federal or state standards directly related to the cleanup goals of the Peconic River sediment, the CERCLA process does consider other pertinent advisories, criteria or guidance. These are known as To Be Considered (TBC). See Appendix C for a more detailed Discussion of ARARs and TBCs." The results of site-specific toxicity tests have led to the determination that toxic effects to aquatic life living in sediment may be expected to be frequently observed at concentrations above 9.8 mg/kg mercury, 310 mg/kg copper, or 88.9 mg/kg silver. Alternatives Two, Three, and Four would reduce sediment concentrations below these levels. A consensus-based sediment quality guideline developed as a generic screening benchmark for mercury in sediment based on non-site specific tests is reported at 1.06 mg/kg. Only Alternative Two would reduce all sediment concentrations below this level. Alternative Four would reduce average sediment concentrations to below this level. Alternative One would not reduce contaminant concentrations.

Federal and State wetlands regulations require that wetland impacts be minimized unless no other viable alternative exists. Alternatives Two, Three, and Four will each result in the temporary disturbance of wetlands. Alternative Three will result in the least disturbance and Alternative Two will result in the most disturbances. Common to Alternatives Two, Three, and Four wetland damage and upland temporary haul-path construction affects will be minimized. Detailed planning and surveys will minimize the number and length of temporary access paths to the wetlands through the upland areas. Prior to initiating construction potential routes will be surveyed to select the shortest routes and routes which minimize the impacts to forest vegetation. The route would next be marked and then inspected and approved by NYSDEC as part of the equivalency permit process. As part of the construction process, the full length of the haul road will be bermed to prevent the spread of sediment in the eventuality of a potential spill. Within the wetlands, serial handling of sediment by multiple excavators to move the sediment from the actual excavation location to the truck loading station will further reduce the length and number of temporary access paths needed.

Within the wetlands, long arm (e.g., 60 foot reach) excavators will allow sediment removal from approximately a 7500 square foot area, thus reducing impacts of placement of construction equipment within the wetlands. Furthermore, the results of the wetland restoration pilot studies have demonstrated that areas previously dominated by an invasive species can be restored with native species of wetland plants. However, the results of the wetland restoration pilot studies have demonstrated that wetlands can be restored, and have even demonstrated significant growth of native wetland plants within restored areas previously dominated by an invasive grass species. Alternative One, the No Action Alternative, will have no temporary impacts to wetlands.

There are also a number of action-specific requirements that must be met before implementation of Alternatives Two, Three, and Four. These include requirements for Dredge and Fill Operations (33 CFR 320.2), the National Pollution Discharge Elimination System (40 CFR 122), Discharge of Storm Water Runoff (40 CFR 122.26),

and others. Compliance with action-specific ARARs is achievable for all Alternatives. There are no action-specific ARARs associated with Alternative One.

4.3 Long-term Effectiveness and Permanence

The contaminants will remain in place and rely on the occurrence of natural sedimentation to minimize the bioaccumulation in fish and the exposure of aquatic life to contaminated sediment under the no action alternative. Sedimentation in the Peconic River on and off of the Laboratory property (upstream of Schultz Road and in the three sections of the river near Manor Road that are proposed for cleanup) is expected to be inadequate to sufficiently seal off the contaminants from aquatic species and to provide a permanent remedy.

Alternative Two involves the removal of most of the contaminated sediment that poses a source for bioaccumulation in fish that may be consumed by people and that pose a potential risk to the aquatic community. This alternative assumes that the STP does not act as a continuing source and that natural re-deposition of clean sediment would occur after removal actions are completed, resulting in a permanent remedy.

Alternative Three involves the removal of contaminated sediment that is expected to be toxic to aquatic life living in the sediment and is expected to reduce the potential for bioaccumulation in fish. However, contaminated sediment within the wetland area east of the eastern firebreak and the wetland and open water areas at North Street would remain in place and could continue to provide a mercury source for potential fish bioaccumulation.

Alternative Four also involves the removal of contaminated sediment that is expected to be toxic to aquatic life living in the sediment. This alternative also removes additional sediments that may lead to bioaccumulation in fish to which people may be exposed. Monitoring of the river sediment for potential contaminant re-deposition and migration are necessary to determine the effectiveness and permanence of

Alternatives Two, Three, and Four, which involve the removal of sediment from significant bioaccumulation source areas, will also assure that edible fish tissue contaminant concentrations are reduced to levels that are protective of human health. Each alternative will also remove sediment that is potentially toxic to aquatic life. Monitoring of both edible fish tissue and whole body fish tissue concentrations will be conducted to evaluate the performance of each alternative in reducing fish concentrations to levels that eliminate the potential health hazard to humans or wildlife consuming fish. Since residual contamination will remain in the Peconic River with any remedy selected, monitoring will be used to assess the long-term effectiveness in meeting remedial action objectives. The results of the monitoring will be assessed as part of the five-year review, and the need for additional actions would be evaluated in the event of unacceptable residual risk.

4.4 Reduction of Toxicity, Mobility, or Volume

Alternatives Two, Three, and Four provide treatment is limited to the removal of sediment followed by the removal of excess water, and not destruction of contaminants. These do not meet the EPA's statutory preference for treatment as a principal element. Alternative One does not provide any treatment.

Alternatives Two, Three and Four, will reduce the volume, toxicity, and mobility of the contaminants that may contribute to site risks through removal. Figure 1 provides a comparison of the areas remediated by each of the alternatives. Table 4.2 provides the estimated percent removal of the mass of contaminants in the surface sediments for mercury, aroclor-1254, and cesium-137 for each of the alternatives. These estimates do include the removals during the pilot studies conducted in the spring of 2002. The area to be cleaned up and the cost are only based on the additional remediation required and also includes portions of the Area A pilot study that will require additional remediation. Note in Table 4.2, that for Alternative 2, which essentially removes all sediment out to Schultz Road, that the percent removal of contaminants is estimated at greater than 95 percent to recognize the potential for uncertainty in characterization.

Table 4.2 Cost of Remediation by Cleanup Alternative*

Alternative	Area to be cleaned up (acres)	Cost	Mercury percent removal	PCB Percent removal	Cesium-137 percent removal
1	0	0	0	0	0
2	20.4	$12,150,000	>96	>96	>97
3	7.6	$5,821,000	66	76	77
4	19.8	$11,461,000	92	93	91

Note: Estimates for PCBs and Cs-137 are based on previous data only and previous estimated river dimensions. River total area has been found to be greater. River remediation area is also greater. Average concentration in newly defined areas was assumed to have the same concentrations as unremediated areas originally defined.

*For comparability between all cleanup alternatives, Alternative Four Percent Removal numbers only represent the area being cleaned up between The Sewage treatment Plant and Schultz Road.

Alternatives Two, Three and Four will reduce the volume, mobility, and toxicity of the material that is available for bioaccumulation to fish or to direct exposure of aquatic life. Alternative Two will reduce these to the greatest degree and Alternative Three will reduce these the least. Alternative Four will achieve significant reduction exposure to the contaminants of concern, and associated risk. Alternative One will not reduce the volume, mobility or toxicity of contaminated sediment and natural sedimentation is not expected to achieve reductions in a reasonable time frame.

4.5 Short-term Effectiveness

Alternative One does not involve any remedial activities. There would be no short-term disturbance to the environment, nor short-term effects to worker safety or the surrounding community. Alternatives Two, Three, and Four are similar with respect to short-term effects to worker safety or the surrounding community. The equipment and methods used to remove, dewater/treat, and dispose of the contaminated sediment under Alternatives Two, Three, and Four pose only minimal risks or hazards to the health and safety of workers and are not anticipated to impact the surrounding community.

The execution of Alternatives Two, Three, and Four will result in the short-term disturbance of wetlands and the associated aquatic community along the stream. Alternative Two would result in the greatest short-term disturbance, whereas Alternative Three would result in the least short-term disturbance. Some contaminant redistribution could occur as a result of sediment re-suspension during removal activities for Alternatives Two, Three, and Four. However, redistribution of large amounts of contaminants is considered unlikely, as monitoring and mitigative measures such as silt curtains would be used, as necessary, to reduce such impacts.

4.6 Implementability

Alternative One requires the least amount of effort to implement from a technical and administrative standpoint. The remedial activities to be conducted under Alternatives Two, Three, and Four would not be difficult to implement from an administrative standpoint because permits are not required. However, the remedial activities must meet those substantive technical requirements. The substantive technical requirements will be addressed during the remedial design. The technical methods associated with Alternatives Two, Three, and Four are conventional and well proven. The reliability associated with these methods is expected to be high. The removal of sediment will cause a short-term disruption of wetlands. The wetland restoration pilot studies have demonstrated that restoration of the disturbed wetlands can be achieved. The pilot studies conducted in the spring of 2002 have successfully demonstrated the removal of contaminated sediment with minimal environmental impact and the successful re-establishment of the river channel and revegetation of the wetlands.

4.7 Cost

A comparison of the total costs associated with each of the evaluated alternatives is presented in Table 4.3. Since Alternative One, No Action, does not involve any remedial activities or disturbance of wetlands, this alternative is the lowest cost option. Alternative Three is the lowest in cost, and Alternative Two is the highest in cost among actual cleanup alternatives. Table 4.2 compares the cost of each alternative relative to the percent of each contaminant removed.

The percent of mercury removed increases from approximately 66 percent to 92 percent for a cost difference of about $5.6 million by implementing Alternative 4 versus

Alternative 3. However, the difference between Alternative 4 and 2 is not estimated to remove any significant additional percent of the contaminants. The cost estimates for Alternatives Two, Three, and Four were based on data from the pilot studies as well as data from similar projects. However, there are a number of uncertainties associated with the total estimated costs. The most important source of uncertainty (Section 4.8) was related to the waste characterization and subsequent disposal options and costs.

Table 4.3 Comparison of Alternatives*

	Baseline Net Cost	Total Area of Remediated Streambed	Stream bed to be remediated (linear feet)	Percent Mercury Removal	Volume of sediment removed (cubic yards)
Alternative 1 No Action	$197,600	0		0	0
Alternative 2 Remove sediment containing mercury concentrations greater than 1.06 parts per million (ppm) from the Sewage Treatment Plant to Schultz Road	$12,150,000	20.4 acres	18,500	96	24,700
Alternative 3 Remove sediment containing mercury concentrations greater than 9.8 ppm from the Sewage Treatment Plant to Schultz Road	$5,821,000	7.6 acres	7,070	66	9,250
Alternative 4 Remove the sediment layer down to sand from depositional areas and from areas identified as preferential methylmercury sources. Achieve average mercury concentrations of less than 1.0 ppm on BNL property and less than 0.75 ppm off BNL property to Schultz Road. This alternative also includes an additional 2.4 acres in the Manor Road area with a mercury concentration goal of less than 2 ppm following the cleanup.	$11,461,000	19.8 acres	14,720	92	24,018

Note: To compare alternatives, the percent mercury removal is from the Sewage Treatment Plant to Schultz Road

4.8 Sensitivity Analysis

Sensitivity analyses were performed to evaluate the sensitivity of the remediation costs to two factors as described below. The sensitivity analyses were only performed for the area between the STP and Schultz Road for consistent comparison between alternatives. The results of these sensitivity analyses are summarized in the tables below. The detailed cost estimate is provided in Appendix A.

4.8.1 Sensitivity Factor 1

Table 4.4 provides a summary of the range of project costs related to Sensitivity Factor 1. This factor assumes some or all of the Peconic River sediments are not accepted as non-hazardous waste in a Subtitle D landfill. A total of 25, 50, 75, or 100 percent of the waste is assumed to be disposed of as a low-level radioactive waste in the sensitivity analysis. The disposal volume of sediment ranges from 9,250 cubic yards to 24,700 cubic yards for the four alternatives. The remediation costs range from $12,150,000 to $20,479,000 for Alternative 2, $5,821,000 to $8,704,000 for Alternative 3, and $10,323,000 to $14,893,000 for Alternative 4.

Table 4.4 Sensitivity Factors 1*

Alternative	Base Case Present Cost	25 percent Low-level red waste	50 percent Low-level red waste	75 percent Low-level red waste	100 percent Low-level red waste
Alternative 1 No Action	$197,600	0	0	0	0
Alternative 2 Lower limit sediment target level	$12,150,000	$14,115,000	$16,236,000	$17,932,000	$20,479,000
Alternative 3 Upper limit sediment target level	$5,821,000	$6,539,000	$7,261,000	$7,982,000	$8,704,000
Alternative 4 Significant methyl mercury source areas and average concentrations on Laboratory property of 1 mg/kg and off Laboratory property of 0.75 mg/kg	$10,323,000	$10,649,000	$12,553,000	$13,199,000	$14,893,000

*For comparability between all cleanup alternatives, Alternative Four numbers only represent the area being cleaned up between The Sewage treatment Plant and Schultz Road.

4.8.2 Sensitivity Factor 2

Table 4.5 provides a summary of the range of project costs related to Sensitivity Factor 2. Sensitivity Factor 2 occurs if, prior to removal actions, additional sampling identifies 25 percent more area or 25 percent less area requiring removal. The base case present costs for the four alternatives involving removal assume that an area of 333,000 to 890,000 square feet require removal. The sensitivity analysis assumes the base case condition that the wastes are characterized as non-hazardous wastes. The resulting costs range from $10,548,000 to $13,875,000 for Alternative 2, from $5,134,000 to $6,498,000 for Alternative 3, and from $8,073,000 to $11,156,000 for Alternative 4.

Table 4.5 Sensitivity Factor 2*

Alternative	Baseline Net Present Worth Cost	25 percent less area requires sediment removal	25 percent more area requires sediment removal
Alternative 1 No Action	$197,585		
Alternative 2 Lower limit sediment target level	$12,150,000	$10,548,000	$13,875,000
Alternative 3 Upper limit sediment target level	$5,821,000	$5,134,000	$6,498,000
Alternative 4 Significant methyl mercury source areas and average concentrations on Laboratory property of 1 mg/kg and off Laboratory property of 0.75 mg/kg	$10,323,000	$8,073,000	$11,630,977

*For comparability between all cleanup alternatives, Alternative Four numbers only represent the area being cleaned up between The Sewage treatment Plant and Schultz Road.

5.0 RECOMMENDED ALTERNATIVE

This FS Addendum addresses contamination in the upstream section of the Peconic River in OU V. The purpose of this FS Addendum is to identify, develop, screen, and evaluate

a range of remedial alternatives that will address the contamination in that area. The primary objective of this report is to provide BNL stakeholders with sufficient data to select a feasible and cost-effective remedial alternative that protects public health and the environment from the potential risks posed by BNL related contamination in the upstream sections of the Peconic River.

5.1 Proposed Alternative

Additional acreage has been added to Alternative 4 based on extensive discussions with the regulators. The expansion will include the cleanup of an additional area of 2.4 acres at an estimated additional cost of $1,138,000. The expanded Alternative 4 is proposed as the alternative that best addresses the CERCLA evaluation criteria, particularly Overall Protection of Human Health and the Environment. A summary of this Recommended Action is provided in Table 5-1. This proposal is based on the results of the comparative analysis presented in this *Feasibility Study Addendum* and extensive discussion with the the regulatory community. The expanded Alternative Four option also meets community expectations to minimize impacts to the wetlands and upland areas. The expanded Alternative Four substantially removes areas of elevated levels of contaminants that could lead to transport of contaminants and bioaccumulation in the future.

This alternative will provide significant mass removal of contaminants focused on protecting the ecosystem and reducing the bioaccumulation of mercury and PCBs in fish. This alternative will be protective of human health and will provide the best balance of contamination removal versus impact to upland and wetland areas.

The implementation of this remedy will take place in two phases: the first phase will address sediment on Laboratory property and the second phase will address sediment that extends beyond the Laboratory boundary and upstream of Schultz Road plus an additional three sections of the river near Manor Road. This phased approach will provide the best means for accelerating cleanup while ensuring that cleanup of the County parkland is as effective as possible.

An "Action Memorandum" was issued for public review in the fall of 2003 to facilitate this phased approach. An Action Memorandum is an authorization by DOE to start work under its Superfund response authorities. The Action Memorandum was used to authorize work called a removal action. The removal action is consistent with the proposed remedy (as modified by public comment), and allowed work to start on Laboratory property. This process is commonly used to accelerate and/or complete discrete portions of a larger response action.

This removal action will serve to: 1) reduce the potential for continued migration of contamination off of Laboratory property, 2) reduce the potential for bioaccumulation of contaminants in fish that may be captured in areas off Laboratory property or accessible areas on Laboratory property, and 3) provide lessons learned that will be used in design of the cleanup to take place off of Laboratory property in the County park land.

This removal action is to be undertaken in accordance with CERCLA and documented in the Peconic River ROD.

Approximately 92 percent of the mass of mercury in the surface sediment in the area from the STP to Schultz Road would be removed based on average concentrations measured in the surface sediment (top six inches). Additionally, it would be expected that 93 percent of the mass of PCBs (measured as aroclor-1254) would be removed from the sediment as well as 91 percent of the mass of cesium-137 as shown in Table 4.2. This is expected to reduce the concentrations of mercury by 87 percent, PCBs by 70 percent, and cesium-137 by 88 percent. Potential human health exposure would be further reduced to levels that are protective of human health.

The expanded Alternative Four will result in the removal of contaminated sediment deemed to be toxic to aquatic life, based on the site-specific toxicity tests, and result in average concentrations of mercury similar to screening levels; thus, it is therefore protective of the environment. Once Alternative Four is demonstrated to be effective in controlling contaminant migration, fate and transport, the temporary sediment trap installed near gauging station HQ will be removed. Sediments trapped behind the trap will be analyzed and removed, if applicable, prior to removal of the sediment trap. Although sediment removal activities would temporarily disturb wetland, pilot studies conducted on the Peconic River have substantiated that the sediment removal techniques described for this alternative are effective at minimizing disturbance to sensitive wetland environments. Wetland restoration techniques have also been demonstrated to be effective through a pilot study. Furthermore, the results of the wetland restoration pilot studies have demonstrated that areas previously dominated by an invasive species can be restored with native species of wetland plants.

In summary, the expanded Alternative Four alternative is recommended for the following reasons:

Overall Protection of Human Health and the Environment: The alternative meets the remedial action objectives for protection of human health and the environment. Contaminated sediment presenting the greatest source of potential mercury bioaccumulation in fish to which people could be exposed would be removed, and average resulting concentrations would be similar to screening levels for protection of benthic organisms. Additionally, a lower average concentration goal is used for the area off of the Laboratory property to allow the County greater flexibility in its use as a parkland or in future development. Monitoring of fish tissue concentrations will assure that potential health hazards are reduced to acceptable levels. Approximately 92 percent of the mass of mercury in the surface sediment in the area from the STP to Schultz Road would be removed. Additionally, approximately 93 percent of the mass of PCBs and 91 percent of the mass of cesium-137 would be removed. Concentrations would be reduced by an estimated 87 percent for mercury, 80 percent for PCBs, and 88 percent for cesium-137.

Compliance with ARARs: There are no promulgated Federal or State standards for the cleanup of contaminated sediment. However, Federal and State regulations require that

impacts to wetlands be minimized unless no other viable option exists. Consequently, the work will be conducted under a New York State Department of Environmental Conservation Equivalency permit to ensure that no ARARs are violated.

Pilot studies conducted on the Peconic River have substantiated that the sediment removal techniques described for this alternative are effective at minimizing disturbance to sensitive wetland environments. Wetland restoration techniques have also been demonstrated to be effective through a pilot study. Action-specific requirements such as requirements for Dredge and Fill Operations (33 CFR 320.2), the National Pollution Discharge Elimination System (40 CFR 122), Discharge of Storm Water Runoff (40 CFR 122.26), and others must be met before implementing of this alternative. Appendix C provides detailed information related to ARARs and TBCs.

Long-term Effectiveness and Permanence: The removal of the targeted sediment will be effective and permanent over the long-term long-term protection of human health and wildlife protection. Because contaminated sediment presenting the greatest source of potential mercury bioaccumulation in fish would be removed. Monitoring of fish tissue concentrations will assure that potential health hazards are at acceptable levels. This alternative would also result in the removal of contaminated sediment that poses a potential risk to the aquatic community. Alternative Four therefore provides a permanent remedy for the contaminants of interest that exist at concentrations deemed to be toxic to aquatic life. The long-term effectiveness will be monitored annually for mercury, methyl mercury, PCBs and Cesium-137 and reviewed per the CERCLA five-year review process to confirm the effectiveness of the cleanup. In addition, pilot studies have demonstrated the effectiveness of wetland restoration following cleanup and replanting.

Reduction of Toxicity, Mobility, or Volume: This alternative, as with the other alternatives evaluated, does not meet the EPA's statutory preference for treatment as a principle component. Although the sediment that is removed will be dewatered in a drying bed, no treatment to reduce the toxicity, mobility, or volume of the contaminants of interest will be conducted. Therefore, the removed sediment will have essentially the same characteristics after excavation as it had in the stream. Failure to reduce the toxicity and mobility of the contaminants of interest may not be a concern since the removed sediment is anticipated to be characteristically non-hazardous.

The removal of the sediment layer will result in a significant reduction of toxicity, mobility and volume of the contaminated sediment presenting the greatest source of potential mercury bioaccumulation in fish. The sediment that remains after remediation poses an acceptable risk to humans and to the aquatic community within regulatory guidelines and will no longer serve as a significant source for mercury bioaccumulation in fish.

Short-term Effectiveness: The execution of this alternative may pose minor short-term risks to worker health and safety. Potential risks to workers include those generally associated with construction activities.

The execution of this alternative will also result in the short-term disturbance of wetlands and the associated aquatic community along the stream. However, remediation will be focused on the low water, winter early spring, periods of the year when potential adverse effects are minimal, thereby minimizing short-term effects. Potential impacts that will be minimized include sediment dispersal via bypassing stream flow during a low water period and use of sediment traps and potential wetland faunal impacts that will be minimized by the absence of seasonal migrants. Wetland restoration techniques have also been demonstrated to be effective through a pilot study. Some contaminant redistribution could occur as a result of sediment re-suspension during removal activities. However, redistribution of large amounts of contaminants is considered unlikely, as monitoring and mitigative measures such as silt curtains would be used to reduce such impacts.

Implementability: This alternative involves temporary stream/wetlands dewatering as necessary, sediment excavation. Sediment management involves dewatering of removed sediment with drying beds, and off-site disposal. The implementability of this alternative has been demonstrated on a smaller scale in the Peconic River through the completion of the pilot studies.

Cost: The base case cost of Alternative 4 is approximately $10,323,000. The expanded area of 2.4 acres cleanup cost estimate is $1,138,000 for a total project cost of $11,461,000.

6.0 REFERENCES

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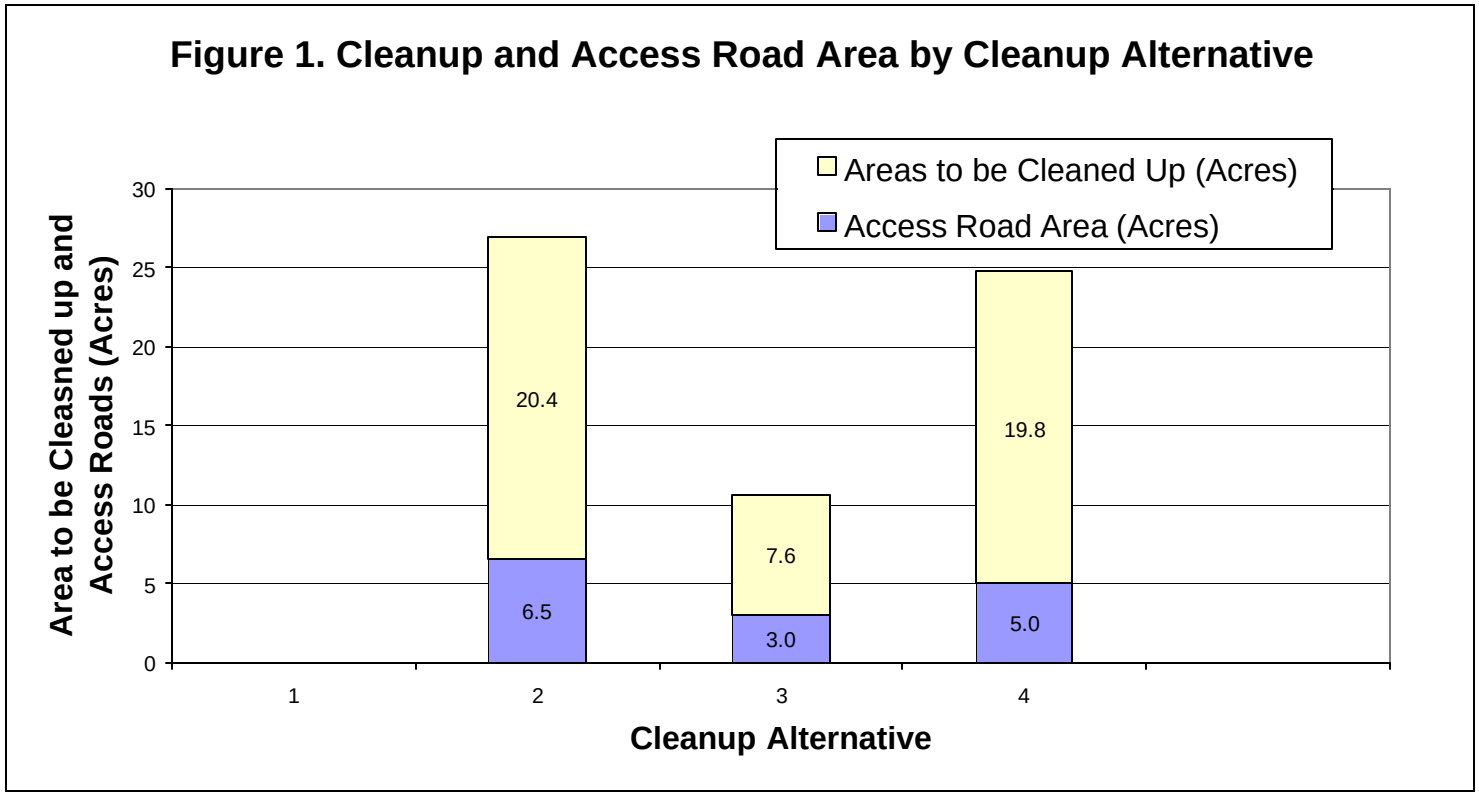
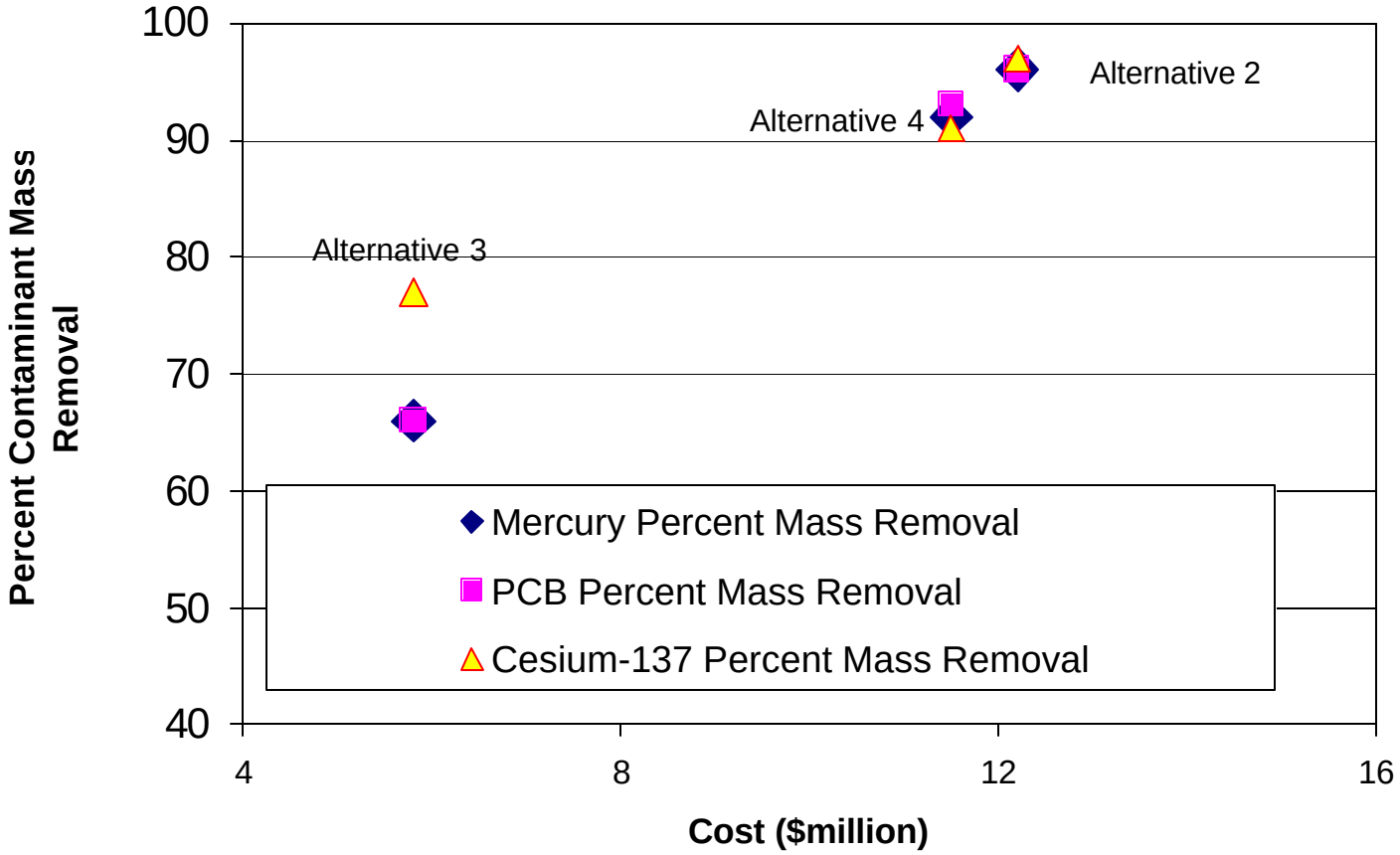


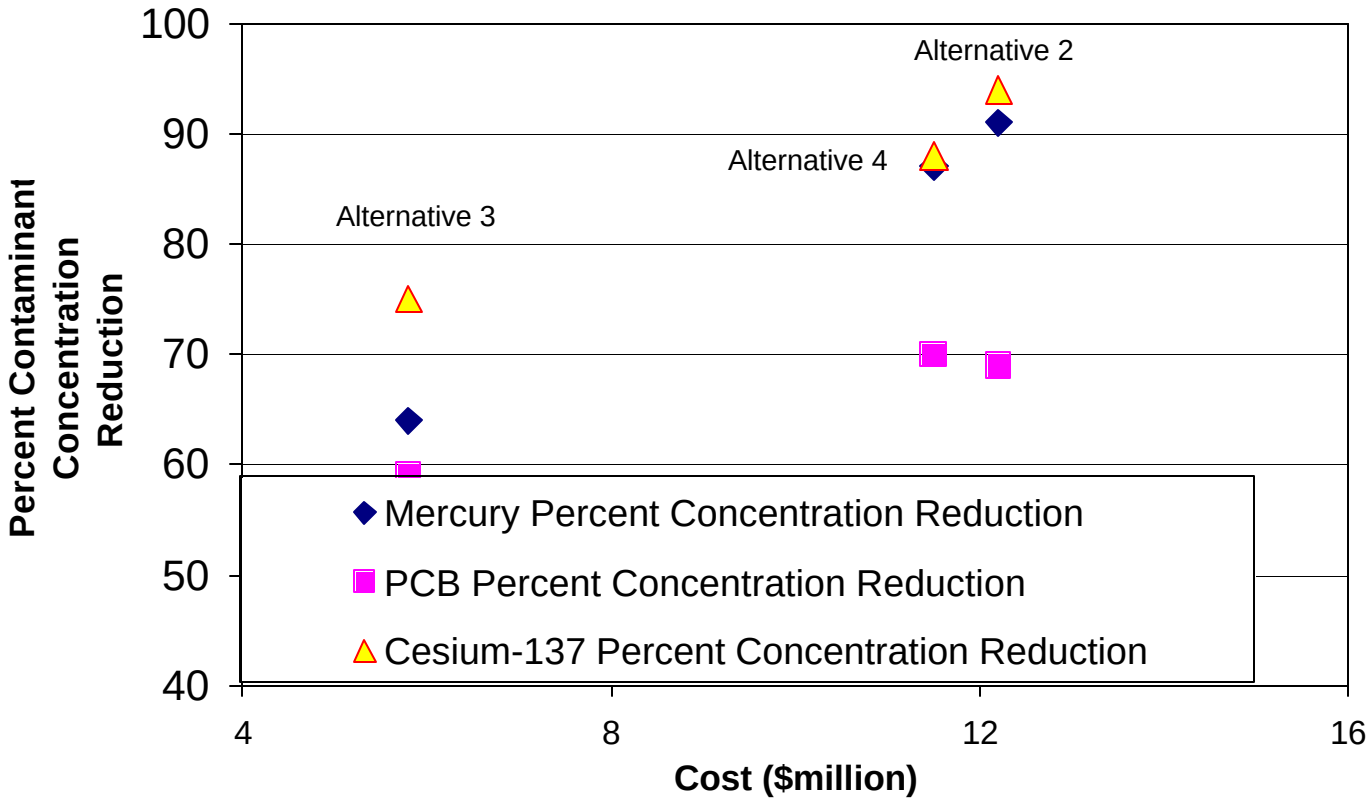
Note: For comparability between all cleanup alternatives, Alternative Four numbers only represent the area being cleaned up between the Sewage treatment Plant and Schultz Road.

Figure 2. Cleanup Cost by Alternative vs Percent Contaminant Mass Removal*



Note: For comparability between all cleanup alternatives, Alternative Four numbers only represent the area being cleaned up between The Sewage treatment Plant and Schultz Road.

Figure 3. Cleanup Cost by Alternative vs Percent Contaminant Concentration Reduction



Note: For comparability between all cleanup alternatives, Alternative Four numbers only represent the area being cleaned up between The Sewage treatment Plant and Schultz Road.

Figure 4 - Peconic River Sediment Removal Area Alternative 2

Figure 5 - Peconic River Sediment Removal Area Alternative 3

Figure 6A - Peconic River Sediment Removal Area Alternative 4

Figure 6B - Peconic River Sediment Removal Area Alternative 4