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Feasibility Study for Site 17 Pettibone Creek and Boat Basin

Naval Station Great Lakes
Great Lakes, Illinois

Contract Task Order 0341

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NAVFAC
Naval Facilities Engineering Command
Southern Division
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180

FEASIBILITY STUDY

SITE 17
PETTIBONE CREEK AND BOAT BASIN
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirement
AUF	Area Use Factor
AWQC	Ambient Water Quality Criteria
BAF	Bioaccumulation Factor
bgs	Below ground surface
BSAF	Biota-Sediment Accumulation Factor
BW	Body Weight
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	Centimeters
COC	Chemical of concern
COPC	Chemical of potential concern
CSF	Cancer Slope Factor
CWA	Clean Water Act
EEQ	Ecological Effects Quotient
ERA	Ecological Risk Assessment
FS	Feasibility Study
ft^2	Square foot/feet
GRA	General Response Action
HHRA	Human health risk assessment
HI	Hazard Index
IAS	Initial Assessment Study
Illinois EPA	Illinois Environmental Protection Agency
ILCR	Incremental Lifetime Cancer Risk
LOAEL	Lowest-Observed-Adverse-Effect-Level
LUC	Land Use Control
LUCMOA	Land Use Control Memorandum of Agreement
MCL	Maximum Contaminant Level
MNR	Monitored Natural Recovery
mg/kg	Milligram(s) per kilogram
µg/kg	Microgam(s) per kilogram
NAV FAC EFD SOUTH	Naval Facilities Engineer, Field Division South

NCP	National Oil and Hazardous Substance Pollution Contingency Plan (also called the National Contingency Plan)
NCRS	North Chicago Refiners and Smelters
NEPA	National Environmental Policy Act
NOAEL	No-Observed-Adverse-Effect-Level
NPW	Net present worth
O&M	Operation and maintenance
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PEC	Probable Effect Concentrations
PPE	Personal protection equipment
PRG	Preliminary Remediation Goal
RAO	Remedial Action Objective
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI/RA	Remedial Investigation/Risk Assessment
ROD	Record of Decision
SERA	Screening-Level ERA
SVOC	Semivolatile organic compound
TACO	Tiered Approach to Corrective Action Objectives
TBC	To Be Considered (criterion)
TEC	Threshold Effects Concentrations
TOC	Total organic carbon
TSDF	Treatment, storage, and disposal facility
TtNUS	Tetra Tech NUS, Inc.
UCL	Upper Confidence Limit
U.S.	United States
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compound
yd^3	Cubic yard(s)

EXECUTIVE SUMMARY

E.1 PURPOSE OF THE REPORT

The purpose of this Feasibility Study (FS) Report is to develop and evaluate remedial alternatives to address those known or suspected risks posed to human health and/or the environment by the presence of contaminated sediment at Site 17, Pettibone Creek and Boat Basin, at the United States Naval Station Great Lakes, located in Lake County, Illinois. The majority of Naval Station Great Lakes activities occur on a plateau atop a steep bluff that rises 70 feet above the beach along Lake Michigan. This FS has been performed and developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, and its governing regulations, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300, and the National Environmental Policy Act (NEPA) (40 CFR 1500-1508).

E.2 SITE DESCRIPTION AND HISTORY

Site 17 comprises two geographic areas. The first is Pettibone Creek, including the North and South Branches. Pettibone Creek and its tributaries flow in a ravine that divides the plateau and discharges to the Boat Basin. This portion of Site 17 covers approximately 0.3 square miles. A path along the North Branch is used by staff, military personnel and their family members, and students who hike, jog, and walk their dogs. The South Branch flows at the base of steep slopes behind buildings and consequently is not frequented by people. The second is the Boat Basin which is approximately 113,256 ft^2 in area. Past use of the Boat Basin prior to the sedimentation included the docking of boats at slips and access to the boat repair building (Building 13). Due to sedimentation, the Boat Basin can no longer be used for these activities. The Boat Basin was dredged in the early 1950s and again in the early 1970s. Currently, recreational fishing occurs in the Boat Basin by base personnel and the public.

E.3 SUMMARY OF THE INVESTIGATIONS FINDINGS

Early investigations of Pettibone Creek and Boat Basin in the 1970s resulted from studies of the abandoned industrial facilities upstream of in the City of North Chicago located upstream of Naval Station Great Lakes. Several of the facilities [Fansteel, North Chicago Refiners and Smelters, and the Vacant Lot] were turn-of-the-century manufacturing facilities that produced tantalum mill products, non-ferrous metals, and zinc oxide. USEPA Region 5 investigated these facilities for volatile organic compounds

(VOCs), semivolatile organic compounds (SVOCs), pesticide, polychlorinated biphenyl (PCB), and metals contamination.

The most recent field investigation for Site 17 was performed in September 2001. The activities consisted of surface water sampling and sediment sampling. Polynuclear aromatic hydrocarbons, pesticides, PCBs, and metal were detected in the sediment samples. A human health risk assessment performed as part of recent investigation indicated unacceptable risks would exist from the ingestion of fish assuming they were contaminated from the ingestion of contaminated sediment in the Boat Basin. A number of uncertainties were associated with those stated risks, including the fact that the fish tissue concentrations were not actual concentrations, but rather were merely estimates (modeled) from sediment concentrations and sediment bioaccumulation factors. However, the results of the risk assessment were generally consistent with fish advisories currently in effect for Lake Michigan.

An ecological risk screening was also performed as part of this recent investigation at Site 17. PAHs, several pesticides, and several metals in sediment samples were retained as chemicals of concern (COCs) for risks to aquatic receptors in the North Branch of Pettibone Creek because they were detected in several samples at concentrations that exceeded the alternate benchmarks. The alternate benchmarks are the literature-based, upper effects levels that were used in the Step 3a refinement of the COPC list. The alternate benchmarks are less conservative than the screening benchmarks that were used in the initial COPC selection and were used to determine the ecological risk-drivers at Site 17. PAHs, several pesticides and PCBs, and several metals in sediment samples were retained as COCs for risks to aquatic receptors in the Boat Basin because they were detected in several samples at concentrations that exceeded the alternate benchmarks. These conclusions are based on literature values, therefore there is uncertainty in the conclusions. In addition, because of the large amount of soil erosion in the creek, there are physical stressors as well as chemical stressors that may be adding to the risks to aquatic organisms. These uncertainties could be reduced by conducting site-specific toxicity tests and/or biological surveys that could be used to determine site-specific, risk-based screening levels.

Pesticides were selected as COCs in the North Branch of Pettibone Creek and the Boat Basin because they may cause a risk to piscivorous birds that consume fish from the area. The risks are based on predicted fish tissue concentrations estimated from the sediment concentrations that incorporate the assumed percent lipids of the fish and site-specific total organic carbon of the sediment. However, the literature values used to make these predictions may not represent actual site conditions. The elevated pesticide detections are located in several samples along the creek and Boat Basin, and the samples were biased toward depositional areas that are expected to have greater chemical concentrations than the rest of the creek. Based on the evaluation in Section 8 of the Site 17 RI/RA (Fish Tissue Uncertainty

Analysis Evaluation with Historical Data), it appears that risks to piscivorous birds and mammals are overestimated. There is considerable uncertainty in concluding that there are potential risks to piscivorous birds from the sediment chemical concentrations.

E.4 REMEDIAL ACTION OBJECTIVES, PRELIMINARY REMEDIAL ACTION GOALS, AND VOLUME OF CONTAMINATED SEDIMENT

The Remedial Action Objectives (RAOs) identified for the Site 17 sediment are as follows:

RAO 1: Protect human health from exposure to contaminants in sediment via fish ingestion at concentrations exceeding Preliminary Remediation Goals (PRGs).

RAO2: Protect benthic invertebrates and fish from direct exposure to contaminants in sediment at concentrations exceeding PRGs.

RAO 3: Protect piscivorous birds from consuming sediment invertebrates and fish potentially present in Pettibone Creek and the Boat Basin that may be exposed to contaminants in sediment at concentrations exceeding PRGs.

The PRGs for RAO 1 (human health risk) were developed for sediment based on the assumption that chemicals in sediment can bioaccumulate into fish. This potential indirect exposure to COCs formed the basis for deriving modeled fish tissue concentrations using sediment bioaccumulation factors and used exposure factors similar to the Lake Michigan Fish Advisories to calculate the PRGs that are expected to be protective of this exposure pathway.

The ecological PRGs for the aquatic receptors were developed using the Tiered Approach for Evaluation and Remediation of Petroleum Product Releases to Sediments (Tier II). The consensus-based probable effect concentrations were used to supplement the Tier II values as the PRGs for the protection of aquatic receptors at Site 17 when a Tier II value for a chemical was not available. The PRGs for the protection of piscivorous birds were developed using the food-chain models. The food-chain models were rearranged so that a sediment risk level could be calculated based on an Ecological Effects Quotient of 1.0

There are several uncertainties with the human health and ecological PRGs used to establish practicable limits for possible future remedial activities and associated volumes of contaminated sediment to be addressed. These uncertainties in this feasibility study relate to the contamination from pesticides and

PAHs, the potential for recontamination, the Lake Michigan Fish Advisories, and development of site-specific PRGs.

The total volume of sediment contaminated in excess of PRGs is estimated at approximately 39,400 cubic yards (yd^3), which can be broken down as follows:

Area	Estimated Depth (feet)	Estimated Volume (yd^3)
Pettibone Creek North Branch	2	5,800
Upper Boat Basin	10	27,600
Lower Boat Basin	8	6,000
TOTAL	-	**39,400**

E.5 SCREENING OF GENERAL RESPONSE ACTIONS, REMEDIATION TECHNOLOGIES, AND PROCESS OPTIONS

General Response Actions (GRAs) and associated technologies and processes were screened for effectiveness, implementability, and cost. Technologies that were determined to be ineffective or too difficult to implement were eliminated from further consideration. The following GRAs, remediation technologies, and process options were retained to develop sediment remedial alternatives for Site 17:

GRA	Remediation Technology	Process Options
No Action	None	Not Applicable
Limited Action	Institutional Controls	Access/Use Restrictions; Fish Consumption Warnings and catch and release requirements
	Monitoring	Sampling and Analysis
Containment	Capping	In-Situ Capping
	Surface Water Controls	Vertical Barriers, Surface Water Diversion
Removal	Mechanical Removal	Mechanical Excavation (use equipment such as a Grad-All, backhoes, etc.
Ex-Situ Treatment	Physical/Chemical	Dewatering
		Stabilization/Fixation
	Thermal	Thermal Desorption
		Incineration
Discharge/Disposal	Landfilling	Off-Base Landfilling

Remedial alternatives were not developed to directly address fish tissue; however, remedial actions taken to address sediment contamination are expected to indirectly address contamination impacts resulting from fish ingestion.

E.6 DEVELOPMENT OF REMEDIAL ALTERNATIVES

The following remedial alternatives were developed for Site 17:

- **Alternative 1: No Action.** No action would be taken. Retained as a baseline for comparison with other alternatives.

- **Alternative 2: Institutional Controls and Monitored Natural Recovery.** Institutional controls to be implemented would consist of the following: (1) establishing a no recreational swimming restriction from Naval Station property in the Boat Basin area; (2) on-site posted signs and periodic publishing of fish consumption warnings; (3) imposition of specific fish catch and release requirements on Naval Station property in the Boat Basin area and; (4) sediment disturbance and disposal controls would be imposed for the Boat Basin area. Monitored Natural Recovery would consist of regularly collecting and analyzing surface water and sediment samples to assess expected natural recovery over time and detect additional contaminant migration from any upstream source(s).

- **Alternative 3: Partial Excavation and Disposal of North Branch of Pettibone Creek Sediment, Excavation of Lower Boat Basin Sediment, In-Situ Capping of the Upper Boat Basin, Surface Water Controls, Institutional Controls, and Monitored Natural Recovery.** Approximately 5,800 yd^3 of contaminated sediment from the North Branch of Pettibone Creek would be excavated and disposed at a permitted off-site disposal facility. Approximately 6,000 yd^3 of contaminated sediment from the Lower Boat Basin would be excavated and consolidated into the Upper Boat Basin. Sand bag dikes, mobile centrifugal pumps and fire or irrigation hoses, and silt screens could be used as necessary to minimize contaminated sediment migration. A concrete dam would then be constructed at the end of the Upper Boat Basin and beginning of the Lower Boat Basin (at the back end of Building 13) in order to contain the contaminated sediment in the Upper Boat Basin. A 75,000 ft^2 cover system consisting of a permeable geotextile layer, a 2-foot-thick main layer of clean fine sand or sediment, and an 18-inch-thick armor layer of rip-rap stones would be constructed over the contaminated sediment. The Institutional controls and Monitored Natural Recovery components of Alternative 3 would be similar to that for Alternative 2.

- **Alternative 4: Partial Excavation of North Branch of Pettibone Creek Sediment, Excavation of Upper and Lower Boat Basin Sediment, Surface Water Controls, On-Site Dewatering, and Off-Base Disposal of Excavated Sediment.** Under this alternative, the excavation of contaminated sediment would be expanded to include excavation and off-site disposal of the sediment from the Upper and Lower Boat Basin and parts of North Branch of Pettibone Creek. The sediment from North Branch of Pettibone Creek and the Boat Basin would be dewatered on-site by temporary stockpiling in a dedicated area near the Boat Basin then transported off-site for disposal at a permitted disposal facility. The surface water control components of Alternative 4 would be similar to those for Alternative 3. For this alternative, it is assumed that approximately 10 percent of that volume of sediment would require chemical stabilization/fixation prior to disposal.

E.7 DETAILED AND COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

The remedial alternatives were analyzed in detail using seven of the nine criteria provided in the USEPA's NCP and the CERCLA. These seven criteria are as follows:

- Overall Protection of Human Health and the Environment,
- Compliance with ARARs and TBCs guidance criteria,
- Long-Term Effectiveness and Permanence,
- Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment,
- Short-Term Effectiveness,
- Implementability, and
- Cost

Two other criteria, State and Community Acceptance were not evaluated in this report. They will be evaluated after regulatory and public comments are available.

E.8 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

The evaluated remedial alternatives were compared to each other using the same criteria that were used for the detailed analysis. The following is a summary of those comparisons:

- **Overall Protection of Human Health and Environment**

Alternative 1 would not provide for protection of human health and the environment because COCs would remain in shallow sediment in excess of PRGs which could pose unacceptable risk to potential human and ecological receptors. Neither possible direct human exposures to contaminated sediment through swimming or wading nor indirect exposures through fish consumption would be restricted. Also, no warnings (other than the Lake Michigan Fish Advisories) would be posted in order to minimize possible human exposures to fish potentially contaminated with COCs above safe consumption levels.

Although Alternative 2 would allow COCs to remain in sediment at concentrations greater than PRGs and possibly migrate off site, it would be protective of human health by reducing risk from exposure to COCs through restrictions on site usage, specific fish consumption warnings and catch and release requirements, periodic monitoring of the expected natural recovery process, and warning of potential COC migration. However, the limited ecological risks at the site would remain with benthic invertebrate exposure to contaminants in the sediment and potential fish and piscivorous bird exposures to contaminants by consumption of contaminated sediment invertebrates until such time as natural recovery reduces concentrations of COCs to less than the PRGs.

Alternative 3 would be more protective than Alternative 2 by further reducing known or potential human health and future ecological risks from direct and/or indirect exposures through consolidation and in-situ capping of contaminated sediment in the Upper Boat Basin. However, implementation of Alternative 3 would result in a temporary impact to benthic invertebrates. It is expected that after some time, benthic invertebrates would again repopulate Pettibone Creek and Boat Basin with less chance of adverse consequences from chemical concentrations.

Alternative 4 would provide the highest level of protection by further minimizing known or potential human health and future ecological risks from direct and/or indirect exposures from COCs through removal and off-base disposal of contaminated sediment above PRGs from the Boat Basin and portions of the North Branch of Pettibone Creek. However, implementation of Alternative 4 would result in a temporary impact to benthic invertebrates. It is expected that after some time, benthic invertebrates would again repopulate Pettibone Creek and Boat Basin with less chance of adverse consequences from chemical concentrations.

- **Compliance with Applicable or Relevant and Appropriate Requirements and To Be Considered (TBC)**

Alternative 1 would not comply with chemical- and location-specific Applicable or Relevant and Appropriate Requirement (ARARs). Action-specific ARARs or TBCs would not apply.

In the short-term, Alternatives 2 and 3 would not comply with chemical-specific ARARs and TBCs, but these alternatives might eventually achieve compliance as they attain the PRGs through natural recovery. Alternatives 2 and 3 would comply with location- and action-specific ARARs and TBCs.

Alternative 4 would comply with chemical-, location-, and action-specific ARARs and TBCs.

- **Long-Term Effectiveness and Permanence**

Alternative 1 would have very limited long-term effectiveness and permanence because no COCs would be removed through treatment although, over time, some reduction in COC concentrations might occur through natural recovery. Because site access and development would be unrestricted and fish consumption would not be regulated, the potential would also exist for unacceptable human health and ecological risk to develop due to exposure to COCs. Since there would be no monitoring, potential off-site migration of COCs would remain undetected.

Alternative 2 would provide some long-term effectiveness and permanence because it would minimize human health risk from exposure to COCs through restrictions to be placed upon swimming in the Boat Basin, the imposition of fish catch and release requirements within the Boat Basin area and posting of on-site signs and periodic publishing of fish consumption warnings. Alternative 2 would also effectively assess the progress of natural recovery and the timeframe for potential termination of institutional controls and would warn of potential off-site migration of COCs and/or contamination from upstream sources. Ecological risks at the site would be addressed to the extent that natural recovery would result in reduced potential exposures by invertebrates, fish and birds over time with additional sedimentation and the biodegradation of contaminants.

Alternative 3 could possibly provide more long-term effectiveness and permanence than Alternative 2 because, in addition to the same remedial measures, a significant portion of the contaminated sediment would be permanently removed from its current location and consolidated with the remaining contaminated sediment under an in-situ cap that would provide a permanent barrier between contaminated sediment and surface water and human and ecological receptors. However, as with the other alternatives, the true long term effectiveness of this or any remedial measure undertaken at Site 17 will be dependent upon the elimination or at least significant reduction in future contaminant migration from both known and presently unknown upstream source(s). The Navy will not commit resources to this alternative until elimination of contaminant sources upstream of Pettibone Creek at the northern Site 17 boundary can be demonstrated and verified.

Alternative 4 could provide the most long-term effective and permanent remedy because it would permanently remove contaminated sediment from the site in an environmentally safe manner. However, as with the other alternatives, the true long term effectiveness of this or any remedial measure undertaken at Site 17 will be dependent upon the elimination or at least significant reduction in future contaminant migration from both known and presently unknown upstream source(s). The Navy will not commit resources to this alternative until elimination of contaminant sources upstream of Pettibone Creek at the northern Site 17 boundary can be demonstrated and verified.

- **Reduction of Toxicity, Mobility, or Volume through Treatment**

Alternatives 1, 2, and 3 would not reduce the toxicity, mobility, or volume of COCs through treatment. It is anticipated that these three alternatives would eventually reduce toxicity, mobility, and volume through natural recovery; however, this reduction would only be verified under Alternatives 2 and 3. There would be no treatment residuals associated with Alternatives 1, 2, and 3.

Alternative 4 would reduce the mobility and volume of COCs through removal and off-base disposal of approximately 33,100 yd^3 of sediment with concentrations of COCs greater than PRGs. Within that volume, the mobility of the inorganic COCs contained in approximately 3,300 yd^3 of high-lead-content sediment would be permanently and irreversibly reduced through chemical stabilization/fixation. Alternative 4 would generate a wastewater residual from the on-site sediment dewatering operations, but it is anticipated that this wastewater could be discharged back to Pettibone Creek or the Boat Basin without treatment.

- **Short-Term Effectiveness**

Implementation of Alternative 1 would not result in risks to site workers or adversely impact the surrounding community or environment because no remedial activities would be performed. Alternative 1 would not achieve the RAOs in the short term and although the PRGs might eventually be attained through natural recovery, this would not be verified through sediment monitoring.

Implementation of Alternative 2 would result in a very slight possibility of exposing site workers to contamination during monitoring activities. However, this risk of exposure would be effectively controlled through compliance with applicable Occupational Safety and Health Act regulations and proper site-specific health and safety procedures. Implementation of Alternative 2 would not adversely impact the surrounding community or environment. Alternative 2 would be expected to achieve the human health RAOs immediately upon implementation of the above described institutional controls. It is expected that

PRGs would be attained through natural recovery, and this could be verified through monitoring. At this time, the timeframe for attainment of PRGs cannot be accurately estimated.

Implementation of Alternatives 3 and 4 would result in the possibility of exposing construction workers to contamination during remedial activities. However, the risk of exposure could be effectively controlled by the implementation of engineering controls (e.g., spill prevention) and compliance with applicable Occupational Safety and Health Act regulations and proper site-specific health and safety procedures. Implementation of Alternative 3 would not adversely impact the surrounding community, but implementation of Alternative 4 potentially could because contaminated sediment would be transported over public roads. However, the potential for adverse impact would be effectively addressed through implementation of such appropriate measures as decontamination of transport vehicles, traffic control, and spill prevention and emergency response.

Alternatives 3 and 4 would achieve short-term effectiveness upon the respective completion of the in-situ cap and removal of contaminated sediment. It is expected that Alternative 3 would attain PRGs through natural recovery, but the required timeframe cannot be accurately estimated. Alternative 4 would attain the PRGs upon completion of the removal of contaminated sediment.

- **Implementability**

Alternative 1 would be extremely simple to implement because no action would occur.

The technical implementability of Alternative 2 would be fairly simple, because it would require implementation of selective institutional controls and sediment monitoring. The necessary equipment and materials are available should the appropriate authority later be obtained through Navy channels to proceed.

The technical implementability of Alternative 3 would be significantly more difficult than that of Alternative 2. In addition to institutional controls and sediment monitoring, this alternative would require the excavation of contaminated sediment, the installation of an in-situ cap, and the implementation of interim surface water controls. However, these activities would be technically implementable and the necessary resources, equipment and materials are readily available should the appropriate authority later be obtained through Navy channels to proceed.

The technical implementability of Alternative 4 would be comparable to that of Alternative 3. Alternative 4 would not require in-situ capping, but it would require on-site dewatering and off-base transportation and disposal. The necessary resources, equipment and materials are readily available should the appropriate authority later be obtained through Navy channels to proceed.

Administratively, Alternatives 2 and 3 would require the development and implementation of institutional controls and the performance of long-term monitoring and five-year site reviews. Alternative 3 could also require a construction permit(s) for the excavation of sediment and installation of an in-situ cap. Alternative 4 would not require institutional controls, long-term monitoring, or five-year reviews, but it would require a construction/dredging permit(s) for the excavation and on-site dewatering of sediment. Alternative 4 would also require manifesting for transportation of the removed sediment, as well as acceptance of that sediment by an off-base TSDF. These administrative requirements could readily be met.

- **Cost**

The capital and operation and maintenance (O&M) costs and net present worth (NPW) of the remedial alternatives were estimated to be as follows:

Alternative	Capital ($)	NPW of O&M ($)	NPW ($)
1	0	0	0
2	25,000	419,000 (30-Year)	444,000 (30-Year)
3 (rip rap cap)	2,407,000	358,000 (30-Year)	2,765,000 (30-Year)
3 (wetland cap)	2,294,000	358,000 (30-Year)	2,652,000 (30-Year)
4	4,689,000	0	4,689,000 (1-Year)

The above cost figures have been rounded to the nearest $1,000 to reflect the preliminary nature of these estimates.

1.0 INTRODUCTION

This Feasibility Study (FS) was prepared for Site 17, Pettibone Creek and Boat Basin, at the United States (U.S.) Naval Station Great Lakes, located in Lake County, Illinois under Contract Task Order 341. This FS was prepared in accordance with the Comprehensive Long-Term Environmental Action Navy III, Contract Number N62467-94-D-0888, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and its governing regulations and Guidance for Conducting Remedial Investigations and Feasibility Studies [United States Environmental Protection Agency (USEPA), October 1988], the Superfund Amendments and Reauthorization Act of 1986 and its governing regulations, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300, and the National Environmental Policy Act (NEPA) (40 CFR 1500-1508).

The Navy implemented this FS with a team including representatives from the Illinois Environmental Protection Agency (Illinois EPA), Naval Facilities Engineering Field Division Southern Division (NAVFAC EFD SOUTH), the Navy's consultant Tetra Tech NUS, Inc. (TtNUS), and the Naval Station Great Lakes Environmental Department. The Statement of Work requires identification of possible remedial alternatives to address those known or suspected risks posed to human health and/or the environment by the presence of contaminated sediment at Site 17, Pettibone Creek and the Boat Basin. The selected remedy will be determined based on evaluation of the developed alternatives against the nine remedy selection criteria outlined in Section 300.430(e) of the NCP and CERCLA Section 121.

1.1 SITE BACKGROUND

Naval Station Great Lakes covers 1,632 acres of Lake County which is located in northeastern Illinois, north of the City of Chicago, and encompasses 1.5 miles of Lake Michigan shoreline. Pettibone Creek is located on the Mainside of Naval Station Great Lakes between Sheridan Road and the western shoreline of Lake Michigan. The North Branch of Pettibone Creek originates in the City of North Chicago and enters the northwestern corner of Naval Station Great Lakes, meandering through Mainside and discharging into Lake Michigan. The South Branch of Pettibone Creek originates in a residential area southwest of Naval Station Great Lakes, meandering through the golf course and Mainside, and joins the North Branch of Pettibone Creek approximately 1,500 feet west of Lake Michigan (Figure 1-1).

Site 17 comprises two geographic areas. The first is Pettibone Creek, including the North and South Branches. This portion of Site 17 covers approximately 8,542,500 square feet (ft^2) or 0.3 square miles. A path along the North Branch is used by staff, military personnel and their family members, and students who hike, jog, and walk their dogs. The South Branch flows at the base of steep slopes behind buildings and consequently is not frequented by people.

The Boat Basin portion of Site 17 is approximately 113,256 ft^2 in area. Boats are docked at the opening of the Boat Basin near the Inner Harbor. Past use of the Boat Basin prior to the sedimentation included the docking of boats at slips and access to the boat repair building (Building 13). Due to sedimentation, the Boat Basin can no longer be used for these activities. Currently, recreational fishing occurs in the Boat Basin by base personnel and the public.

Early investigations of Pettibone Creek and Boat Basin in the 1970s resulted from studies of the abandoned industrial facilities in the City of North Chicago located upstream of Naval Station Great Lakes. Several of the facilities [Fansteel, North Chicago Refiners and Smelters (NCRS), and the Vacant Lot] were turn-of-the-century manufacturing facilities that produced tantalum mill products, non-ferrous metals, and zinc oxide. USEPA Region 5 investigated these facilities for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticide, polychlorinated biphenyl (PCB), and metals contamination. The locations of these facilities are shown on Figure 1-1 also.

1.1.1 Site Description

Pettibone Creek

The majority of Naval Station Great Lakes activities occur on a plateau atop a steep bluff that rises 70 feet above the beach along Lake Michigan. Pettibone Creek and its tributaries flow in a ravine that divides this plateau and discharges to the Boat Basin.

Pettibone Creek has two major branches. The North Branch originates in the City of North Chicago near Commonwealth Avenue, flows south under Martin Luther King Jr. Drive and a parking area, resurfaces north of Sheridan Road, flows below Sheridan Road, resurfaces on the Naval Station Great Lakes property, and flows south and east through Naval Station Great Lakes until it enters the Boat Basin and then Lake Michigan. The South Branch originates in a residential area southwest of Naval Station Great Lakes, flows through the Shore Acres Golf Course Country Club, and flows north, entering Naval Station Great Lakes near the intersection of G Street and 3rd Street. Pettibone Creek ranges between 15 and 30 feet in width, and several inches to 2 feet in depth. Storm sewers collect stormwater from a large section of the City of North Chicago (Illinois EPA, December 1995) and 30 Naval Station Great Lakes stormwater sewer system outfalls from roadway drainage systems drain to the creek as shown on Figure 1-2 (Halliburton NUS, Inc., June 1993).

Pettibone Creek is not used as a drinking water source; however, children may play in the creek. Fish are present in the creek and fish have been observed migrating upstream in the spring (Illinois EPA, December 1995). No federally listed endangered or threatened species are known to exist in the area. The highly developed nature of the general vicinity makes it unlikely that suitable habitat exists for endangered or threatened species (U.S. Navy, February 2001).

Boat Basin

The Boat Basin, which is approximately 2.6 acres in area, is the most protected portion of the Naval Station's harbor system. It served as an area for boat slips when the water was deeper (Halliburton NUS, Inc., June 1993). In June 1990, the water depth of the Boat Basin ranged from less than 1 foot to 5 feet. The eastern portion of the Boat Basin provided access to the boat repair building, but accumulated sediment now prevents access for most vessels. Public Works Center Great Lakes has estimated that some 30,000 cubic yards (yd^3) of material would have to be dredged from the Boat Basin to reestablish a desired water depth of 8 feet (U.S. Navy, May 1990).

1.1.2 <u>Site History</u>

Pettibone Creek

The urban nature of the creek's watershed has resulted in flash floods that caused severe erosion and sedimentation problems. Efforts to stabilize the erosion in the ravine have been made in the past. In 1982, Naval Station Great Lakes initiated emergency slope stabilization. In 1989, after a period of major storms in 1987 and 1988, emergency pipe replacement and slope stabilization measures were conducted in three severely eroded areas (McGuire Group Inc., December 1993).

Boat Basin

The original Boat Basin and Harbor were constructed in 1906 with the outer breakwater structures added by 1923. Extensive erosion of Pettibone Creek has contributed to the silting in of the Boat Basin and Harbor. The silting in of the Boat Basin and Harbor has hampered operations. The outer harbor anchorage has reduced capacity, limiting the size of watercrafts that are able to be loaded/off-loaded at the recreational boat ramps. The Boat Basin was dredged in the early 1950s and again in the early 1970s (U.S. Navy Memorandum, August 1988).

1.1.3 Previous Investigations

A brief summary of historical investigations of potential contamination at Site 17 and reported historical releases to the environment is provided below. Additional details regarding the source areas and releases are provided in Section 2.2 of the Site 17 Remedial Investigation/Risk Assessment (RI/RA) (TtNUS, September 2003).

Industries located upstream of Naval Station Great Lakes include the NCRS (also known as R. Lavin) facility, the Vacant Lot, and Fansteel. Discharges from these industries in combination with several storm sewers collecting water/runoff from a large section of the City of North Chicago have contributed to elevated concentrations of contaminants in Pettibone Creek and Boat Basin sediments according to the Illinois EPA (Illinois EPA, December 1995) and USEPA (USEPA, April 2002a, April 2002b, and May 2002) based on the historical information provided in Section 2 of the Site 22 RI/RA. In addition, the Navy identified potential areas where hazardous materials may have been released to the environment at Naval Station Great Lakes in the Initial Assessment Study (IAS) (Rogers, Golden, & Halpern and BCM Eastern Inc., March 1996). The IAS identified 14 potentially contaminated sites along with potential sources such as surface runoff or fallout from engine exhaust from nearby roadways, historical pesticides usage applied when it was legal to do so, and VOCs detected in the groundwater samples collected from monitoring wells. The following table provides a brief overview of environmental studies conducted from 1970 to 2001 and a summary of the findings.

Date	Conducted by	Comments
1970 - 1971	Illinois EPA	PCBs and pesticides found in samples
1975	USEPA	Inner Harbor sediment samples polluted with toxic metals
May 1980	USEPA Contractor	Contaminated sediment samples
April 1988	STS Consultants Ltd. for the Navy	USEPA did not approve open water disposal of sediments
July 1988	Jacobs Engineering	Copper and lead had elevated concentrations in the sediment sediments
April 1989	STS Consultants Ltd. for the Navy	Highest concentrations at the Boat Basin bend to join a channel to the Inner Harbor
June 1990	Illinois EPA	Elevated concentrations of zinc, copper, and lead in sediments downstream of the NCRS Facility
1991	Illinois EPA	Surface water samples were contaminated with VOCs and SVOCs
Nov. 1991	Illinois EPA	Metals and SVOCs were present at three times above background concentrations
Aug. 1992	Halliburton NUS for the Navy	Contaminants present in Pettibone Creek and Boat Basin sediments

Date	Conducted by	Comments
Sept. 1992	Illinois EPA	Elevated concentrations of inorganics, chlorinated solvents, polynuclear aromatic hydrocarbons (PAHs), pesticides, and PCBs were detected in soil and sediment samples
April 1994	Illinois EPA	Presence of VOCs, SVOCs, pesticides, and metal compounds in sediment samples
1995	Illinois EPA	Significant metals contamination in sediment samples. Illinois EPA identified many potential sources that were part of upstream facilities.
1997	Ecology & Environmental, Inc. for USEPA	Contaminants found in soil samples from the Vacant Lot site and sediment samples. Off-site active industrial discharge and stormwater drainage into Pettibone creek represent potential sources of contamination.
2000	Contractor for Fansteel Inc.	Contaminants found in sediment samples
Oct. 2000	TN& Associates for USEPA Region 5	Downstream sampling suggested that the contaminants are migrating downstream from the NCRS/City of North Chicago discharge into Pettibone Creek
Sept. 2001	TtNUS	Presence of PAHs, pesticides, PCBs, metals in sediment samples; presence of VOCs and metals in surface water samples

The most recent field investigation for Site 17 was performed in September 2001. The activities consisted of surface water sampling and sediment sampling. Six surface water samples were collected and analyzed. Sediment samples were collected from 38 locations along the North and South Branches of Pettibone Creek from a depth range of 0 to 4 centimeters (cm) and from 14 locations at a depth of 1 foot. The PAHs, pesticides, PCBs, and metals were detected in the off-site, upstream samples collected during previous environmental investigations of Pettibone Creek. Sediment samples were collected from 12 locations in the Boat Basin. At each location, four samples were collected from the following depth intervals: 0 to 4 cm, 4 cm to 3 feet, 3 to 6 feet, and 6 to 10 feet. There is a general trend that the sediment at the surface is "cleaner" than the sediment at depth (i.e., the concentrations of pesticides, PCBs, and metals in the deeper sediment samples of the Boat Basin were greater than the surface sediment samples). The difference in concentration with depth may reflect decreases in contaminant loading over time; sediments have built up, undisturbed in the Boat Basin over an extended period (approximately 30 years since last dredging). The concentrations of most pesticides, PCBs, and metals in the at-depth samples of the Boat Basin also exceed concentrations for surface or at-depth sediments collected along Pettibone Creek. The following section summarizes the findings of this investigation.

1.2 ENVIRONMENTAL CONDITIONS

The following briefly reviews the RI/RA investigation, the condition of Site 17 as of September 2001; more detailed information is available in Section 4.0 of the RI/RA report (TtNUS, September 2003). In this *section, the environmental conditions, including the nature and extent of contamination and human health* and ecological risk assessment results, are briefly reviewed.

1.2.1 Nature and Extent of Contamination

VOCs were not significant site-related contaminants at Site 17. Maximum concentrations of chlorinated solvents and toluene were reported for the sample collected at the upstream boundary of Site 17.

PAHs were the predominant SVOCs detected in the sediment samples collected at Site 17. In general, concentrations of PAHs were greatest in surface sediment samples. Concentrations were typically lower in samples increasing with depth. Average concentrations reported for the North Branch of Pettibone Creek and the Boat Basin [typically less than 5,000 micrograms per kilogram (µg/kg)] tend to exceed those reported for the South Branch of Pettibone Creek (typically less than 1,000 µg/kg). PAHs were not detected in Site 17 surface water samples. The PAH concentrations in sediment samples have increased compared to historical data, and this is believed to be caused by wide spread use of petroleum products in our modern, industrialized society.

Pesticides, PCBs, and metals exhibit a different extent profile than do the PAHs in sediment. In general, concentrations of pesticides, PCBs, and metals were lower in surface sediment samples and concentrations increased with increasing depth. Pesticides were detected in the sediment samples collected at Site 17 at concentrations that reflect the widespread and historical use of chemicals for pesticide control.

PCBs were detected in less than 50 percent of the sediment samples analyzed. Average concentrations reported for Aroclor-1248, 1254, and 1260 for the at-depth samples in the Boat Basin (240 µg/kg, 1400 µg/kg, and 300 µg/kg, respectively) were greater than those reported for the surface sediment samples and the sediment samples from Pettibone Creek by a factor of two or more. PCBs were detected in the off-site, upstream samples collected during previous environmental investigations. Previous PCB data suggest significant possible upstream sources may have contributed to the sediment contamination. In addition, PCB contamination of sediments may have occurred due to storage by Naval Station Great Lakes of out-of-service transformers (some filled with PCB-containing oil) at various locations within the base. Past investigations at these storage locations indicated that some limited soil contamination exceeded federal and state clean-up guidelines. However, there is no clean-up documentation available on the PCB-contaminated soil. Contamination was reported to be limited and restricted to the transformer storage locations. There are no analytical data available indicating that the transformer storage locations are a source of contamination to Pettibone Creek and the Boat Basin.

Copper, lead, and zinc were identified as significant environmental contaminants in sediment samples collected upstream and off site of Site 17 during past environmental investigations. The concentrations that were reported for the off-site, upstream samples were often two to three times greater than concentrations noted in the Site 17 sediment samples. Although overland runoff and stormwater discharges may contribute pollutants to the watershed, the analytical results available for the Site 17 area do not suggest that a significant point source(s) from Naval Station Great Lakes is (are) impacting the surface water/sediment quality of Pettibone Creek or the Boat Basin. Several metals (e.g., copper, lead, mercury, selenium, silver, zinc) were detected in the sediments of the Boat Basin and the North Branch of Pettibone Creek at average concentrations an order of magnitude greater than background sediment concentrations reported in Tiered Approach to Corrective Action Objectives (TACO). In contrast, most analytical results reported for the South Branch of Pettibone Creek are similar to background sediment concentrations reported in TACO. The analytical data suggest that the primary source of contamination is historical discharge and stormwater discharge within the Pettibone Creek Watershed particularly because contaminant concentrations in the deeper sediment samples of the Boat Basin were greater than the surface sediment samples. These differences in concentration with depth may reflect decreases in contaminant loading over time (i.e., sediments have built up over the past 30 years since the last dredging; however, the most recent sediments deposited into the Boat Basin are generally "cleaner").

The potential sources of contamination still remain especially the stormwater sewer systems and surface water runoff from the industrial facilities into Pettibone Creek. However, a few of the industrial facilities (R. Lavin & Sons and Fansteel) that have contributed to the historical contamination in Pettibone Creek have filed petitions for bankruptcy and have ceased operations. Pettibone Creek may continue to receive a variety of wastes from the upstream industries, road runoff, storm sewers, and runoff/discharges from local residential properties. Several of the potential sources (industrial sites) have been cleaned up, and it is thought that additional releases to the creek should not be as significant as they were in the past. Nevertheless, there could be residual runoff into Pettibone Creek and the upstream outfalls are still permitted under the state National Pollutant Discharge Elimination System program.

Also, as discussed above and in Section 2.5.2, because the sources of PAHs in the sediment include runoff from roads and parking lots, the sediment may become recontaminated with PAHs. Therefore, the potential for recontamination of the sediment with PAHs and/or other chemicals from runoff and/or residual contamination at the upstream sites needs to be considered in the decision to remediate the site. Even if the Boat Basin were remediated, the fish advisory for Lake Michigan fish would still be in effect for people fishing in the Boat Basin. The fish advisories are voluntary and cannot be enforced, and they may have no impact upon human fish consumption.

1.2.2 Human Health and Ecological Risk Assessments

1.2.2.1 Human Health Risk Assessment

A human health risk assessment (HHRA) was conducted to determine whether contamination in surface water, sediment, and fish in Pettibone Creek and the Boat Basin poses potential health risks to potential receptors (child and adult recreational users) under current and/or foreseeable future site conditions. The results of the HHRA are presented in Section 6.0 of the RI/RA report (TtNUS, September 2003) and summarized in this section.

Chemicals of potential concern (COPCs) were identified by comparing maximum concentrations of constituents detected in the Site 17 samples to USEPA Region 9 risk-based preliminary remediation goals (PRGs), Illinois EPA remediation objectives for residential land use, and USEPA Region 3 risk-based concentrations (RBCs) for fish ingestion. Under current/future land use, quantitative estimates of noncarcinogenic and carcinogenic risks [Hazard Indices (HIs) and Incremental Lifetime Cancer Risks (ILCRs), respectively] were developed for adult and adolescent recreational users hypothetically exposed to COPCs in surface water, surface sediment, and fish tissue (estimated from chemical concentrations in sediment). The results of the risk assessment are discussed below and presented in Table 1-1.

Risks from Exposure to Surface Sediment

HIs for adult and adolescent recreational users in Pettibone Creek (2.7E-03 and 3.0E-02, respectively) and the Boat Basin (3.1E-02 and 3.2E-02, respectively) were less than the regulatory goal of unity (1.0). The ILCR for the adolescent recreational user for exposure to sediment in the South Branch of Pettibone Creek was less than 1.0E-06. The ILCR for the adult recreational user for exposure to surface sediment in the South Branch of Pettibone Creek (1.6E-06) was within the USEPA risk management range of 1.0E-06 to 1.0E-04. ILCRs for adult and adolescent recreational users for exposure to surface sediment in the North Branch of Pettibone Creek (6.9E-06 and 2.6E-06, respectively) and the Boat Basin (8.1E-06 and 3.0E-06, respectively) were within the USEPA risk management range. ILCRs greater than 1.0E-06 were mainly the result of exposure to PAHs.

Risks from Exposure to Surface Water

HIs for adult (6.9E-02) and adolescent (6.9E-02) recreational users from exposure to COPCs in Pettibone Creek and the Boat Basin were less than unity. The ILCRs for the adult (1.8E-06) recreational user for exposure to surface water was within the USEPA risk management range and the adolescent (9.7E-07) recreational user for exposure to surface water was less than 1.0E-06.

Risks from Exposure by Fish Ingestion

The ILCR for the ingestion of fish caught by the recreational fisherman (1.8E-04) exceeded 1.0E-04, and the total HI (6.6) was greater than unity (1.0). PCBs (mainly Aroclor-1254) accounted for 66 percent of the total cancer risk for fish ingestion. Pesticides accounted for the remainder of the cancer risk. A number of significant uncertainties were associated with the fish ingestion risks, including the fact that the fish tissue concentrations were not actual fish tissue concentrations but rather were merely estimates (modeled) from sediment concentrations and sediment bioaccumulation factors. However, the results of the risk assessment were generally consistent with fish advisories currently in effect for Lake Michigan.

No significant potential health hazards are associated with exposure to COPCs in surface water and surface sediment under the recreational land use scenarios. The quantitative risk evaluation indicated that noncarcinogenic HIs were less than unity (1.0) for adult and adolescent recreational users. Carcinogenic risks were less than or within USEPA's risk management range of 1.0E-06 to 1.0E-04. The HIs and ILCRs estimated for recreational fisherman consuming fish contaminated with PCBs and pesticides exceeded USEPA benchmarks.

1.2.2.2 Ecological Risk Assessment

An ecological risk screening was also performed as part of this recent investigation at Site 17. The goal of the Ecological Risk Assessment (ERA) for Site 17 was to determine whether adverse ecological impacts are possible as a result of exposure to chemicals. The Screening-Level ERA (SERA) relied on environmental chemistry data; biological sampling or testing was not conducted for the RI/RA. The SERA methodology used at Naval Station Great Lakes followed the guidance presented in the Final Guidelines for Ecological Risk Assessment (USEPA, April 1998), the Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (USEPA, June 1997), and the Navy Policy for Conducting Ecological Risk Assessments [U.S. Navy, April 1999], and the Quality Assurance Project Plan (TtNUS, July 2001) prepared for this project. The results of the ERA are presented in Section 7.0 of the RI/RA report (TtNUS, September 2003).

Several chemicals detected in surface water and/or sediment were initially retained as COPCs because their concentrations exceeded screening levels or because they were bioaccumulative chemicals with Ecological Effects Quotients (EEQs) greater than 1 based on conservative exposure scenarios. These chemicals were then reevaluated in Step 3a of this ERA to determine which chemicals had the greatest potential for causing risks to ecological receptors and therefore should be retained as chemicals of concern (COCs) for further discussion/evaluation. The two primary ecological endpoints evaluated in this ERA were aquatic organisms (i.e., fish and invertebrates) and mammals and birds that consume invertebrates and/or fish. Therefore, different lists of chemicals were retained as COCs for these different endpoints. Also, different lists of COCs were retained for each of the areas (i.e., the North Branch of Pettibone Creek, the South Branch of Pettibone Creek, and the Boat Basin).

Table 1-2 lists the chemicals retained as ecological COCs for each of the endpoints in each of the areas. No chemicals detected in surface water were retained as COCs for risks to aquatic organisms. A few of the chemicals detected in the surface water were included in the food-chain model; however, the drinking water portion of the food-chain models is insignificant for exposure because the chemicals concentrations in surface water are much lower than they are in sediment. Consequently, no chemicals in surface water were retained as COCs for either of the primary endpoints. Therefore, although some of the pesticides (4,4'-DDE and 4,4'-DDT) and metals were retained as COCs for the food-chain model, it was because of the concentrations in sediment not in surface water. However, because Pettibone Creek and the Boat Basin do not support large fish populations, the piscivorous exposure route is not expected to be significant. Additionally, exposure of terrestrial wildlife to contaminants in the sediment (and surface water) via dermal contact is unlikely to represent a major exposure pathway because fur, feathers, and chitinous exoskeletons are expected to minimize transfer of contaminants across dermal tissue.

No chemicals were retained as COCs for sediments in the South Branch of Pettibone Creek for aquatic receptors or mammals/birds. With the exception of a few sporadic elevated detections, the chemical concentrations in this branch are relatively low and may represent a good background/reference location for comparisons to data (i.e., chemical and biological) collected in the North Branch and Boat Basin.

PAHs, several pesticides, and several metals in sediment samples were retained as COCs for risks to aquatic receptors in the North Branch of Pettibone Creek because they were detected in several samples at concentrations that exceeded the alternate benchmarks. The alternate benchmarks are the literature-based, upper effects levels that were used in the Step 3a refinement of the COPC list. The alternate benchmarks are less conservative than the screening benchmarks that were used in the initial COPC selection and were used to determine the ecological risk-drivers at Site 17. Also, two pesticides (4,4'-DDE and 4,4'-DDT) were retained as COCs because they may cause risks to piscivorous birds; however, as discussed above, Pettibone Creek and the Boat Basin do not support large fish populations, and the piscivorous exposure route is not expected to be significant. Most of the elevated concentrations of these chemicals were detected in the most upstream sample, which indicates that the predominant source of these chemicals appears to be off site of Naval Station Great Lakes. In addition, the concentrations of pesticides are indicative of those associated with typical applications of the pesticides when it was legal to do so. Therefore, although these chemicals were retained as COCs, the fact that they may not be site related needs to be factored into the risk management decisions.

PAHs, several pesticides and PCBs, and several metals in sediment samples were retained as COCs for risks to aquatic receptors in the Boat Basin because they were detected in several samples at concentrations that exceeded the alternate benchmarks. Also, one pesticide (4,4'-DDE) was retained as a COC because the pesticide may cause risks to piscivorous birds. In addition, the concentrations of pesticides are indicative of those associated with typical applications of the pesticides when it was legal to do so. Therefore, although these chemicals were retained as COCs, the fact that they may not be site-related needs to be factored into the risk management decisions.

In summary, several chemicals were retained as COCs in the North Branch of Pettibone Creek and the Boat Basin because they were detected in several samples at concentrations that exceeded the alternate benchmarks. This indicates that there may be potential risks to aquatic receptors from these chemicals. However, because these conclusions are based on literature values, there is uncertainty in the conclusions. Also, because of the large amount of soil erosion in the creek, there are physical stressors as well as chemical stressors that may be adding to the risks to aquatic organisms. These uncertainties could be reduced by conducting site-specific toxicity tests and/or biological surveys that could be used to determine site-specific, risk-based screening levels.

Finally, pesticides were selected as COCs in the North Branch of Pettibone Creek and the Boat Basin because they may cause a risk to piscivorous birds that consume fish from the area. The risks are based on predicted fish tissue concentrations estimated from the sediment concentrations that incorporate the assumed percent lipids of the fish and site-specific total organic carbon (TOC) of the sediment. The sediment in Pettibone Creek and the Boat Basin is very sandy with little TOC. Therefore, the predicted fish tissue concentrations of pesticides are much greater than the pesticide concentrations in the sediment. The literature values used to make these predictions may not represent actual site conditions. In addition, although the elevated pesticide detections are located in several samples along the creek and Boat Basin, the samples were biased toward depositional areas that are expected to have greater chemical concentrations than the rest of the creek. Also, based on the evaluation in Section 8 of the RI/RA (Fish Tissue Uncertainty Analysis Evaluation with Historical Data), it appears that risks to piscivorous birds and mammals are overestimated. The amount of overestimation cannot be quantified with the existing data. Additionally, Pettibone Creek and the Boat Basin do not support large fish populations and the piscivorous exposure route is not expected to be significant because it is not expected that significant numbers of piscivorous birds are feeding in Pettibone Creek. For these reasons, there is considerable uncertainty in concluding that there are potential risks to piscivorous birds from the sediment chemical concentrations.

In conclusion, PAHs, PCBs, and metals data indicate potential risks to aquatic organisms and piscivorous birds exposed to the contaminated sediment in the North Branch of Pettibone Creek and Boat Basin. The potential risks are based on literature data and can be better defined by conducting site-specific biological studies.

1.3 DOCUMENT ORGANIZATION

This FS Report has been organized with the intent of meeting the general format requirements specified in the RI/FS Guidance Document (USEPA, October 1988). This report consists of the following five sections:

- Section 1.0, Introduction - summarizes the purpose of the report, provides site background information, summarizes findings of the previous investigations, and provides the report outline.

- Section 2.0, RAOs and General Response Actions (GRAs) - presents the RAOs, identifies ARARs and To Be Considered (TBC) criteria, develops PRGs and associated GRAs, and provides an estimate of the volume of contaminated media to be remediated. This section also discusses the uncertainties for this FS related to site-specific conditions.

- Section 3.0, Screening of Remediation Technologies and Process Options - provides a two-tiered screening of potentially applicable remediation technologies and identifies the technologies that will be assembled into remedial alternatives.

- Section 4.0, Assembly and Detailed Analysis of Remedial Alternatives - assembles the remedial technologies retained from the Section 3.0 screening process into multiple remedial alternatives, describes these alternatives, and performs a detailed analysis of these alternatives in accordance to the seven CERCLA criteria.

- Section 5.0, Comparative Analysis of Remedial Alternatives - compares the remedial alternatives on a criterion-by-criterion basis, for each of the seven CERCLA analysis criteria used in Section 4.

TABLE 1-1

SUMMARY OF HUMAN HEALTH RISKS
POTENTIAL CURRENT AND FUTURE LAND USE SCENARIOS
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Receptor	Medium of Concern	Exposure Route	Total ILCR	
			RME	CTE
North Branch Pettibone Creek				
Adolescent Recreational User	Sediment	Incidental Ingestion and Dermal Contact	2.6E-06	4.1E-07
Adult Recreational User	Sediment	Incidental Ingestion and Dermal Contact	6.9E-06	2.2E-07
South Branch Pettibone Creek				
Adolescent Recreational User	Sediment	Incidental Ingestion and Dermal Contact	5.4E-07	7.9E-08
Adult Recreational User	Sediment	Incidental Ingestion and Dermal Contact	1.6E-06	4.5E-08
Boat Basin				
Adolescent Recreational User	Surface Water	Dermal Contact	9.7E-07	2.3E-07
	Sediment	Incidental Ingestion and Dermal Contact	3.0E-06	4.7E-07
Adult Recreational User	Surface Water	Dermal Contact	1.8E-06	1.3E-07
	Sediment	Incidental Ingestion and Dermal Contact	8.1E-06	2.6E-07
	Fish Tissue	Ingestion	1.8E-04	2.1E-05

Receptor	Medium of Concern	Exposure Route	Total HI	
			RME	CTE
North Branch Pettibone Creek				
Adolescent Recreational User	Sediment	Incidental Ingestion and Dermal Contact	3.0E-02	6.0E-03
Adult Recreational User	Sediment	Incidental Ingestion and Dermal Contact	2.7E-02	4.1E-03
South Branch Pettibone Creek				
Adolescent Recreational User	Sediment	Incidental Ingestion and Dermal Contact[1]	4.4E-03	1.1E-03
Adult Recreational User	Sediment	Incidental Ingestion and Dermal Contact	2.7E-03	6.6E-04
Boat Basin				
Adolescent Recreational User	Surface Water	Dermal Contact	6.9E-02	1.6E-02
	Sediment	Incidental Ingestion and Dermal Contact	3.2E-02	5.9E-03
Adult Recreational User	Surface Water	Dermal Contact	6.9E-02	1.6E-02
	Sediment	Incidental Ingestion and Dermal Contact	3.1E-02	4.2E-03
	Fish Tissue	Ingestion	6.6E+00	2.6E+00

TABLE 1-1

SUMMARY OF HUMAN HEALTH RISKS
POTENTIAL CURRENT AND FUTURE LAND USE SCENARIOS
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

NOTES:

1 Not evaluated for dermal contact because thallium was the only noncarcinogen selected as a COPC, see Section 6.2.4.1 of Site 17 RI/RA (TtNUS, September 2003).

Details of the human health risk assessment assumptions and computations are provided in the Section 6 of the Site 17 RI/RA (TtNUS, September 2003).

CTE - Central Tendency Exposure.

ILCR - Incremental Lifetime Cancer Risk.

RME - Reasonable Maximum Exposure.

HI - Hazard Index.

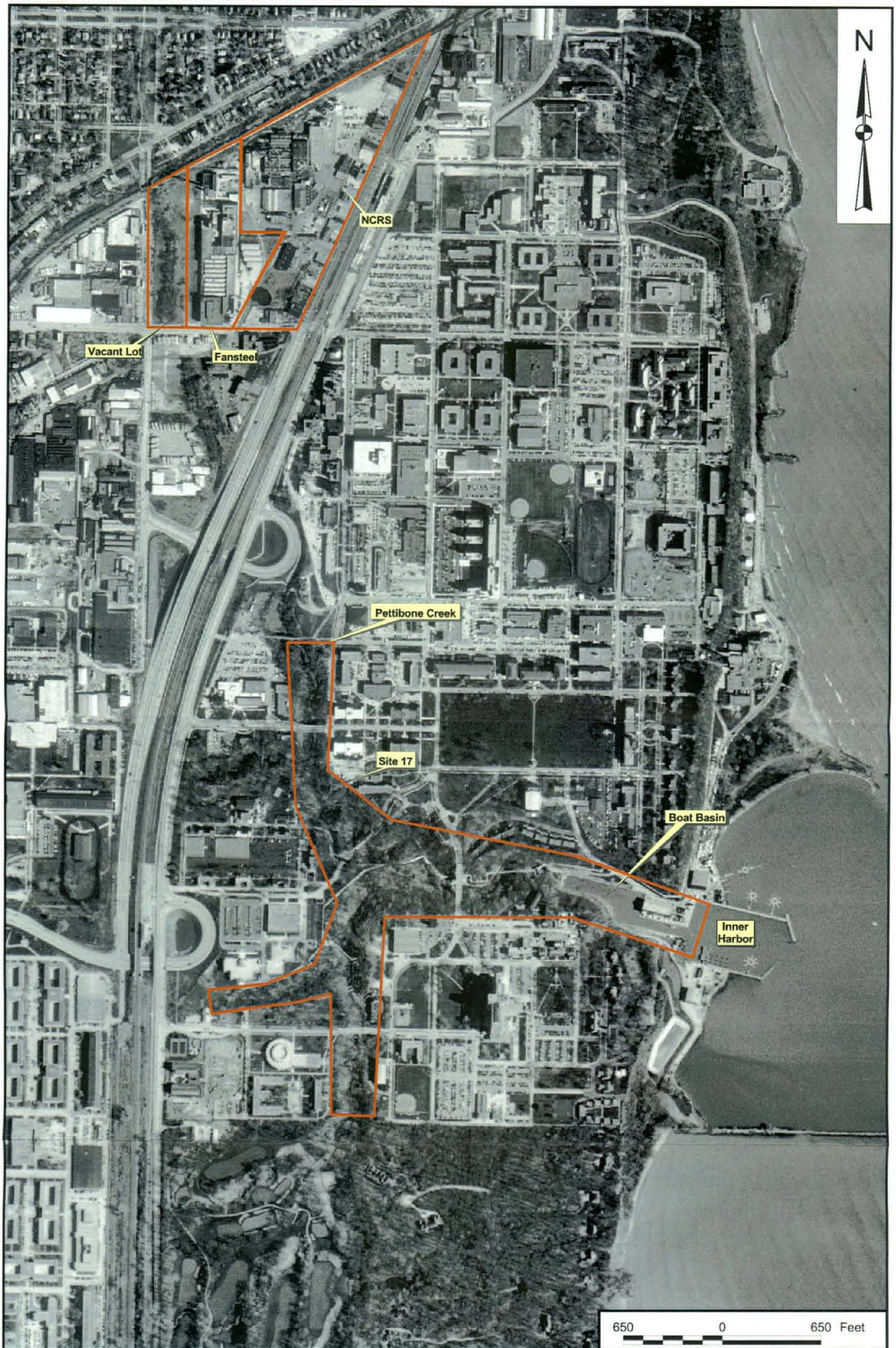
TABLE 1-2

SUMMARY OF ECOLOGICAL RISKS
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Receptor[1]	Exposure Route[2]	Chemical of Concern	EEQ[3]
North Branch Pettibone Creek			
Benthic Invertebrates and Fish	Direct contact, Ingestion of sediment, Ingestion of prey	PAHs	2.3 to 1364
		4,4'-DDT	1800
		4,4'-DDE	105
		4,4'-DDD	85
		Endosulfan II	80
		Copper	30
		Lead	10
		Mercury	24
		Zinc	18.0
Piscivorous birds	Direct contact, Ingestion of sediment, Ingestion of prey	4,4'-DDT	43
		4,4'-DDE	94
Boat Basin			
Benthic Invertebrates and Fish	Direct contact, Ingestion of sediment, Ingestion of prey	PAHs	3.5 to 62
		4,4'-DDT	120
		4,4'-DDE	115
		4,4'-DDD	155
		Endosulfan I	58
		Endosulfan II	80
		Aroclor-1254	11
		Aroclor-1260	54
		Copper	18
		Lead	9.3
		Zinc	17
Piscivorous birds	Direct contact, Ingestion of sediment, Ingestion of prey	4,4'-DDE	60

1- Risks to carnivorous mammals were also evaluated; however, no COCs were retained for this receptor.
2- COCs were detected in sediment. Surface water was also evaluated as a medium of concern; however, no chemicals were retained as COCs.
3- The LOAEL EEQ using the average concentrations and average exposure assumptions is shown for piscivorous birds because this EEQ was used in the final risk determination.
EEQ = Ecological Effect Quotient.
PAHs = Polynuclear Aromatic Hydrocarbons.
COCs = Chemicals of Concern.
LOAEL = Lowest Observable Adverse Effect Level.

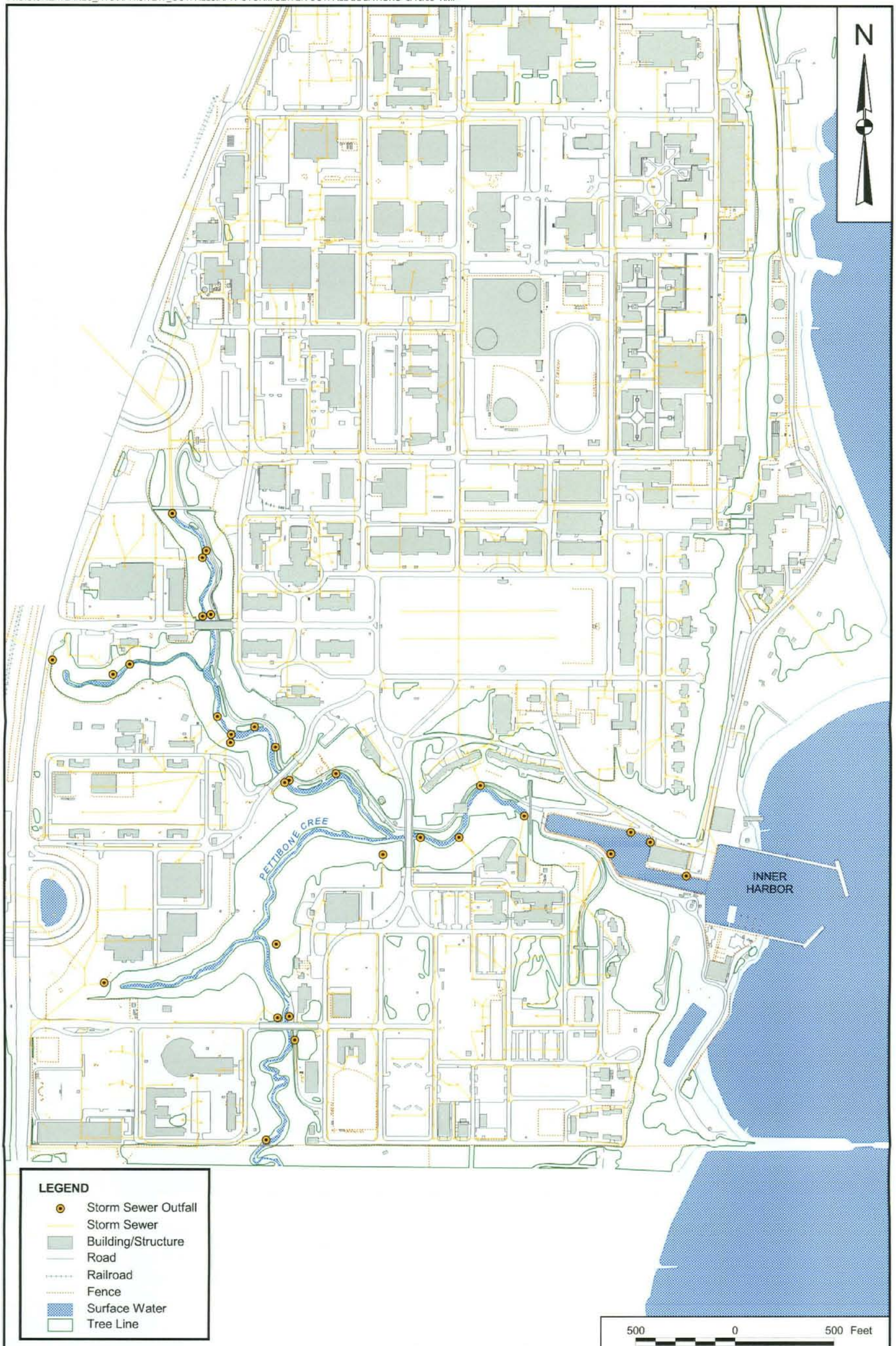
P:\GIS\GREATLAKES_NTC\QAPP_2001.APR\SITE LOCATIONS MAP - 7 AND 17 5/6/04 KMP



DRAWN BY J. BELLONE	DATE 4/5/01	SITE VICINITY MAP SITE 17 NAVAL STATION GREAT LAKES, ILLINOIS	CONTRACT NUMBER N7303
CHECKED BY GP	DATE 4/18/01		APPROVED BY RFD — DATE 4/20/01
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED	NAVFAC		DRAWING NO. FIGURE 1-1 — REV 0

000180FB01Y

P:\GIS\GREATLAKES_NTC\APR\SITE17_OUTFALLS.APR STORM SEWER OUTFALL LOCATIONS 8/16/05 KMP



DRAWN BY J. LAMEY	DATE 8/6/03	STORM SEWER OUTFALL LOCATIONS	CONTRACT NUMBER N3939
CHECKED BY B. DAVIS	DATE 9/23/04	SITE 17 - PETTIBONE CREEK AND BOAT BASIN	APPROVED BY — DATE —
COST/SCHEDULE-AREA		NAVAL TRAINING CENTER	APPROVED BY — DATE —
SCALE AS NOTED		GREAT LAKES, ILLINOIS	DRAWING NO. FIGURE 1 - 2 REV 0

NAVFAC

2.0 REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS

This section develops RAOs and derives PRGs for the contaminated sediment at Site 17, Pettibone Creek and the Boat Basin based on the site conditions presented in Section 1. The RAOs provide the basis for selecting appropriate remedial alternatives. The PRGs for the contaminated sediment are developed in this section, and GRAs that may be suitable to achieve the PRGs are presented.

The regulatory requirements and guidance chemical-, location-, and action-specific ARARs that may potentially govern remedial activities at the site are also presented in this section. In addition, this section presents the COCs and the conceptual pathways through which these chemicals may affect human health, and thus derives the environmental media of concern. Finally, this section presents an estimate of the volume of contaminated sediment and discusses the uncertainties in this feasibility study as it relates to the contamination from pesticides and PAHs, the potential for recontamination, the Lake Michigan Fish Advisories, and development of site-specific PRGs.

2.1 REMEDIAL ACTION OBJECTIVES

The purpose of this section is to develop RAOs for Site 17 at Naval Station Great Lakes, Illinois. Development of RAOs is an important step in the FS process. The RAOs are medium-specific goals that define the objective of conducting remedial actions to protect human health and the environment. The RAOs specify the COCs, potential exposure routes and receptors, and an acceptable range of contaminant concentrations (i.e., PRGs) for the site. Section 2.1.1 presents the RAOs developed for Site 17.

The development of PRGs takes into consideration ARARs and TBCs. Section 2.1.2 identifies the ARARs and TBCs, Section 2.1.3 identifies the medium of concern, and Section 2.1.4 identifies the COCs for remediation.

2.1.1 Statement of Remedial Action Objectives

Site-specific RAOs specify COCs, media of interest, exposure pathways, and cleanup goals or acceptable contaminant concentrations. This FS addresses sediment contamination at Site 17. The RAOs were developed to permit consideration of a range of treatment and containment alternatives based on the current and potential future land use as public recreation. To protect the public from current and potential future health risks, as well as to protect the environment, the following RAOs were developed:

- Prevent unacceptable human health risk associated with the ingestion of fish caught in the Boat Basin and containing pesticides and PCBs at concentrations greater than the established PRGs and health advisories.

- Reduce unacceptable risk to aquatic receptors exposed to North Branch of Pettibone Creek and Boat Basin sediment containing PAHs, pesticides, PCBs, and metals at concentrations greater than literature-based risk values.

- Reduce unacceptable risk to piscivorous wildlife consuming fish exposed to sediment containing pesticides at concentrations greater than literature-based risk values in the North Branch of Pettibone Creek and the Boat Basin.

2.1.2 Applicable or Relevant and Appropriate Requirements and To Be Considered Criteria

ARARs consist of the following:

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

TBCs are nonpromulgated, nonenforceable guidelines or criteria that may be useful for developing a remedial action or are necessary for determining what is protective to human health and/or the environment. Examples of TBCs include USEPA's Drinking Water Health Advisories, Reference Doses (RfDs), and Cancer Slope Factors (CSFs).

One of the primary concerns during the development of remedial action alternatives for hazardous waste sites under CERCLA is the degree of human health and environmental protection offered by a given remedy. Section 121 of CERCLA requires that primary consideration be given to remedial alternatives that attain or exceed ARARs. The purpose of this requirement is to make CERCLA response actions consistent with other pertinent federal and state environmental requirements.

2.1.2.1 Definitions

The definitions of ARARs are as follows:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

- Relevant and appropriate requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law. While these relevant and appropriate requirements are not "applicable" to a hazardous substance, pollutant, contaminant, or remedial action, location, or other circumstance at a CERCLA site, they address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

- TBCs are a category created by the USEPA that includes nonpromulgated criteria, advisories, and guidance issued by federal or state government that are not legally binding and do not have the status of potential ARARs. However, pertinent TBCs will be considered along with the ARARs in determining the necessary level of cleanup or technology requirements.

Under CERCLA Section 121(d)(4), the USEPA may waive compliance with an ARAR if one of the following conditions can be demonstrated:

- The remedial action selected is only part of a total remedial action that will attain the ARAR level or standard of control upon completion.

- Compliance with the requirement will result in greater risk to human health and the environment than other alternatives.

- Compliance with the requirement is technically impracticable from an engineering perspective.

- The remedial action selected will attain a standard of performance that is equivalent to that required by the ARAR through the use of another method or approach.

- With respect to a state requirement, the state has not consistently applied the ARAR in similar circumstances at other remedial actions within the state.

The NCP has identified three categories of ARARs [40 CFR Section 300.400 (g)] as follows:

- Chemical-Specific: Health-risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples include USEPA's Maximum Contaminant Levels (MCLs) and Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC).

- Location-Specific: Restrict actions or contaminant concentrations in certain environmentally sensitive areas. Examples of these areas regulated under various federal laws include floodplains, wetlands, and locations where endangered species or historically significant cultural resources are present.

- Action-Specific: Technology- or activity-based requirements, limitations on actions, or conditions involving special substances. Examples of action-specific ARARs include wastewater discharge standards and performance or design standards, controls, or restrictions on particular types of activities.

This section discusses chemical- and location-specific ARARs and TBCs. Action-specific ARARs and TBCs are presented in Section 2.3 along with the discussion of GRAs.

2.1.2.2 Chemical-Specific ARARs and TBCs

Tables 2-1 and 2-2 present respective lists of federal and State of Illinois chemical-specific ARARs and TBCs for this FS. The chemical-specific ARARs and TBCs provide some medium-specific guidance on "acceptable" or "permissible" concentrations of contaminants.

2.1.2.3 Location-Specific ARARs and TBCs

Tables 2-3 and 2-4 present respective lists of federal and State of Illinois' location-specific ARARs and TBCs for this FS. The location-specific ARARs and TBCs place restrictions on concentrations of contaminants or the conduct of activities solely based on the site's particular characteristics or location.

2.1.3 Medium of Concern

The investigation of Pettibone Creek and the Boat Basin consisted of evaluating potential human and ecological risks from chemicals in sediment and surface water. Based upon the results of the risk assessment for both human and ecological receptors, the only medium of concern at Site 17 was determined to be sediment.

2.1.4 Chemicals of Concern for Remediation

Human health COCs for Site 17 were established based on the results of the risk assessment performed for Pettibone Creek and the Boat Basin included in the Site 17 RI/RA report. The results of the risk assessment indicated that the risks to recreational receptors from direct exposure to surface water and sediment in Pettibone Creek and the Boat Basin were acceptable (i.e., were less than USEPA benchmarks). However, risks from exposure to fish assumed to be caught and consumed by a recreational fisherman in the Boat Basin exceeded benchmark values for carcinogenic and noncarcinogenic health effects. The fish tissue concentrations evaluated in the risk assessment were modeled from sediment concentrations and sediment bioaccumulation factors. Based on the recreational fish ingestion scenario, several pesticides (4,4'-DDT and metabolites, aldrin, dieldrin, and alpha-BHC) and PCBs were identified as COCs for human health in Boat Basin sediment. Sediment cleanup concentrations based on the fish ingestion scenario were calculated for these COCs, as described in Section 2.2.1.

Ecological COPCs were first established based on a risk screening of concentrations compared to screening values developed for each medium. The ecological COPCs were retained for the Step 3a refinement, which refines the list of COPCs from the SERA using less conservative benchmarks and more site-specific exposure assumptions to more realistically estimate potential risks to ecological receptors. Several concerns/issues were considered in the Step 3a refinement including the magnitude of criterion exceedance, the frequency of chemical detection, contaminant bioavailability, receptor habitat, alternate benchmarks, and more realistic food-chain models. Table 1-2 lists the ecological COCs at Site 17 that were retained after the Step 3a refinement.

2.2 PRELIMINARY REMEDIATION GOALS

PRGs are concentrations of contaminants in environmental media that, when attained, should achieve RAOs. PRGs are developed to make sure that contaminant concentrations left on site are protective of human receptors (based on future recreational land-use) and ecological receptors. In general, PRGs are established with consideration given to the following:

- Protecting human receptors from adverse health effects.
- Protecting the environment from detrimental impacts from site-related contamination.
- Compliance with federal and state ARARs.

Sediment PRGs were determined for the COCs identified in Tables 1-1 and 1-2 based on the following criteria:

- Protection of human health from exposure to contaminants in sediment via fish ingestion at concentrations exceeding PRGs.
- Protection of benthic invertebrates and fish from direct exposure to contaminants in sediment at concentrations exceeding PRGs.
- Protection of piscivorous birds consuming sediment invertebrates and fish potentially present in Pettibone Creek and the Boat Basin that may be exposed to contaminants in sediment at concentrations exceeding PRGs.

The development of the PRGs, also referred to as the sediment cleanup concentrations, is presented in the following sections.

2.2.1 Development of Cleanup Concentrations for Human Health

The results of the HHRA for Site 17 indicated that carcinogenic and noncarcinogenic risks for the recreational fisherman exceeded USEPA benchmarks mainly from consuming fish contaminated from the ingestion of sediment contaminated with PCBs and pesticides in the Boat Basin. The COCs in fish tissue included 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, alpha-BHC, dieldrin, Aroclor-1254, and Aroclor-1260. Site-specific cleanup concentrations protective of the recreational fisherman were developed for these COCs. The cleanup concentrations were developed for sediment based on the assumption that chemicals in sediment can bioaccumulate into fish. Therefore, the sediment cleanup concentrations are based on the potential indirect exposure to COCs in sediment via fish ingestion and are expected to be protective of this exposure pathway.

Based on the known future uses of the site (i.e., land use is not expected to change) and comments from Illinois EPA, human health PRGs protective of the recreational fisherman were developed using the exposure assumptions in Table 2-5.

In developing the PRGs protective of the recreational fisherman, it was assumed that the fish are continually ingest the contaminants in sediment in the Boat Basin. This assumption applies mainly to bottom-feeding fish such as carp and catfish that spend most of their time in the study area and would not apply to game fish, such as trout, that are not bottom feeders and whose range would not be confined to the Boat Basin. The fish ingestion scenario assumes that the recreational fisherman eats 20 grams of fish caught in the Boat Basin for 365 days per year and that the fish caught in the Boat Basin constitute 10 percent of the fish caught and consumed by the recreational fisherman. This is equivalent to eating approximately 1.5 pounds of fish per year obtained from the Boat Basin.

The State of Illinois has issued fish consumption advisories for Lake Michigan (http://www.idph.state.il.us/public/press97/fish97.htm) for salmon, trout, whitefish, perch, and bottom-feeding fish such as catfish and carp. Although the fish advisories indicate that some fish such as trout can be consumed on a restricted basis (e.g., one meal a month), they state that carp and catfish should not be consumed. The fish advisories are based on the assumption that one meal consists of one-half pound of fish. In the risk assessment for Site 17, recreational fishermen were assumed to eat approximately 1.5 pounds per year that corresponds to three meals per year according to the State (i.e., one meal equals one-half pound of fish).

The PRGs for fish tissue were developed using the exposure factors discussed above. The cleanup concentrations for sediment were derived from the fish tissue concentrations using the sediment bioaccumulation factors (BSAFs) and methodology described in the Site 17 RI/RA. The sediment cleanup concentrations are presented in Table 2-5.

2.2.2 Development of PRGs for Ecological Receptors

In determining the concentrations to use as PRGs, concentrations equivalent to lowest-observed-adverse-effects levels (LOAELs) rather than no-observed-adverse-effects levels (NOAELs) at Site 17 were compared to sediment toxicological benchmarks. There are three main reasons for this: (1) NOAELs alone do not give an accurate representation as to how much greater concentrations can be before adverse effects are seen; (2) NOAELs have more uncertainties associated with their use than do LOAELs (Sample et al., June 1996); and (3) LOAELs for effects on individuals of a population are expected to correspond to NOAELs on wildlife populations as a whole (Efryomson, et al., August 1997).

NOAELs and/or LOAELs could be used as PRGs and would cover a wide range of values. NOAELs are conservative because they represent the largest dose that produces "no effect" in a toxicity study or in a database of several toxicity studies. The use of a NOAEL as a threshold toxicity value estimates a point below which effects are unlikely and above which effects are uncertain. The uncertainty associated with site-related doses that lie between the NOAEL and LOAEL is often not acceptable for setting PRGs because of the expense and habitat disruption that is often involved in remediation to these PRGs. In order to avoid unnecessary remediation, LOAELs are often used to set PRGs. LOAELs, when used as threshold toxicity values, estimate points above which effects are likely, and below which effects are uncertain. LOAELs reflect the most sensitive species and the most sensitive appropriate endpoints available and therefore, a measure of conservativeness is retained.

In developing the ecological PRGs, the Tiered Approach for Evaluation and Remediation of Petroleum Product Releases to Sediments (Illinois EPA, September 2000) was used. This document provides options for developing cleanup objectives for sites where sediments have been impacted by petroleum product releases. The tiered approach allows for the consideration of site-specific conditions in the evaluation and development of remedial alternatives. Specifically, the Tier II values are a set of screening concentrations developed with the consideration of the actual nature of the sediments and the expected exposure potential of ecological receptors at Site 17. The Tier II values were first developed for Site 17 as a part of the ecological risk assessment and are presented in Table 7-2 of the RI/RA Report (TtNUS, September 2003). These Tier II values were preferentially chosen for use as the ecological PRGs.

The consensus-based probable effect concentrations (PECs) (MacDonald, et al., 2000) were chosen to supplement the Tier II values as the PRGs for the protection of aquatic receptors at Site 17 when a Tier II value for a chemical was not available. The consensus-based PECs were developed from multiple freshwater sediment studies conducted throughout the United States (MacDonald et al., 2000). The PECs indicate concentrations above which adverse effects are expected to occur compared to the threshold effects concentrations (TECs) that are intended to identify contaminant concentrations below which harmful effects on sediment-dwelling organisms are not expected. These ecological PRGs were chosen and approved for use by representatives of the Navy and Illinois EPA. Table 2-6 is a summary of the aquatic receptor PRGs and their sources.

Additionally, PRGs were developed for the protection of piscivorous birds because it was determined during the Site 17 RI/RA (TtNUS, September 2003) that risks to these receptors from exposure to pesticide and metal concentrations in sediment of Pettibone Creek and the Boat Basin were possible. Risks to carnivorous mammals were also evaluated during the Site 17 RI/RA; however, no COCs were retained after the Step 3a evaluation for these receptors. The dose intake equation and the risk calculation equation in Sections 7.3 and 7.4, respectively, of the Site 17 RI/RA report (TtNUS, September 2003) were rearranged so that a sediment risk level could be calculated based on an EEQ of 1.0. Additionally, risks to piscivorous birds from exposure to contaminants in surface water of Pettibone Creek and the Boat Basin were also evaluated; however, only minimal risks were identified, and no COCs were retained after the Step 3a evaluation. For this reason, surface water was not included in the following equation developed for the PRG calculation for piscivorous birds:

$$PRG_{fcm} = \frac{BW * LOAEL * EEQ}{[(BSAF_f \frac{\%L}{\%TOC} * If) + Is] * AUF} \quad \textit{(pesticides)}$$

$$PRG_{fcm} = \frac{BW * LOAEL * EEQ}{[(BAF_f * If) + Is] * AUF} \quad \textit{(inorganics)}$$

Where:

PRG_{fcm}	=	Preliminary Remediation Goal based on food-chain modeling as contaminant concentration in sediment (mg/kg, dry weight)
BW	=	Average body weight (kg)
LOAEL	=	Lowest Observed Adverse Effect Level (mg/kg-day)
EEQ	=	Ecological Effects Quotient (assumed = 1.0)
BAF_f	=	Biota-Accumulation Factor (sediment to fish, unitless)
$BSAF_f$	=	Biota-Sediment Accumulation Factor (sediment to fish, unitless)
%L	=	Average percent lipids in the fish tissue
%TOC	=	Average percent total organic carbon in the sediment
If	=	Average ingestion rate of food (kg/day, wet weight)
Is	=	Average rate of incidental sediment ingestion (kg/day, dry weight)
AUF	=	Area Use Factor (assumed 10% or 0.10, unitless)

The PRG calculation assumes that the belted kingfisher's diet was comprised of 100 percent fish. An AUF of 10 percent was used to calculate the PRG because of the relatively low abundance of fish in Pettibone Creek and the small area of the Boat Basin compared to the larger home range for piscivorous birds. The percent lipid (%L) value used in the PRG calculation was 3.56 percent, which was calculated from whole fish percent lipid values in the literature for species potentially present in Pettibone Creek [see Appendix E.3 of the Site 17 RI/RA (TtNUS, September 2003)]. The percent TOC values used in the PRG calculations were the average TOC concentrations for each area; the percent TOC for the North Branch was 0.39 percent, the percent TOC for the South Branch was 0.529 percent, and the percent TOC for the Boat Basin was 0.642 percent. The LOAEL used to develop the PRGs for 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT was different than the LOAEL used in the Site 17 ERA based on additional information that was reviewed. The LOAEL as cited in Sample et al., (1996), and used in the Site 17 RI/RA was 0.028 mg/kg-day based on a study conducted by Anderson et al., (1975). The study by Anderson et al., (1975) is cited in the Great Lakes Water Quality Initiative Criteria Documents for the Protection of Wildlife, DDT; Mercury;

2,3,7,8-TCDD; and PCBs (USEPA, 1995). The LOAEL in this Great Lakes report is listed as 0.027 mg/kg-day because of slight differences in the way it was calculated. As part of the sensitivity analysis presented in this report, the lag time between when the total DDT concentrations decline in anchovies, and when a response was noted in the fledging success of pelicans was evaluated. By assuming a two-year lag time, a LOAEL of 0.2 mg/kg-day was calculated and by assuming a one-year lag time, a LOAEL of 0.052 mg/kg-day was calculated. The LOAEL of 0.052 mg/kg-day was used to develop the PRGs, which is calculated using the more conservative of the two lag time assumptions. If the PRGs were calculated using the LOAEL of 0.028 mg/kg-day, they would be about two times lower than the PRGs using the LOAEL of 0.052 mg/kg-day.

The resulting PRG_{fcm} values are the allowable constituent concentration in the sediment over the exposure area. Chemical concentrations at individual sample locations may be greater than the PRG_{fcm} without causing a risk to piscivorous birds because piscivorous birds feed on fish that have accumulated chemicals from the sediment over an exposure area and not from a single sediment location. Table 2-7 presents a summary of the PRG_{fcm} values.

2.2.3 Determining the Extent of Remediation Required to Achieve PRGs

COCs for human health were based on ingestion of fish caught in the Boat Basin. The risks for fish ingestion were based on 95-percent Upper Confidence Limits (UCLs) over the entire Boat Basin, with Aroclor-1254 being the primary risk driver. Sediment PRGs were derived from fish tissue concentrations that were within USEPA benchmark values. Since fish swim throughout the Boat Basin (as well as in and out of the Boat Basin), the site-specific PRGs were not compared to sediment concentrations at individual locations but rather to averages or UCLs. Based on the risk assessment for the Boat Basin, the average sediment concentration across the Boat Basin for Aroclor-1254 should be less than 0.004 mg/kg. A comparison of the analytical sediment data with this PRG indicates that the Aroclor-1254 concentrations at several locations exceed 0.004 mg/kg, indicating the need for removal across the entire Boat Basin.

In order to determine the extent of remediation required to achieve ecological PRGs, chemical concentrations detected at each sample location were compared to the PRGs for benthic invertebrates. This point-by-point comparison was made because benthic invertebrates are unlikely to move between sample locations (approximately 100 to 150 feet apart) typically exposed to small areas of sediment. Tables 2-8 and 2-9 present a comparison of the PRGs for aquatic receptors to sediment concentrations at each location in the Boat Basin and the North Branch of Pettibone Creek, respectively. These tables only present comparisons to the chemicals detected at each location that were also retained as COCs. As seen on Table 2-8, every sample location within the Boat Basin exceeds multiple PRGs, indicating the need for removal across the entire Boat Basin. Three locations, NTC17BBSD50, NTC17BBSD53, and NTC17BBSD55 have pesticide exceedances only. No other contaminant concentrations at these locations exceed PRGs for benthic invertebrates. As shown on Table 2-9, the sample locations in the North Branch of Pettibone Creek exceed at least two PRGs. Six locations have pesticide exceedances only; however, these locations are adjacent to samples exceeding other PRGs.

2.3 GENERAL RESPONSE ACTIONS AND ACTION-SPECIFIC ARARs

GRAs are broadly defined remedial approaches that may be used (by themselves or in combination with one or more others) to attain the RAOs. Action-specific ARARs and TBCs are those regulations, criteria, and guidances that must be complied with or taken into consideration during remedial activities on site.

2.3.1 General Response Actions

GRAs describe categories of actions that could be implemented to satisfy or address a component of an RAO for the site. Remedial action alternatives will then be composed using GRAs individually or in combination to meet the remedial action objectives. The RAOs, composed of GRAs, will be capable of achieving the RAOs for contaminated sediment at Site 17.

The following GRAs were be considered for sediment:

- No Action
- Limited Action (Institutional Controls and Monitoring)
- Containment
- Removal
- In-Situ Treatment
- Ex-Situ Treatment
- Disposal

2.3.2 Action-Specific ARARs

Action-specific ARARs and TBCs are technology- or activity-based regulatory requirements or guidance that would control or restrict remedial action. Tables 2-10 and 2-11 present respective lists of federal and State action-specific ARARs and TBCs for this FS.

2.4 ESTIMATED VOLUMES OF CONTAMINATED SEDIMENT

For remedial action purposes, preliminary volumes of contaminated sediment were estimated from samples that contained contaminants at concentrations that exceeded PRGs for current and potential future recreational land use.

The volume of contaminated sediment in the North Branch of Pettibone Creek area of Site 17 assuming a depth of 2 feet below ground surface (bgs) and an area of 77,800 square feet (based on data from the RI/RA investigation) is 5,763 yd^3 (see Appendix A for the calculations). The volume of contaminated sediment at the Lower Boat Basin, assuming a depth of 8 feet bgs and an area of 20,275 square feet is 6,007 yd^3. The volume of contaminated sediment at the Upper Boat Basin, assuming a depth of 10 feet bgs and an area of 74,350 square feet, is 27,537 yd^3. The areas of contamination are generally widespread with discrete areas of higher concentrations not always coincident for each of the COCs.

2.5 UNCERTAINTIES IN THE FEASIBILITY STUDY

There are several uncertainties with the human health and ecological PRGs used to establish practicable limits for possible future remedial activities and associated volumes of contaminated sediment to be addressed. This section discusses each of those uncertainties.

2.5.1 Pesticides and PAHs

The concentrations of pesticides in the sediment, although greater than the human health and ecological PRGs, are consistent with concentrations from typical spraying activities, i.e., the concentrations are not indicative of spills or other past disposal practices. Although it may not be appropriate to remediate Pettibone Creek and the Boat Basin for pesticides if they cannot be tied to an unauthorized release, there are only a few locations where pesticides are the only chemicals detected at concentrations greater than PRGs as discussed in Section 2.2.3 (see Tables 2-8 and 2-9).

PAHs detected in the sediment may be due to a variety of sources including runoff from roads and parking lots. As can be see from Tables 2-8 and 2-9, there in only one location where PAHs are the only chemicals detected at concentrations greater than PRGs.

Therefore, remediation of the areas with only pesticide concentrations or only PAH concentrations that exceed the PRGs will not significantly add to the cost. In addition, because of the movement of the sediment, these areas may have changed or now have elevated concentrations of other chemicals.

2.5.2 Potential Recontamination

Before either North Branch of Pettibone Creek or the Boat Basin is remediated, the potential source areas of contamination to the creek and/or Boat Basin need to be evaluated to determine the potential for recontamination of the site. Most of the upstream industries have closed and are no longer discharging chemicals to the creek through permitted discharges. However, there may be residual contamination at these sites that may add contamination to the surface water. Examples of the potential sources of contamination include surface water runoff from waste piles and discharge of contaminated groundwater. Also, as discussed above, because the sources of PAHs in the sediment include runoff from roads and parking lots, the sediment may become recontaminated with PAHs. Therefore, the potential for recontaminating the sediment with PAHs and/or other chemicals from runoff and/or residual contamination at the upstream sites needs to be considered in the decision to remediate the site.

2.5.3 Fish Advisories

The Illinois Department of Public Health has developed fish advisories for Lake Michigan. Most of the fish collected in the Boat Basin that may be consumed by humans are larger fish that likely did not spend their entire life in the Boat Basin. Therefore, the amount of chemicals that have bioaccumulated in these fish from the Boat Basin sediment are likely to be a small portion of their total chemical loading. For that reason, even if the Boat Basin were remediated, the fish advisory for Lake Michigan fish would still be in effect for people fishing in the Boat Basin. The fish advisories are voluntary and cannot be enforced, and they may have no impact upon human fish consumption. However, the remediation of the Boat Basin would remove a potential source area of contamination to Lake Michigan.

2.5.4 Site-Specific PRGs

The PRGs selected for protecting benthic invertebrates are literature values; they were not developed using site-specific toxicity data. Literature values typically should not be used as cleanup concentrations except in cases where the development of cleanup concentrations would cost more than the remedial action. The reason is that site-specific conditions can make the chemicals in the sediment either more or less toxic that predicted by the screening levels. For example, although most of the samples at a site may have chemical concentrations greater than a literature-based PRG, it is possible that the sediment is not toxic and does not need remediation. For Site 17, several of the sediment samples have chemical concentrations greater than PRGs. Because the costs associated with remediating those sediments are high, it is recommended that site-specific cleanup concentrations be developed before proceeding with a remedial action.

As discussed in Section 8 of the Site 17 RI/RA (TtNUS, September 2003), risks from the ingestion of fish may have been overestimated because the calculated fish tissue concentrations using sediment to fish bioaccumulation factors are likely to have been overestimated. Therefore, there is uncertainty in remediation of the sediment using PRGs based fish tissue concentrations for this reason as well as the reasons discussed above in Section 2.5.3.

TABLE 2-1

FEDERAL CHEMICAL-SPECIFIC ARARs
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
RCRA Regulations, Identification, and Listing of Hazardous Wastes	40 CFR Part 261	Potentially Relevant and Appropriate	Defines the listed and characteristic hazardous wastes subject to RCRA. Appendix II contains the Toxicity Characteristic Leaching Procedure.	These regulations would apply when determining whether or not a solid waste is hazardous, either by being listed or by exhibiting a hazardous characteristic, as described in the regulations.
CSFs	-	TBC	CSFs are guidance value used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	CSFs would be considered for development of human health protection PRGs for sediment and fish tissue at this site.
RfDs	-	TBC	RfDs are guidance values used to evaluate the potential noncarcinogenic hazard caused by exposure to contaminants.	RfDs would be considered for development of human health protection PRGs for sediment and fish tissue at this site.
Sediment Quality Guidelines	Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems	TBC	The consensus-based numbers are geometric means of sediment screening levels that were developed as part of other studies.	There are no federal ARARs for sediment, so Illinois EPA agreed to use the consensus-based probable effects concentrations (PECs) to supplement the Tier II values as the PRGs for the site, when necessary.

TABLE 2-2

STATE CHEMICAL-SPECIFIC ARARs
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Contaminant Cleanup Target Levels	State of Illinois Title 35: Environmental Protection Subtitle G: Chapter I: Subchapter F: Risk Based Cleanup Objectives, Part 742 TACO	TBC	This document provides guidance for developing cleanup levels that can be developed on a site-by-site basis.	These guidelines would be used in determining cleanup goals.
State of Illinois Fish Advisories for Lake Michigan	Illinois Department of Public Health http://www.idph.state.il.us/envhealth/fishadv/fishadvisory03.htm	TBC	Meal advisories for fish based primarily on protecting sensitive populations, particularly women of childbearing age, pregnant women, fetuses, nursing mothers and children younger than 15 years of age. The advisories may be overprotective for women beyond childbearing age and males 15 years of age and older.	These guidelines are used when evaluating the potential harm posed by ingesting fish caught in the Boat Basin.
Tier 2 Sediment Cleanup Levels	Tiered Approach for Evaluation and Remediation of Petroleum Product Releases to Sediments	TBC	This document outlines options for evaluating and, if necessary, developing cleanup objectives for sediments impacted by releases of petroleum products which are overseen by the office of Toxicity Assessment Unit at Illinois EPA.	These guidelines would be used in determining ecological cleanup levels.

TABLE 2-2

STATE CHEMICAL-SPECIFIC ARARs
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Lake Michigan Basin Water Quality Standards	Illinois Regulatory Guidance http://risk.lsd.ornl.gov/cgi-bin/guide/ARAR_select?select=il	TBC	This document contains values based on acute, chronic, acute and chronic aquatic life standards for bioaccumulative COCs, wildlife standards and human health standards for bioaccumulative COCs, and open waters of Lake Michigan.	These guidelines would be used in determining cleanup levels.
Water Quality Standards	Illinois Regulatory Guidance http://risk.lsd.ornl.gov/cgi-bin/guide/ARAR_select?select=il	TBC	This document outlines general use water quality standards for aquatic life, acute and chronic. It also contains standards based on Secondary Contact and Indigenous Aquatic Life Standard.	These guidelines would be used in determining cleanup levels.

TABLE 2-3

FEDERAL LOCATION-SPECIFIC ARARs
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Endangered Species Act Regulations	50 CFR Parts 81, 225, 402	Potentially Applicable	This act requires federal agencies to take action to avoid jeopardizing the continued existence of federally listed endangered or threatened species.	If a site investigation or remediation could potentially affect an endangered species or their habitat, these regulations would apply.
Historic Sites Act Regulations	36 CFR Part 62	Potentially Applicable	Requires federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks.	The existence of natural landmarks would be identified prior to remedial activities onsite including remedial investigations.
Fish and Wildlife Coordination Act Regulations	33 CFR Subsection 320.3	Potentially Applicable	Requires that the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and related state agencies be consulted prior to structural modification of any body of water, including wetlands. If modifications must be conducted, the regulation requires that adequate protection be provided for fish and wildlife resources.	If a remedial alternative involves the alteration of a stream or wetland, these agencies would be consulted.

TABLE 2-3

FEDERAL LOCATION-SPECIFIC ARARs
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
National Environmental Policy Act (NEPA) Regulations, Wetlands, Floodplains, etc.	40 CFR Subsection 6.302 [a]	Potentially Applicable	These regulations contain the procedures for complying with Executive Order 11990 on wetlands protection. Appendix A states that no remedial alternative adversely affect a wetland if another practicable alternative is available. If no alternative is available, impacts from implementing the chosen alternative must be mitigated.	If remedial action affects a wetland, these regulations would apply.
NEPA Regulations, Floodplain Management, Executive Order 11988	40 CFR Part 6, Appendix A	Potentially Applicable	Appendix A describes the policy for carrying out the Executive Order regarding floodplains. If no practicable alternative exists to performing cleanup in a floodplain, potential harm must be mitigated and actions taken to preserve the beneficial value of the floodplain.	If removal actions take place in a floodplain, alternatives would be considered that would reduce the risk of flood loss and restore and preserve the floodplain.
Fish and Wildlife Conservation Act	40 CFR Section 6.302	Potentially Applicable	Requires action to be taken to protect fish and wildlife from projects affecting streams or rivers.	United States Fish and Wildlife Service officials would be consulted on how to minimize impacts of any remedial activities on any wildlife.

TABLE 2-4

STATE LOCATION-SPECIFIC ARARs
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Illinois Wetlands Protection Program	Chapter 20 DNR, Act 830	Potentially Applicable	Illinois Interagency Wetland Policy Act of 1989 - These regulations contain the procedures for complying with wetlands protection.	If a remedial action could potentially affect a wetland, this policy would be considered.
Illinois Threatened and Endangered Species	520 ILCS 10/1	Potentially Applicable	Illinois Endangered Species Act - This act requires actions to avoid jeopardizing the continued existence of state listed endangered or threatened species.	This act would be considered in conjunction with the federally listed endangered species, if a site investigation or remediation could potentially affect a state listed threatened or endangered species.

TABLE 2-5

SUMMARY OF HUMAN HEALTH RISK-BASED CLEANUP CONCENTRATIONS
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Chemical of Concern	Risk-Based Cleanup Level	
	Fish Tissue[1] (mg/kg)	Sediment[2] (mg/kg)
4,4'-DDD	0.3	0.2
4,4'-DDE	0.2	0.006
4,4'-DDT	0.2	0.03
ALDRIN	0.005	0.0005
ALPHA-BHC	0.01	0.001
DIELDRIN	0.005	0.0005
AROCLOR-1254	0.04	0.004
AROCLOR-1260	0.04	0.004

1 Acceptable fish tissue concentrations based on the following:
- Target Cancer Risk = 1.0×10^{-6}
- Exposure Frequency = 365 days/year
- Exposure Duration = 30 years
- Fraction from Contaminated Source = 0.1
- Recreational Fish Ingestion Rate = 20 g/day
- Body Weight = 70 kg

2 Derived from Fish Tissue Cleanup Levels using chemical-specific biota sediment accumulation factors (BSAFs).

TABLE 2-6

SUMMARY OF AQUATIC RECEITPR PRGs
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Parameter	PRG	Source[1]
PAHs (ug/kg)		
ANTHRACENE	960	Tier II
BENZALDEHYDE	4	Tier II
BENZO(A)ANTHRACENE	1,600	Tier II
BENZO(A)PYRENE	2,500	Tier II
BENZO(B)FLUORANTHENE	NV	--
BENZO(G,H,I)PERYLENE	NV	--
CARBAZOLE	400	Tier II
CHRYSENE	2,800	Tier II
FLUORANTHENE	9,920	Tier II
FLUORENE	640	Tier II
INDENO(1,2,3-CD)PYRENE	NV	--
PHENANTHRENE	2,880	Tier II
PYRENE	2,200	Tier II
TOTAL PAHs	35,000	Tier II
Pesticides/PCBs (ug/kg)		
4,4'-DDD	20	Tier II
4,4'-DDE	15	Tier II
4,4'-DDT	7	Tier II
total DDT	572	PEC
AROCLOR-1254	676	PEC
AROCLOR-1260	676	PEC
ENDOSULFAN I	0.5	Tier II
ENDOSULFAN II	0.5	Tier II
Inorganics (mg/kg)		
COPPER	149	PEC
LEAD	128	PEC
MERCURY	1.06	PEC
ZINC	459	PEC

1 - Source of the Tier II PRGs is Illinois EPA, September 2000 and the source of the PEC PRGs is MacDonald et al., 2000.
NV - No value

TABLE 2-7

TERRESTRIAL WILDLIFE MODEL PRG CALCULATION
BELTED KINGFISHER - AVERAGE INPUTS
NAVAL STATION GREAT LAKES, ILLINOIS

Parameter	PRG(1) (mg/kg)	Biotransfer Factor (sed to fish)	% TOC	LOAEL (mg/kg/day)
Pesticides				
SOUTH BRANCH				
4,4'-DDE	2.21E-02	7.70E+00	5.29E-01	5.20E-02
4,4'-DDT	1.02E-01	1.67E+00	5.29E-01	5.20E-02
NORTH BRANCH				
4,4'-DDD	4.45E-01	2.80E-01	3.90E-01	5.20E-02
4,4'-DDE	1.63E-02	7.70E+00	3.90E-01	5.20E-02
4,4'-DDT	7.52E-02	1.67E+00	3.90E-01	5.20E-02
BOAT BASIN				
4,4'-DDD	7.29E-01	2.80E-01	6.42E-01	5.20E-02
4,4'-DDE	2.69E-02	7.70E+00	6.42E-01	5.20E-02
4,4'-DDT	1.24E-01	1.67E+00	6.42E-01	5.20E-02
Inorganics				
SOUTH BRANCH, NORTH BRANCH, BOAT BASIN				
CHROMIUM	1.08E+02	1.00E+00	NA	5.00E+00
COPPER	1.33E+03	1.00E+00	NA	6.17E+01
LEAD	2.44E+02	1.00E+00	NA	1.13E+01
MERCURY	1.38E+00	1.00E+00	NA	6.40E-02
ZINC	2.83E+03	1.00E+00	NA	1.31E+02

Average Exposure Assumptions (Belted Kingfisher):

Body Weight = (BW) 0.152 kg
Food Ingestion Rate = (If) 0.069 kg/day
Sediment Ingestion Rate = (Is) 0.001378 kg/day

Footnotes:

1- The PRG is the average sediment concentration based on a LOAEL EEQ of 1.0.

Definitions:

EEQ - Ecological Effects Quotient
LOAEL - Lowest Observed Adverse Effects Level
BSAF = Biota Sediment Accumulation Factor

$$PRG(pesticides) = \frac{BW*LOAEL*EEQ}{[(BSAF)(\%L)(If)/(\%TOC) + Is]*AUF}$$

$$PRG(inorganics) = \frac{BW*LOAEL*EEQ}{(BSAF*If + Is)*AUF}$$

where:

% lipid (wet weight) =3.56
Area Use Factor (AUF) = 10% or 0.10

TABLE 2-8

COMPARISON OF PRGS FOR AQUATIC RECEPTORS TO SEDIMENT - BOAT BASIN
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS
PAGE 1 OF 2

PARAMETER[1]	PRG[2]	SAMPLE LOCATION					
		NTC17BBSD4501	NTC17BBSD4601	NTC17BBSD4701	NTC17BBSD4801	NTC17BBSD4901	NTC17BBSD5001
SEMIVOLATILE ORGANICS (UG/KG)							
ANTHRACENE	960	1800	1900	240	190	49	89
BENZO(A)ANTHRACENE	1,600	4900	3300	670	680	250	380
BENZO(A)PYRENE	2,500	4500	2700	550	680	260	360
BENZO(B)FLUORANTHENE	NV	4500	2700	590	680	280	370
BENZO(G,H,I)PERYLENE	NV	2800	1500	330	630	200	250
CHRYSENE	2,800	4900	3100	730	670	270	390
FLUORANTHENE	9,920	14000	10000	2400	1900	730	960
FLUORENE	640	1300	1300	220	120	51	40
PHENANTHRENE	2,880	10000	9700	2000	1000	380	510
PYRENE	2,200	11000	7700	1800	1300	560	850
TOTAL PAHS	35,000	64360	47550	10166	8590	3354	4635
PESTICIDES/PCBs (UG/KG)							
4,4'-DDD	20	89	82	100	310	76	110
4,4'-DDE	15	85	60	68	230	55	55
4,4'-DDT	7	87	42	120	67	43	86
TOTAL DDT	572	261	184	288	607	174	251
AROCLOR-1254	676				660	88	
AROCLOR-1260	676	49			270		
ENDOSULFAN I	0.5	0.68	1.1	4.6	8.7		2.5
ENDOSULFAN II	0.5	3.6	2.8		7.5		
INORGANICS (MG/KG)							
COPPER	149	78.5	79.6	90	283	232	60.6
LEAD	128	81.6	88.4	66.7	289	149	72.6
ZINC	459	367	525	535	1050	2070	387

TABLE 2-8

COMPARISON OF PRGS FOR AQUATIC RECEPTORS TO SEDIMENT - BOAT BASIN
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

PARAMETER(1)	PRG(2)	SAMPLE LOCATION					
		NTC17BBSD5101	NTC17BBSD5201	NTC17BBSD5301	NTC17BBSD5401	NTC17BBSD5501	NTC17BBSD5601
SEMIVOLATILE ORGANICS (UG/KG)							
ANTHRACENE	960	110	620	110	180	360	360
BENZO(A)ANTHRACENE	1,600	350	1900	390	380	770	1000
BENZO(A)PYRENE	2,500	370	1700	430	400	690	900
BENZO(B)FLUORANTHENE	NV	410	1600	400	370	700	1100
BENZO(G,H,I)PERYLENE	NV	270		210		410	700
CHRYSENE	2,800	390	1800	380	380	720	1100
FLUORANTHENE	9,920	1100	4500	1000	1100	2200	3200
FLUORENE	640	54	270	53	76	170	330
PHENANTHRENE	2,880	710	2600	540	700	1400	2300
PYRENE	2,200	720	3600	640	740	1500	2300
TOTAL PAHS	35,000	4934	20360	4573	4726	9640	14420
PESTICIDES/PCBs (UG/KG)							
4,4'-DDD	20	73	190	80	71	140	82
4,4'-DDE	15	62	140	59	57	100	67
4,4'-DDT	7	90		34	58	73	43
TOTAL DDT	572	225	330	173	186	313	192
AROCLOR-1254	676					400	79
AROCLOR-1260	676					170	
ENDOSULFAN I	0.5	1.2	7.7	1.8	1.1	2.8	
ENDOSULFAN II	0.5	1.9	12	1.6	0.94	8.2	2.7
INORGANICS (MG/KG)							
COPPER	149	83.1	78.8	55.5	150	125	73.2
LEAD	128	77.3	56.4	47.6	130	88.1	61.9
ZINC	459	623	531	255	976	378	247

1 - The parameter list consists of only those chemicals retained as COCs in sediment at the Boat Basin.
2 - See Table 2-6 for the source of the PRGs.

Cells are shaded black when the detected concentration exceeds the PRG.
NV = No Value

TABLE 2-9

COMPARISON OF PRGS FOR AQUATIC RECEPTORS TO SEDIMENT - NORTH BRANCH PETTIBONE CREEK
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

PARAMETER[1]	PRG[2]	SAMPLE LOCATION					
		NTC17PCSD0101	NTC17PCSD0201	NTC17PCSD0301	NTC17PCSD0401	NTC17PCSD0501	NTC17PCSD0601
SEMIVOLATILE ORGANICS (UG/KG)							
ANTHRACENE	960	4000	930	410	120	320	58
BENZALDEHYDE	4				1500		
BENZO(A)ANTHRACENE	1,600	11000	2400	1400	560	1000	440
BENZO(A)PYRENE	2,500	11000	2300	1500	570	1100	460
BENZO(B)FLUORANTHENE	NV	12000	2400	1500	650	1200	490
BENZO(G,H,I)PERYLENE	NV	7500	1600	1200	530	930	230
CAPROLACTAM	NV						
CARBAZOLE	400				150		
CHRYSENE	2,800	12000	2400	1500	600	1000	480
FLUORANTHENE	9,920	33000	7400	4600	1500	3000	1000
FLUORENE	640	2400	570	320	62	190	40
PHENANTHRENE	2,880	24000	4800	2600	730	1700	460
PYRENE	2,200	27000	5500	3400	1200	2300	890
TOTAL PAHs	35,000	156000	32540	20009	8952	13950	5088
PESTICIDES/PCBs (UG/KG)							
4,4'-DDD	20	25	7.2	63	120	150	3.7
4,4'-DDE	15	36	66	110	130	200	5.1
4,4'-DDT	7	32	51	190	240	1800	4.9
ENDOSULFAN II	0.5	12		4.1	7.4		0.52
INORGANICS (MG/KG)							
COPPER	149	368	477	222	181	225	129
LEAD	128	322	144	213	181	117	123
MERCURY	1.06	0.94	0.17	0.25	0.32	0.17	0.09
ZINC	459	1140	1390	774	836	1030	899

TABLE 2-9

COMPARISON OF PRGS FOR AQUATIC RECEPTORS TO SEDIMENT - NORTH BRANCH PETTIBONE CREEK
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

PARAMETER(1)	PRG(2)	SAMPLE LOCATION					
		NTC17PCSD0701	NTC17PCSD0801	NTC17PCSD0901	NTC17PCSD1001	NTC17PCSD1101	NTC17PCSD1201
SEMIVOLATILE ORGANICS (UG/KG)							
ANTHRACENE	960	75	73	61	820	1100	120
BENZALDEHYDE	4						
BENZO(A)ANTHRACENE	1,600	470	430	390	2000	2900	340
BENZO(A)PYRENE	2,500	530	470	470	2100	2700	300
BENZO(B)FLUORANTHENE	NV	580	510	460	2100	2800	300
BENZO(G,H,I)PERYLENE	NV	430	420	360	1500	1500	200
CAPROLACTAM	NV						
CARBAZOLE	400						
CHRYSENE	2,800	530	470	410	2100	2900	360
FLUORANTHENE	9,920	1200	1100	950	5900	8400	1000
FLUORENE	640	56	74	46	440	850	110
PHENANTHRENE	2,880	670	630	490	3900	6400	820
PYRENE	2,200	1000	940	810	4400	6600	850
TOTAL PAHs	35,000	6231	5757	4977	27542	39250	4720
PESTICIDES/PCBs (UG/KG)							
4,4'-DDD	20	2.3	4.7	4.4	7.5	58	73
4,4'-DDE	15	4.3	11	20	20	110	53
4,4'-DDT	7	5.6	7.5	17	18	170	160
ENDOSULFAN II	0.5	0.58	0.55		0.82		
INORGANICS (MG/KG)							
COPPER	149	72.5	43.1	42.6	40	123	127
LEAD	128	76.7	73	30.8	68.3	120	142
MERCURY	1.06	0.04	0.05	0.31	0.07	0.45	0.13
ZINC	459	538	192	126	183	570	1110

TABLE 2-9

COMPARISON OF PRGS FOR AQUATIC RECEPTORS TO SEDIMENT - NORTH BRANCH PETTIBONE CREEK
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

PARAMETER[1]	PRG[2]	SAMPLE LOCATION					
		NTC17PCSD1301	NTC17PCSD1401	NTC17PCSD1501	NTC17PCSD1601	NTC17PCSD1701	NTC17PCSD1801
SEMIVOLATILE ORGANICS (UG/KG)							
ANTHRACENE	960	600	110	37	63	160	280
BENZALDEHYDE	4						
BENZO(A)ANTHRACENE	1,600	2000	440	150	240	530	630
BENZO(A)PYRENE	2,500	1900	410	130	240	500	510
BENZO(B)FLUORANTHENE	NV	1900	440	150	220	510	550
BENZO(G,H,I)PERYLENE	NV	1300	260	70	170	320	320
CAPROLACTAM	NV						57
CARBAZOLE	400		720		130		380
CHRYSENE	2,800	1900	430	150	230	490	590
FLUORANTHENE	9,920	5200	1200	380	650	1300	1700
FLUORENE	640	280	80	21	65	40	110
PHENANTHRENE	2,880	3100	720	210	430	590	1100
PYRENE	2,200	4200	930	310	500	980	1300
TOTAL PAHs	35,000	24400	6250	1769	3168	5920	8072
PESTICIDES/PCBs (UG/KG)							
4,4'-DDD	20	100	100	73	78	30	110
4,4'-DDE	15	110	150	68	130	46	130
4,4'-DDT	7	150	190	92	170	110	150
ENDOSULFAN II	0.5					1.8	
INORGANICS (MG/KG)							
COPPER	149	197	123	189	141	206	194
LEAD	128	155	108	106	130	135	162
MERCURY	1.06	0.22	4.7	0.16	0.12	0.08	0.12
ZINC	459	856	810	2120	797	1210	1290

TABLE 2-9

COMPARISON OF PRGS FOR AQUATIC RECEPTORS TO SEDIMENT - NORTH BRANCH PETTIBONE CREEK
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS
PAGE 4 OF 4

PARAMETER[1]	PRG[2]	SAMPLE LOCATION					
		NTC17PCSD1901	NTC17PCSD2001	NTC17PCSD2101	NTC17PCSD2201	NTC17PCSD2301	NTC17PCSD2401
SEMIVOLATILE ORGANICS (UG/KG)							
ANTHRACENE	960	290	100	120	240	150	400
BENZALDEHYDE	4						
BENZO(A)ANTHRACENE	1,600	760	450	380	990	470	930
BENZO(A)PYRENE	2,500	790	470	330	970	470	840
BENZO(B)FLUORANTHENE	NV	790	480	340	1000	450	870
BENZO(G,H,I)PERYLENE	NV	540	340	230	650		610
CAPROLACTAM	NV						
CARBAZOLE	400			75		250	
CHRYSENE	2,800	740	450	350	1000	450	890
FLUORANTHENE	9,920	2000	1200	940	2800	1300	2800
FLUORENE	640	120	92	77	180	76	170
PHENANTHRENE	2,880	1300	670	500	1600	730	1800
PYRENE	2,200	1500	940	720	2100	1000	2000
TOTAL PAHs	35,000	9590	5722	4420	12601	5929	12200
PESTICIDES/PCBs (UG/KG)							
4,4'-DDD	20	170	50	51	88	89	78
4,4'-DDE	15	210	68	42	90	91	89
4,4'-DDT	7	230	65	62	81	81	93
ENDOSULFAN II	0.5			1.1			
INORGANICS (MG/KG)							
COPPER	149	118	35.1	79.6	199	50.3	151
LEAD	128	109	44.2	45.5	104	57.6	60.3
MERCURY	1.06	0.61	0.04	0.06	0.09	0.09	0.09
ZINC	459	377	166	362	672	279	376

1 - The parameter list consists of only those chemicals retained as COCs in sediment at the North Branch of Pettibone Creek.
2 - See Table 2-6 for the source of the PRGs.

Cells are shaded black when the detected concentration exceeds the PRG.
NV = No Value

TABLE 2-10

FEDERAL ACTION-SPECIFIC ARARs
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
CWA, National Pollution Discharge Elimination System	40 CFR Parts 122 through 125, and 131	Potentially Relevant and Appropriate	National Pollution Discharge Elimination System permits are required for any discharges to navigable waters. If remedial activities include such a discharge, the National Pollution Discharge Elimination System standards would be ARARs.	Any alternative which would discharge into any navigable water would require compliance with these regulations including treatment, if necessary.
Occupational Safety and Health Act Regulations, General Industry Standards	29 CFR Part 1910	Applicable	Requires establishment of programs to assure worker health and safety at hazardous waste sites, including employee training requirements.	These regulations would apply to the response activities.
Occupational Safety and Health Act Regulations	29 CFR Part 1910, Subpart Z	Potentially Applicable	Establishes permissible exposure limits for workplace exposure to a specific listing of chemicals.	Standards are applicable for worker exposure to Occupational Safety and Health Act hazardous chemicals during remedial activities.
Occupational Safety and Health Act Regulations, Recordkeeping, Reporting, and Related Regulations	29 CFR Part 1904	Potentially Applicable	Provides recordkeeping and reporting requirements applicable to remedial activities.	These requirements apply to the site contractors and subcontractors and must be followed during the site work.
Occupational Safety and Health Act Regulations, Health and Safety Standards	29 CFR Part 1926	Potentially Applicable	Specifies the type of safety training, equipment, and procedures to be used during the site investigation and remediation.	Phases of the remedial response project would be executed in compliance with this regulation.

TABLE 2-10

FEDERAL ACTION-SPECIFIC ARARs
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Resource Conservation and Recovery Act (RCRA) Regulations, Contingency Plan and Emergency Procedures	40 CFR 264, Subpart D	Potentially Relevant and Appropriate	Outlines requirements for emergency procedures to be followed in case of an emergency.	The administrative requirements established in this rule would be met for remedial actions involving the management of hazardous waste.
CWA Regulations, National Pretreatment Standards	40 CFR Part 403	Potentially Relevant and Appropriate	Sets pretreatment standards through the National Categorical Standards of the General Pretreatment Regulations for the introduction of pollutants from non-domestic sources into publicly owned treatment works in order to control pollutants that pass through, cause interference, or are otherwise incompatible with treatment processes at a publicly owned treatment works.	If groundwater is discharged to a publicly owned treatment works, the discharge must meet local limits imposed by the publicly owned treatment works. A discharge from a CERCLA site must meet the publicly owned treatment works pretreatment standards in the effluent of the publicly owned treatment works. Discharge to a publicly owned treatment works is considered an offsite activity and is, therefore subject to both the substantive requirements of this rule.
RCRA Regulations, General Facility Standards	40 CFR Subpart B, 264.10-264.18	Potentially Relevant and Appropriate	Sets the general facility requirements including general waste analysis, security measures, inspections, and training requirements. Section 264.18 establishes that a facility located in a 100-year floodplain must be designed, constructed, and maintained to prevent washout of any hazardous wastes by a 100-year flood.	If the remedial action involves construction of an onsite treatment facility, such as a groundwater treatment facility, the substantive requirements of this rule would be applicable requirements. A permitted treatment facility must be selected for offsite treatment. These regulations do not apply to the aboveground treatment or storage of hazardous waster before it is injected into underground. However, this rule may be an applicable requirement for alternatives that do not involve groundwater reinjection.

TABLE 2-10

FEDERAL ACTION-SPECIFIC ARARs
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
RCRA Regulations, Miscellaneous Units	40 CFR Part 264, Subpart X	Potentially Relevant and Appropriate	These standards are applicable to miscellaneous units not previously defined under existing RCRA regulations. Subpart X outlines performance requirements that miscellaneous units be designed, constructed, operated, and maintained to prevent releases to the subsurface, groundwater, and wetland that may have adverse effects on human health and the environment.	The design of proposed treatment alternatives, not specifically regulated under other subparts of RCRA, must prevent the release of hazardous constituents and future impacts on the environment. This subpart would apply to onsite construction of any treatment facility that is not previously defined under the RCRA regulation.
RCRA Regulations, Preparedness and Prevention	40 CFR Part 264, Subpart C	Potentially Relevant and Appropriate	Outlines requirements for safety equipment and spill control for hazardous waste facilities. Facilities must be designed, maintained, constructed, and operated to minimize the possibility of an unplanned release that could threaten human health or the environment.	Safety and communication equipment would be incorporated into aspects of the remedial process and local authorities would be familiarized with site operations.
RCRA Regulations, Releases from Solid Waste Management Units	40 CFR Part 264, Subpart F	Potentially Relevant and Appropriate	Establishes the requirements for Solid Waste Management Units at RCRA regulated treatment, storage, and disposal facility (TSDFs). The scope of the regulation encompasses groundwater protection standards, point of compliance, compliance period, and requirements for groundwater monitoring.	These regulations would be followed for the treatment of hazardous waste.

TABLE 2-10

FEDERAL ACTION-SPECIFIC ARARs
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
RCRA Regulations, Standards for Owners and Operators of Hazardous Waste TSDFs	40 CFR Part 264	Potentially Relevant and Appropriate	Establishes minimum national standards defining the acceptable management of hazardous wastes for owners and operators of facilities that treat, store, or dispose of hazardous wastes.	If remedial actions involving management of RCRA wastes at an off-site TSDF or if RCRA wastes are managed onsite, the requirements of this rule would be followed.
RCRA Regulations, Use and Management of Containers	40 CFR Part 264, Subpart I	Potentially Relevant and Appropriate	Sets standards for the storage of containers of hazardous waste.	This requirement would apply if a remedial alternative involves the storage of a hazardous waste (i.e. contaminated groundwater) in containers, prior to treatment.
SWDA Regulations, Underground Injection Control Regulations	40 CFR Parts 144, 146, 147, and 1000	Potentially Relevant and Appropriate	Establishes minimum program and performance standards for underground injection programs. Technical criteria and standards for siting, operation, maintenance, reporting, and recordkeeping are included in Part 146. Also requires protection of underground sources of drinking water.	Discharge of treated groundwater, by well injection, would be in accordance with the criteria and standards in these regulations, as well as meet the State Underground Injection Control Program requirements. Treated groundwater would meet the SWDA standards for reinjection prior to well injection.

TABLE 2-11

STATE ACTION-SPECIFIC ARARs
SITE 17 FEASIBILITY STUDY REPORT
NAVAL STATION GREAT LAKES, ILLINOIS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Illinois Waste Disposal (Hazardous)	Illinois Administrative Code Title 35 Subtitle G Chapter I Subchapter C	Potentially Applicable	Adopts by reference sections of the Federal hazardous waste regulations and establishes minor additions to these regulations concerning the generation, storage, treatment, transportation and disposal of hazardous wastes.	These regulations would apply if waste onsite were deemed hazardous and needed to be stored, transported, or disposed of properly.
Illinois Drinking Water Standards	Illinois Administrative Code Title 35 Subtitle F Chapter I Subchapter C	Potentially Applicable	This rule adopts Federal primary and secondary drinking water standards	These regulations would apply to remedial activities that involve discharges to potential sources of drinking water.
Illinois Wetland Policy Act, 1989	Appendix A Chapter 20 Act 830	Potentially Applicable	Sets requirements for discharge of domestic wastewater to wetland. This rule mainly addresses the discharge of domestic wastewater to wetlands. Discharge limits are established for biochemical oxygen demand, total suspended solids, nitrogen, and phosphorus.	This rule would be considered for remedial alternatives that would result in discharges to wetlands where these limits may be approached.
Illinois National Pollution Discharge Elimination System	Illinois Administrative Code Title 35 Subtitle C Chapter II	Potentially Applicable	This rule establishes requirements for wastewater permits.	Facilities in Illinois requiring a wastewater permit will meet the permitting requirements under this rule. Because of Illinois being a "delegated" state, facilities will be allowed to have a single permit to meet both Federal and State discharge requirements.

TABLE 2-11

STATE ACTION-SPECIFIC ARARs
SITE 17 FEASIBILITY STUDY REPORT
NAVAL STATION GREAT LAKES, ILLINOIS
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Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Illinois Sewer Discharge Criteria	Illinois Administrative Code Title 35 Subtitle C Chapter I 301-310	Potentially Relevant and Appropriate	Establishes requirements for discharges of untreated stormwater to ensure protection of the surface water of the state.	Remedial actions would consider the impact of the discharge of untreated stormwater.
Illinois Solid Waste and Special Waste Hauling	Illinois Administrative Code Title 35 Subtitle C Chapter I Subchapter i	Applicable	Establishes requirements for solid waste and hauling of special waste.	These regulations would apply if waste is transported to a disposal facility.

3.0 SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

This section identifies, screens, and evaluates the potential remediation technologies and process options that may be applicable to sediment remedial alternatives for Site 17 at Naval Station Great Lakes. The primary objective of this phase of the FS is to develop an appropriate range of remedial technologies and process options that will be used for developing remedial alternatives.

The basis for remediation technology identification and screening began in Section 2.0 with a series of discussions that included the following:

- Identification of ARARs
- Development of RAOs
- Identification of GRAs
- Identification of volumes and areas of media of concern

Remediation technology screening is performed in this section with the completion of the following analytical steps:

- Identification and screening of remediation technologies and process options
- Evaluation and selection of representative process options

In this section, a variety of remediation technologies and process options are first identified for each of the GRAs listed in Section 2.3 and then screened. The selection of remediation technologies and process options for initial screening is based on the Guidance for Conducting Remedial Investigations/Feasibility Studies under CERCLA (USEPA, October 1988). The screening is first conducted at a preliminary level to focus on relevant remediation technologies and process options. Then the screening is conducted at a more detailed level based on certain evaluation criteria. Finally, process options are selected to represent the remediation technologies that have passed the detailed evaluation and screening.

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

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

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

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

3.1 PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

This section identifies and screens sediment remediation technologies and process options at a preliminary stage based on implementation with respect to site conditions and COCs. Table 3-1 summarizes the preliminary screening of remediation technologies and process options by presenting the GRAs, identifying the remediation technologies and process options, and providing a brief description of each process option followed by a screening comment.

The following are the sediment remediation technologies and process options remaining for detailed screening:

GRA	Remediation Technology	Process Options
No Action	None	Not Applicable
Limited Action	Institutional Controls	Access/Use Restrictions, Fish Consumption Warnings and catch and release requirements
	Monitoring	Sampling and Analysis
Containment	Capping	In-Situ Capping
	Surface Water Controls	Vertical Barriers, Surface Water Diversion
Removal	Mechanical Removal	Mechanical Excavation (use equipment such as a Grad-All, backhoes, etc.)
Ex-Situ Treatment	Physical/Chemical	Dewatering
		Stabilization/Fixation
	Thermal	Thermal Desorption
		Incineration
Discharge/Disposal	Landfilling	Off-Base Landfilling

3.2 DETAILED SCREENING OF REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

3.2.1 No Action

No Action consists of maintaining the status quo at the site. As required under CERCLA regulations, the No Action alternative is carried through the FS to provide a baseline for comparison to other alternatives and their effectiveness in mitigating risks posed by site COCs. Because no remedial actions are conducted under this alternative, there are no costs associated with "walking away from" the site. Neither is there a reduction in risk through exposure control or treatment.

Effectiveness

No Action would not be effective in meeting the RAOs for the site. No Action would not be effective in evaluating either potential reduction of COC concentrations through monitored natural recovery (MNR) or potential migration of COCs because no monitoring would be performed.

Implementability

There would be no implementability concerns because no actions would be implemented.

Cost

There would be no costs associated with No Action.

Conclusion

No action is retained for comparison to other options.

3.2.2 Limited Action

3.2.2.1 Institutional Controls

Institutional controls would consist of access restrictions, fish consumption warnings and catch and release requirements, and LUCs. Access restrictions would consist of fencing the site and providing security to prevent access to trespassers. Signs would be posted to warn of existing contamination and against consumption and catch and release requirements of fish caught on site. LUCs would consist of placing restrictions on the sale and transfer of the property and prohibiting future residential development of the site.

Effectiveness

Access restrictions, fish consumption warnings and catch and release requirements, and LUCs would be effective in preventing unacceptable risk from exposure of human receptors to contaminated sediment and fish. However, ecological receptors would not be protected. Therefore, institutional controls cannot be used as a permanent solution to protect ecological receptors.

Implementability

Institutional controls would be implementable. Fencing and site security are assumed to continue as long as the Navy continues to own the property. LUCs would be easy to formulate and implement.

Cost

Costs associated with institutional controls would be low to moderate and would typically be a minor component when included in remedial actions.

Conclusion

Institutional controls are retained in combination with other process options for the development of remedial alternatives.

3.2.2.2 Monitoring

Monitoring would consist of regularly collecting and analyzing samples of sediment and surface water to assess trends in concentrations of COCs and to evaluate for the potential migration of these COCs already in the environment.

Effectiveness

Monitoring would not of itself remedy contaminated sediment, but it would be an effective tool to evaluate the progress of natural recovery processes or active remediation and to evaluate the potential migration of COCs.

Implementability

A sediment and surface water monitoring program would be readily implementable.

Cost

Costs associated with monitoring would be moderate.

Conclusion

Monitoring is retained in combination with other process options for the development of remedial alternatives.

3.2.3 Containment

In-situ capping and surface water controls are the technologies considered for containment of contaminated sediment.

3.2.3.1 In-Situ Capping

In-situ capping would consist of placing a horizontal cover system over the contaminated sediment. The cover system typically consists of one or more layers of clean sediment, sand, and gravel that may be separated with geotextile membranes. An armor layer typically consisting of rip-rap stones or gabions is normally placed on top of the cover system to minimize erosion and to prevent animal burrowing into the cover system.

Effectiveness

In-situ capping would not of itself reduce concentrations of COCs, but it would effectively minimize exposure of human and ecological receptors from direct contact with contaminated sediment. In-situ capping would also significantly reduce the potential for migration of COCs either through diffusion from sediment to surface water or through erosion and spreading of contaminated sediment to previously non-contaminated areas. In-situ capping would also significantly impact the ecological habitat of the capped areas that would subsequently require restoration.

Implementability

In-situ capping of North Branch of Pettibone Creek would be impractical. Installation of a 2- to 3-foot-thick cap would effectively fill in the creek bed, and such a cap would be subject to severe erosion even with the use of a protective layer of rip-rap stones or gabions. In-situ capping of the Boat Basin would be implementable, and the necessary resources, equipment, and material are readily available. To retain the function of the Lower Basin, capping would have to be limited to the Upper Basin with contaminated sediment from the Lower Basin consolidated into the Upper Basin.

Cost

The capital and O&M costs of in-situ capping would be moderate to high.

Conclusion

In-situ capping is eliminated from consideration for Pettibone Creek because of implementability concerns. However, in-situ capping is retained for the formulation of remedial alternatives for the Upper Boat Basin.

3.2.3.2 Surface Water Controls

Surface water controls would consist of using vertical barriers and surface water diversion to contain or divert surface or storm water so as to minimize the potential for infiltration and/or migration of contaminated sediment.

Vertical barriers would consist of sand bags and silt curtains. Sand bags would be arranged to form impervious barriers around areas to be remediated to divert surface water from these areas. Permeable silt curtains would be installed immediately downstream/downgradient from areas of concern to prevent migration of contaminated sediment from these areas.

Surface water diversion would consist of using pumping and temporary piping or ditches or culverts to intercept surface or storm water and divert it around the areas to be remediated.

Effectiveness

Surface water controls would not reduce COC concentrations, but they would generally be effective in diverting surface water from areas being remediated and in minimizing migration of contaminated sediment particles entrained in surface water.

Sand bagging in conjunction with pumping would be effective in diverting water around specific sections of Pettibone Creek and the Boat Basin. Silt curtains would be effective for capturing suspended sediment particles resulting either from natural surface water erosion or on-going remedial activities such as excavation or dredging.

Surface water diversion systems would effectively reduce and control the flow of water running on the remediation areas, thereby minimizing the potential for erosion or infiltration.

Implementability

Surface water controls would be easy to implement. The resources, equipment, and materials required for the installation and maintenance of sand bag barriers and silt curtains and for the installation and maintenance of surface water diversion systems are readily available.

Cost

The cost of installing, operating, and maintaining surface water control systems would be low to moderate, depending on the size of the area around which surface water would have to be diverted.

Conclusion

Surface water controls including sand bagging and silt curtains and surface water diversion systems are retained in conjunction with other remedial technologies for the formulation of remedial alternatives.

3.2.4 Removal

The only technology considered for removal is mechanical excavation.

3.2.4.1 Mechanical Excavation

Mechanical excavation of the relatively narrow and easily accessible areas of contaminated sediment such as the bed of the North Branch of Pettibone Creek would be performed using a Grade-All type excavator. Mechanical excavation of the wider and harder to reach areas such as those in the Upper and Lower Boat Basin would be performed using an all-terrain, long-arm excavator.

Effectiveness

Mechanical excavation would not of itself reduce concentrations of COCs in sediment, but it would be an effective means for removing from the site the sediment with concentrations of COCs greater than PRGs. Mechanical excavation would permanently remove contaminated sediment, but it would also essentially destroy the ecological habitat of the excavated areas, which would subsequently require restoration.

Implementability

Mechanical excavation would be relatively easy to implement. The necessary resources, equipment, and materials are readily available. Controls would have to be implemented to divert surface water around the areas to be excavated. Depending on the areas to be excavated and site conditions at the time of excavation, the use of specialized tracked or even amphibious equipment may be required. If mechanical excavation is used, the design will include reconstruction activities to correct the slope stability and erosion issues as discussed in the Environmental Assessment for Erosion Control for Pettibone Creek (Maguire Group Inc., 1993) and the Comprehensive Slope Stability and Erosion Study (STS Consultants LTD., 1988).

Cost

The cost of mechanical excavation would be low to moderate, depending on the ease of access of the areas to be excavated and the extent of the needed site restoration.

Conclusion

Mechanical excavation is retained in conjunction with other remedial technologies for the formulation of remedial alternatives.

3.2.5 Ex-Situ Treatment

Dewatering, chemical stabilization, and thermal treatment are the technologies considered for ex-situ treatment of contaminated sediment.

3.2.5.1 Dewatering

Dewatering is a process for reducing the free water content of solid wastes. Dewatering would likely be required to reduce the free water present in the submerged sediment dredged from Pettibone Creek and the Boat Basin to improve handling and to reduce volumes/weights prior to additional treatment and disposal.

Dewatering can be achieved either through passive (gravity-aided) decantation such as drainage of free water from stockpiled material, by filtration through a porous medium such as a geotube, or by mechanical expression with specialized equipment such as belt filter presses, plate-and-frame filter presses, vacuum filters, or centrifuges.

Stockpiling of wet sediment would cause most of the free water to decant from that sediment due to gravity and to some extent to mechanical compression of the lower layers of stockpiled sediment by the weight of the upper layers. The separated water could then either be collected into a sump for disposal or left to drain back into the body of surface water from which it came. If necessary, the removed free water could be treated on site.

Filtration would consist of pumping the sediment to be dewatered into a geotube, which is a very large bag (typically 15 to 20 feet in diameter and several hundred feet long) made of a porous textile material that lets water flow through while retaining solids within the bag. As with stockpiling, the separated water could either be collected and disposed or simply drained back. Geotube filtration was previously used at Naval Station Great Lakes for the dewatering of sediment dredged from the Inner Harbor.

Mechanical dewatering techniques would utilize pressure (filter press) or vacuum (vacuum filter) to enhance the filtration process or centrifugal force (centrifuge) to separate free water from sediment. As with stockpiling, the separated water could either be collected and disposed or simply drained back.

Effectiveness

Stockpiling, geotube filtration, and mechanical dewatering would be effective in removing excess free water from the wetter sediment excavated from Pettibone Creek or the Boat Basin so that this sediment can be more easily and effectively be transported and disposed. The effectiveness of mechanical dewatering is typically greater than that of geotube filtration, which is in turn greater than that of stockpiling, because the first two technologies use forces greater than gravity alone to separate solids from liquids. However, the presence of significant fractions of vegetative matter (i.e., matted leaves, twigs and stems) could negatively impact the effectiveness of geotube filtration and even more so that of mechanical dewatering. It is anticipated that with relatively coarse and sandy material such as the sediment removed from Pettibone Creek and the Boat Basin stockpiling would achieve sufficient dewatering.

Implementability

Stockpiling would be very easy to implement because very little specialized equipment is needed, but it would require significant space. Geotube filtration would be slightly more complex to implement than stockpiling because it would not only require significant space but some specialized equipment (i.e., geotubes) would be needed. Geotube filtration would also require that after being filled the geotubes be cut into manageable sections before transport. Mechanical dewatering would be significantly more complex to implement than geotube filtration because much specialized and high-maintenance equipment (e.g., filter press, centrifuge) would be needed. However, this technology would typically require much less space. The resources, equipment, and materials required for the application of these technologies are readily available.

Cost

The capital and O&M costs of stockpiling would be low. The capital and O&M costs of geotube filtration would be moderate. The capital and O&M costs of mechanical dewatering would be moderate to high.

Conclusion

Stockpiling is retained in conjunction with other remedial technologies for the formulation of remedial alternatives. This technology would be the most appropriate and cost effective to provide the relatively modest degree of dewatering required.

3.2.5.2 Chemical Stabilization/Fixation

Chemical stabilization/fixation would consist of blending the material to be treated with one or more chemical additives, typically pozzolanic products such as Portland Cement or cement kiln dust. Typically, the chemical additive is blended with the material to be treated by a mechanical device such as a pug mill.

Alternately, when space is available and the treated material is to be left in place, the blending can be accomplished by spreading the additive over a layer of the material to be treated and working it in with equipment such as discs. The chemical additives react with the matrix of the treated material to create a lattice network that limits the mobility of certain contaminants.

Effectiveness

Chemical stabilization/fixation would not of itself reduce the concentrations of COCs in contaminated sediment but is a very well proven technology for the immobilization of most inorganic compounds and some high molecular weight, low mobility organic compounds (e.g., PAHs and PCBs) in sediment matrix. For the Site 17 contaminated sediment, chemical stabilization would be very effective for the immobilization of copper, lead, and zinc, which are the main inorganic COCs.

Based upon the results of site characterization and for the purpose of this FS, it is assumed that approximately 10 percent of the Site 17 contaminated sediment contains lead at concentrations that would require chemical/stabilization.

Implementability

Chemical stabilization/fixation would be easy to implement. For the Site 17 sediment, this technology would most likely be implemented off base at a permitted treatment, storage, and disposal facility (TSDF). Several such TSDFs are available to provide this service.

Cost

The capital and O&M costs of chemical stabilization/fixation would be low to moderate.

Conclusion

Off-base chemical stabilization/fixation is retained in conjunction with other remedial technologies for the formulation of remedial alternatives.

3.2.5.3 Thermal Treatment

The two technologies being considered for thermal treatment are thermal desorption and incineration. These technologies differ mainly in operating conditions and end results. Thermal desorption operates at a lower temperature and only volatilizes COCs. Incineration operates at a higher temperature and destroys COCs. Either of these remedial technologies could be used as part of off-base disposal.

Thermal desorption uses low to medium temperatures [200 to 1,200 degrees Fahrenheit] to desorb or volatilize organic COCs. The temperatures used are contaminant and matrix specific. Typically, wastes are processed through an externally fired pug mill or rotary drum system equipped with heat transfer surfaces that are heated by circulating hot oil. An induced airflow conveys the desorbed organic chemicals through a secondary treatment system, such as a granular activated carbon adsorption unit, a catalytic oxidation unit, a condenser unit, or even an afterburner. It should be noted however, that use of an afterburner for secondary treatment has typically resulted in the thermal desorption unit being considered as an incinerator by regulatory agencies. The off-gas is then discharged through a stack.

Incineration uses high temperatures (1,400 to 2,200°F) to volatilize contaminants and combust them in the presence of excess air. Commercial units are typically rotary kilns equipped with an afterburner. The rotary kiln is a refractory-lined, slightly-inclined, rotating cylinder wherein the wastes are fed at one end and discharged as ash on the other end. The off-gases are treated to remove particulates (in a baghouse), quenched to cool, and scrubbed to remove acid gases formed by the combustion of organic compounds.

Effectiveness

The effectiveness of thermal desorption is highly contaminant and matrix specific. Therefore, a full characterization of the waste to be treated would be required, and treatability testing would have to be performed to verify the level of effectiveness and to determine the optimum operating temperature and detention time. Thermal desorption is a well-proven technology that should be effective for the removal of the PAHs and PCBs that are the main organic COCs for the Site 17 sediment. Because these PAHs and PCBs are not particularly volatile, the operating temperature would be expected to be towards the higher end of the range (probably 800 to 900° F).

Incineration is a well-proven technology that would likely be very effective for destroying the PAHs and PCBs in the Site 17 sediment. Incineration would typically achieve in excess of 99.99 percent destruction of organic COCs with the resulting formation of inert carbon dioxide and water. Incinerated sediment could typically be reused as fill material.

Based upon the results of site characterization and for the purpose of this FS, it is assumed that the concentrations of PAHs and PCBs in the Site 17 contaminated sediment are not sufficiently high to require thermal treatment. In addition, the moisture/water in the sediment will reduce the effectiveness of this technology.

Implementability

Thermal desorption and incineration would be implementable. Qualified and permitted off-base TSDFs would be readily available to provide the necessary services. Treatability testing may have to be performed, especially to verify the effectiveness and to confirm the operating parameters of thermal desorption. Off-gases from the thermal desorption unit would have to be treated, most likely with vapor-phase GAC adsorption.

Cost

The costs of thermal desorption would be moderate to high. The costs of incineration would be high to very high.

Conclusion

Although it is assumed that it will not be necessary, thermal treatment is retained for the formulation of remedial alternatives. Off-base incineration is retained as the thermal treatment option of choice because this technology remains one of the very few proven means of PCB destruction. Thermal desorption is eliminated from further consideration because its effectiveness is not as well proven as that of incineration.

3.2.6 Disposal

The only technology considered for disposal is off-base landfilling. As previously mentioned, the chemical stabilization/fixation and incineration treatment technologies evaluated above can also be considered as off-base disposal options.

3.2.6.1 Off-Base Landfilling

Off-base landfilling would consist of transporting the excavated, dredged, and dewatered sediment for burial in a permitted off-base TSDF. Resource Conservation and Recovery Act (RCRA) non-hazardous waste may be disposed in a RCRA Subtitle D, or solid waste, landfill. RCRA-hazardous waste must be disposed of in a RCRA Subtitle C, or hazardous waste, landfill.

Based upon the results of site characterization and for the purpose of this FS, it is assumed that 90 percent of the Site 17 contaminated sediment is classified as RCRA non-hazardous. The remaining 10 percent of Site 17 contaminated sediment is classified as RCRA hazardous because of high lead concentrations. It is also assumed that this portion of the Site 17 contaminated sediment could be re-classified as RCRA non-hazardous following off-base chemical fixation/stabilization.

Effectiveness

Off-base landfilling would not permanently or irreversibly reduce COC concentrations. However, although the CERCLA preference for treatment relegates landfilling to a less preferable option, this technology is an effective disposal option for contaminated sediment. Off-base landfills are only permitted to operate if they meet certain requirements of design and operation governing foundation, liner, leak detection, leachate collection and treatment, daily cover, post-closure inspections, and monitoring. The requirements of a RCRA Subtitle C hazardous waste landfill are typically more stringent than those of a RCRA Subtitle D solid waste landfill.

Implementability

Off-base landfilling would be easily implementable. Permitted TSDFs are available for this purpose. Disposal at a RCRA Subtitle D solid waste landfill may require certain pre-treatment including dewatering of dredged sediment, chemical stabilization/fixation of sediment containing excess metals, and/or incineration of sediment containing excess PAHs or PCBs. In addition, a waste profile would have to be prepared, providing COC concentrations and their leachability.

Cost

Costs of off-base landfilling would be low to moderate.

Conclusion

Off-base landfilling is retained in combination with other process options for the development of remedial alternatives.

3.3 SELECTION OF REPRESENTATIVE PROCESS OPTIONS

The following technologies and process options are retained for the formulation of sediment remedial alternatives for Site 17:

- No Action
- Institutional Controls (access control, posting fish consumption warnings and catch and release requirements at the Boat Basin, and LUCs)
- Monitoring
- In-Situ Capping (Boat Basin only)
- Surface Water Controls (sand bagging, silt curtains, and surface water diversion)
- Mechanical Excavation
- Stockpile Dewatering
- Off-Base Chemical Stabilization/Fixation
- Off-Base Incineration
- Off-Base Landfilling

TABLE 3-1

PRELIMINARY SCREENING OF SEDIMENT REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
		GENERAL RESPONSE ACTION: NO ACTION		
No Action	No Action	No Action	Must be retained as baseline for comparison.	Yes
		GENERAL RESPONSE ACTION: LIMITED ACTION		
Institutional Controls	Land Use Controls (LUCs)	Property deed would contain notice regarding site contamination and would restrict disturbance of sediment. Signs would be posted about fish consumption warnings and catch and release requirements at the Boat Basin.	Would prevent exposure of human receptors. Would not prevent exposure of ecological receptors. Could be used in conjunction with monitored natural recovery and containment response actions.	Yes
	Fencing	A physical barrier would prevent unauthorized site access.	Would prevent exposure of human receptors. Would not prevent exposure of ecological receptors. Could be used in conjunction with containment.	Yes
Monitoring	Monitoring	Sampling and analysis of sediment and surface water.	Would assess on-site contaminant concentrations and off-site contaminant migration.	Yes
		GENERAL RESPONSE ACTION: CONTAINMENT		
Capping	In-Situ Cap	Single or multiple layers of clean sediment, sand, and/or gravel with geotextile membrane placed over contaminated areas.	Would not reduce concentrations of COCs, but would provide a barrier to direct exposure pathways. Might require some sediment consolidation.	Yes
Surface Water Controls	Vertical Barriers	Use of sand bags and silt curtains to contain water and minimize sediment transport.	Would not reduce concentrations of COCs but would minimize their migration during remedial activities and would be effective for the isolation of work areas.	Yes
	Surface Water Diversion	Use of pumping and piping or ditches to divert surface/stormwater from areas being remediated.	Would not reduce concentrations of COCs but would minimize their migration during remedial activities and would be effective for diverting water from work areas.	Yes
		GENERAL RESPONSE ACTION: REMOVAL		
Excavation	Mechanical	Physical removal of contaminated sediment by mechanical equipment such as backhoe, Grade-all, etc.	Would be effective for the removal of sediment. Excavation of hard-to-reach or wetter areas may require specialized equipment.	Yes
Dredging	Mechanical	Physical removal of contaminated sediment by mechanical dredging-type equipment such as dragline or excavator.	Would be effective for the removal of sediment. Would not be practical to implement in Pettibone Creek.	No
	Hydraulic	Removal of contaminated sediment in a liquid slurry form.	Would be effective for the removal of sediment. Would not be practical to implement in Pettibone Creek or the Boat Basin and would generate excessive volumes of water.	No
		GENERAL RESPONSE ACTION: IN-SITU TREATMENT		
Physical/ Chemical	Soil Venting/Air Sparging	Injection and extraction wells pump ambient air through sediment to remove contaminants.	Not effective for relatively nonvolatile organic compounds such as PAHs and PCBs. Not effective for metals. Would be difficult to implement due to the relatively shallow depth of contaminated sediment in Pettibone Creek.	No
	Soil Washing	Removal of contaminants by flushing sediment with aqueous surfactants or solvents.	Might be effective for metals but would not be very effective for PAHs and PCBs due to their relatively low solubility. Would be difficult to implement due to the relatively shallow depth of contaminated soil/sediment in Pettibone Creek.	No

TABLE 3-1

PRELIMINARY SCREENING OF SEDIMENT REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
			GENERAL RESPONSE ACTION: IN-SITU TREATMENT (continued)	
Physical/ Chemical (continued)	Steam Injection	Steam is injected in the sediment to enhance the recovery of organic compounds.	Would be marginally effective for PAHs and PCBs due to their low volatility. Not effective for metals. Would be difficult to implement due to the relatively shallow depth of contaminated sediment in Pettibone Creek.	No
	Stabilization	Subsurface materials solidified, fixated, or encapsulated to prevent leaching of contaminants.	Would be effective for metals and might be effective for PAHs and PCBs. Would impact site hydrogeology and might impede wetland restoration.	No
Biological	Aerobic and Anaerobic Degradation	Enhancement of natural biological activity by the addition of oxygen- or hydrogen-release compounds, nutrients, and cultured microorganisms.	Aerobic biodegradation might be effective for PAHs and, in combination with anaerobic biodegradation, for PCBs as well. However, aerobic biodegradation would not be effective for metals and its implementation in non-homogeneous site conditions would be difficult.	No
Thermal	Vitrification	Electrically heating contaminated sediment into a glass/crystalline structure.	Relatively unproven technology. Would not be applicable to the wetter sediment.	No
	Electro-Acoustic	Application of direct current and acoustic fields to increase migration of leachable contaminants through material.	Technology is in the research and development stage. Might be effective for PAHs, but removal of PCBs by leaching is questionable because of their very low mobility. Would not be effective for metals.	No
	Radio-Frequency Destruction	Radio-frequency electrodes placed along the ground surface heat the subsurface and volatilize and/or destroy organics.	Technology is in the research and development stage. Might be effective for PAHs, but removal of PCBs by leaching is questionable because of their very low mobility. Would not be effective for metals.	No
			GENERAL RESPONSE ACTION: EX-SITU TREATMENT	
Biological	Landfarming	Controlled application of contaminated sediment, nutrients, and microbes to land area that is tilled.	Might be effective for PAHs but not proven for PCBs and ineffective for metals. Would require spreading of contaminated sediment over a large area. No site available for this application.	No
	Composting	Degradation of wastes using thermophilic aerobic microbes under forced air conditions.	Might be effective for PAHs but not proven for PCBs and ineffective for metals. Would require spreading of contaminated sediment over a large area. No site available for this application.	No
	Bioslurry	Enhanced biodegradation by increasing the mass transfer of organic compounds into the aqueous phase.	Might be effective for PAHs but not proven for PCBs and ineffective for metals. Would be difficult to implement with dredged material mixed with vegetative material.	No
	Anaerobic Degradation	Anaerobic microbial species and conditions are developed to enhance utilization of hazardous constituents.	Anaerobic biodegradation may be effective for PCBs when followed by aerobic degradation. Would not be effective for metals.	No

TABLE 3-1

PRELIMINARY SCREENING OF SEDIMENT REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
GENERAL RESPONSE ACTION: EX-SITU TREATMENT (continued)				
Physical/ Chemical	Steam Stripping	Steam is pumped through contaminated sediment to remove contaminants.	Marginally effective for low volatility organic compounds such as PAHs and PCBs. Not effective for metals.	No
	Air Stripping	Air is pumped through contaminated sediment to remove contaminants.	Not effective for low volatility organic compounds such as PAHs and PCBs. Not effective for metals.	No
	Dechlorination/ Hydro-dehalogenation	Chemical dechlorination using a sodium reagent (HAPEG).	Might be effective for PCBs. Treated solids/wastewater phase separation would be difficult to implement for dredged sediment mixed with vegetative matter.	No
	Oxidation	Process by which oxidizing agents decompose organic compounds to carbon dioxide and water, and inorganic compounds to salts.	Might be effective for PAHs and PCBs. Treated solids/wastewater phase separation would be difficult to implement for dredged sediment mixed with vegetative matter.	No
	Dewatering	Use of passive, gravity-aided removal of excess water from sediment or use of a mechanical technique such as geotube, filter press, etc.	Would be effective as pretreatment to reduce moisture content.	Yes
	Soil Washing/ Solvent Extraction	Extraction of contaminants from sediment by aqueous solutions and solvents.	Would be effective for metals. Would be marginally effective for PAHs and PCBs due to their low solubility. Phase separation would be difficult to implement for dredged sediment mixed with vegetative matter. Solvents such as acids could adversely impact sediment geochemistry and make them unsuitable for reuse.	No
	Stabilization/ Fixation	Excavated material is stabilized/fixated to improve bearing capacity and/or minimize leaching of contaminants.	Would be effective for metals and might be effective for PAHs and PCBs. Would improve load-bearing characteristics of sediment. Would reduce mobility of some of the COCs (mostly metals) but not their toxicity and would still require containment.	Yes
Thermal	Thermal Desorption	Separation of contaminants from sediment by heating the mixture to drive off contaminants.	Effective for removal of PAHs and PCBs but would not destroy them. Would not be effective for metals. Would require further treatment and/or disposal of residuals.	Yes
	Incineration	High-temperature oxidation of organics in a controlled combustion process.	Would be very effective in destroying PAHs and PCBs. Would not be effective for metals.	Yes
	Pyrolysis	High-temperature heating of materials in the absence of air to thermally degrade wastes to a volatile gaseous portion and residual solid portion comprised of fixed carbons and ash.	Would be very effective in destroying PAHs and PCBs. Would be more complex and expensive than incineration. Would not be effective for metals.	No

TABLE 3-1

PRELIMINARY SCREENING OF SEDIMENT REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
			GENERAL RESPONSE ACTION: DISPOSAL	
On-Base Landfill	Solid Waste Disposal Area	Removal and transportation of wastes to an existing or newly constructed landfill on base permitted to handle nonhazardous solid waste.	No site available on base for such a landfill.	No
	RCRA Landfill	Removal and transportation of wastes to an existing or newly constructed landfill on base permitted to handle hazardous waste.	No site available on base for such a landfill.	No
Off-Base Landfill	Solid Waste Disposal Area	Removal and transportation of wastes to an existing landfill permitted to handle nonhazardous solid waste off base.	Applicable to non-RCRA wastes.	Yes
	RCRA Landfill	Removal and transportation of wastes to an existing landfill permitted to handle hazardous waste off base.	Applicable to all types of wastes.	Yes
On-Base Reuse	Fill after Treatment	Use of treated sediment as landfill material in non-regulated areas.	Not applicable because degree of treatment required to meet PRGs is typically not achievable.	No
Off-Base Reuse	Use in Asphalt Batch Plant	Removal and transportation of wastes to an existing batch plant to be used as supplemental aggregate. In the aggregate kiln, organics are volatized and incinerated.	Might be applicable to PAH-contaminated sediment. Not applicable to PCB- and metals-contaminated sediment.	No
	Fill after Treatment	Use of treated sediment as landfill material in non-regulated areas.	High degree of treatment required for material to be classified as "clean" fill. There are potential long-term liabilities associated with this option.	No
	Fuel for Boilers or Kilns	Use of wastes as supplemental fuel in industrial boilers or kilns.	Wastes must have heat value generally greater than 5,000 British Thermal Unit per pound (BTU/lb). None of the sediment meet this criterion.	No

4.0 ASSEMBLY AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

4.1 INTRODUCTION

This section presents an evaluation and discusses the relative importance of each remedial alternative with respect to the criteria required by the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) of 40 CFR Part 300, as revised in 1990. The criteria as required by the NCP and the relative importance of these criteria are described in the following subsections.

4.1.1 Evaluation Criteria

In accordance to the NCP (40 CFR 300.430), the following nine criteria are used for the evaluation of remedial alternatives:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, and Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost
- State Acceptance
- Community Acceptance

4.1.1.1 Overall Protection of Human Health and the Environment

Alternatives must be assessed for adequate protection of human health and the environment, in both the short and long term, from unacceptable risks posed by hazardous substances or contaminants present at the site. For this purpose, alternatives should eliminate, reduce, or control exposure to concentrations of contaminants exceeding remediation goals. Overall protection draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

4.1.1.2 Compliance with ARARs

Alternatives must be assessed to determine whether they attain ARARs under federal and state environmental or facility siting regulations. If one or more regulations that are applicable cannot be complied with, a waiver must be invoked by the appropriate regulatory body for the alternative to be considered acceptable. Grounds for invoking a waiver include the following circumstances:

- The alternative is an interim measure and will become part of a total remedial action that will attain the ARAR.
- Compliance will result in greater risk to human health and the environment.
- Compliance is technically impracticable from an engineering perspective.
- The alternative will attain a standard of performance equivalent to that required under the otherwise applicable standard, requirement, or limit through use of another method or approach.
- A state requirement has not been consistently applied, or the state has not demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances at other remedial actions within the state.
- For CERCLA-financed response actions only, an alternative that attains the ARAR will not provide a balance between the need for protection of human health and the environment at the site and the availability of CERCLA monies to respond to other sites that may present a threat to human health and the environment. This circumstance is not applicable for Site 17.

4.1.1.3 Long-Term Effectiveness and Permanence

Alternatives must be assessed for the long-term effectiveness and permanence they offer, along with the degree of certainty that the alternative will prove successful. Factors that shall be considered as appropriate include the following:

- Magnitude of Residual Risk - Residual risk is risk posed by untreated waste or treatment residuals at the conclusion of remedial activities. The characteristics of residuals should be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

- Adequacy and Reliability of Controls - Controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste must be shown to be reliable. In particular, the following should be addressed: the uncertainties associated with land disposal for providing long-term protection from residuals; the potential need to replace technical components of the alternative such as a cap, a slurry wall, or a treatment system; and the potential exposure pathways and risks posed if the remedial action needed replacement.

4.1.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which the alternative employs recycling or treatment that reduces the toxicity, mobility, or volume shall be assessed, including how treatment is used to address the principal threats posed by the site. Factors that shall be considered, as appropriate, include the following:

- The treatment or recycling processes the alternative employs and the materials that they will treat.

- The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled.

- The degree of expected reduction in toxicity, mobility, or volume of waste due to treatment or recycling and the specification of which reduction(s) are occurring.

- The degree to which the treatment is irreversible.

- The type and quantity of residuals that will remain following treatment considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents.

- The degree to which treatment reduces the inherent hazards posed by principal threats at the site.

4.1.1.5 Short-Term Effectiveness

The short-term impacts of the alternative shall be assessed considering the following:

- Short-term risks that might be posed to the community during implementation.

- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures.

- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation.

- Time until protection is achieved.

4.1.1.6 Implementability

The ease or difficulty of implementing the alternatives shall be assessed by considering the following types of factors, as appropriate:

- Technical feasibility including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

- Administrative feasibility including activities needed to coordinate with other offices and agencies and the ability and time required obtaining necessary approvals and permits from other agencies (for off-site actions).

- Availability of services and materials including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to make sure of necessary additional resources; the availability of services and materials; and the availability of prospective technologies.

4.1.1.7 Cost

Capital costs shall include both direct and indirect costs. Annual O&M costs shall be provided. A net present value of the capital and O&M costs shall also be provided. Typically, the cost estimate accuracy range is plus 50 percent to minus 30 percent.

4.1.1.8 State Acceptance

The State of Illinois' concerns that must be assessed include the following:

- The state's position and key concerns related to the preferred alternative and other alternatives.
- State comments on ARARs or the proposed use of waivers.

These concerns cannot be evaluated at this time in the FS until the State has reviewed and commented on the FS. These concerns will be discussed, to the extent possible, in the Proposed Plan to be issued for public comment.

4.1.1.9 Community Acceptance

This assessment consists of responses of the community to the Proposed Plan. This assessment includes determining which components of the alternative interested persons in the community support, have reservations about, or oppose. This assessment can be done after comments on the Proposed Plan are received from the public.

4.1.2 Relative Importance of Criteria

Among the nine criteria, the threshold criteria are considered to be:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs (excluding those that may be waived)

The threshold criteria must be satisfied in order for an alternative to be eligible for selection.

Among the remaining criteria, the following five criteria are considered to be the primary balancing criteria:

- Long-Term Effectiveness and Permanence
- Reduction of Contaminant Toxicity, Mobility, or Volume Through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

The balancing criteria are used to weigh the relative merits of alternatives.

The remaining two of the nine criteria, State Acceptance and Community Acceptance, are considered to be modifying criteria that must be considered during remedy selection. These last two criteria can be evaluated after the document has been reviewed by Illinois EPA and the Proposed Plan has been discussed in a public meeting. Therefore, this document addresses only seven of the nine criteria.

4.1.3 Selection of Remedy

The selection of a remedy is a two-step process. The first step consists of identification of a preferred alternative and presentation of the alternative in a Proposed Plan to the community for review and comment. The preferred alternative must meet the following criteria:

- Protection of human health and the environment.
- Compliance with ARARs unless a waiver is justified.
- Cost effectiveness in protecting human health and the environment and in complying with ARARs.
- Utilization of permanent solutions and alternate treatment technologies or resource recovery technologies to the maximum extent practicable.

The second step consists of the review of the public comments and determination of whether or not the preferred alternative continues to be the most appropriate remedial action for the site, in consultation with USEPA and Illinois EPA.

4.2 ASSEMBLY OF REMEDIAL ALTERNATIVES

Based on the technology screening presented in Sections 3.2 and 3.3, the following four remedial alternatives were developed.

- Alternative 1: No Action

- Alternative 2: Institutional Controls and MNR

- Alternative 3: Partial Excavation and Disposal of North Branch of Pettibone Creek Sediment, Excavation of Lower Boat Basin Sediment, In-Situ Capping of the Upper Boat Basin, Surface Water Controls, Institutional Controls, and MNR

- Alternative 4: Partial Excavation of North Branch of Pettibone Creek Sediment, Excavation of Upper and Lower Boat Basin Sediment, Surface Water Controls, On-Site Dewatering, and Off-Base Disposal of Excavated Sediment

Alternative 1 was formulated and analyzed to serve as a baseline for other alternatives, as required by CERCLA and the NCP. Alternative 2 was formulated and analyzed to evaluate the adequacy of minimal action. Alternatives 3 and 4 were formulated and analyzed to evaluate active remediation of the contaminated sediment. A description and detailed analysis of these alternatives are presented in the following sections.

4.3 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

4.3.1 Alternative 1: No Action

4.3.1.1 Description

The No Action alternative maintains the site as is. This alternative does not address sediment contamination and is only retained to provide a baseline for comparison to other alternatives (required under CERCLA). There would be no reduction in toxicity, mobility, or volume of COCs other than what might result from natural processes such as dispersion, dilution, biodegradation, and other attenuating factors. Existing monitoring programs and institutional controls would be discontinued, and the site would be available for unrestricted use (other than the Lake Michigan Fish Advisories). This alternative cannot be chosen if waste remains on site.

4.3.1.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 1 would not provide protection of human health and the environment. Under the current land use scenario (recreational use), the potential for unacceptable risks to human health from exposure to consumption of contaminated fish would remain. In regards to the environment, the direct exposure to contaminants in the sediment for the benthic invertebrates and fish and exposure to contaminants by consumption of contaminated sediment invertebrates and fish by piscivorous birds would remain. The site would also be available for unrestricted development, which could result in increased human health and ecological risks. COCs might migrate to previously uncontaminated areas and, because no monitoring would be performed, this potential migration would not be detected.

Compliance with ARARs and TBCs

Alternative 1 would not comply with chemical-specific ARARs or TBCs because no action would be taken to reduce COC concentrations. Compliance with location-specific ARARs or TBCs would be purely coincidental. Action-specific ARARs or TBCs are not applicable.

Long-Term Effectiveness and Permanence

Alternative 1 would have no long-term effectiveness and permanence because exposed contaminated sediment would remain on site. Because there would be no institutional controls to control current fish consumption and future land use (other than the Lake Michigan Fish Advisories), the potential would exist for unacceptable risk to develop for human receptors. Since there would be no monitoring, potential migration of COCs would not be detected. Although concentrations of COCs might eventually decrease to acceptable concentrations through natural recovery, no monitoring would be conducted to verify this.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 would not reduce the toxicity, mobility, or volume of COCs through treatment because no treatment would occur. Some reduction in the toxicity and/or volume of COCs might occur through natural recovery, but no monitoring would be performed to verify this.

Short-Term Effectiveness

Since no action would occur, implementation of Alternative 1 would not pose any risks to on-site workers or result in short-term adverse impact to the local community and the environment. Alternative 1 may eventually achieve the RAOs if concentrations decrease below the PRGs through natural recovery, although no monitoring would verify this.

Implementability

Since no action would occur, Alternative 1 would be readily implementable. The technical feasibility criteria including constructability, operability, and reliability are not applicable. Implementability of administrative measures is not applicable because no such measures would be taken.

Cost

There would be no costs associated with the No Action alternative.

4.3.2 Alternative 2: Institutional Controls and MNR

4.3.2.1 Description

Alternative 2 is illustrated on Figure 4-1 and would consist of two major components: (1) institutional controls and (2) MNR.

Component 1: Institutional Controls

Institutional controls to be implemented would consist of the following: (1) establishing a no recreational swimming restriction from Naval Station property in the Boat Basin area; (2) on-site posted signs and period publishing of fish consumption warnings; (3) imposition of specific fish catch and release requirements on Naval Station property in the Boat Basin area, and; (4) sediment disturbance and disposal controls would be imposed for the Boat Basin area. Access to contaminated areas of Pettibone Creek and the Boat Basin would be restricted and controlled through fencing and posting of signs that would warn against fish consumption and catch and release requirements at the Boat Basin. LUCs would prevent future development of the site.

Site 17 would be added to the Navy's Land Use Control Memorandum of Agreement (LUCMOA). Due to the unique nature of ownership interests in the real property (federal property) at Naval Station Great Lakes and the inability of Naval Station Great Lakes to comply with the LUC recording requirements of Illinois EPA, Naval Station Great Lakes would follow the requirements of the LUCMOA until the property is transferred out of federal ownership. At the time of such transfer, the requirements and corresponding rules of Illinois EPA as they apply to Site 17 would be met.

The administrative requirement of the LUCMOA require Naval Station Great Lakes to implement processes for long-term maintenance of the LUCs that are selected as part of the remedy; elevate the general level of awareness of the LUC amongst Naval Station Great Lakes personnel; periodically advise USEPA and Illinois EPA representatives of the continued maintenance of the LUCs and of any planned changes in land use; implement procedures for integrating the LUCs into the land use planning process (Base Master Plan); provide reasonable assurances that specific pathway and exposure assumptions relied upon remain valid; and comply with the LUC requirements until it is determined that the LUCs are no longer necessary for the protection of human health and the environment. The listing of sites in the LUCMOA and the Base Master Plan would be updated on a quarterly basis by Naval Station Great Lakes with additions or deletions of sites; and copies of the updates would be distributed to USEPA and Illinois EPA.

A LUC Implementation Plan would be developed by Naval Station Great Lakes for Site 17 and this plan would identify the location by reference to the facility's land use plan; identify the LUC objective as well as those particular LUCs to be relied upon to achieve the objective; specify what must be done in order to implement and maintain the specific LUCs required; and contain a cross-reference to whatever decision document(s) apply. The LUCMOA and the Base Master Plan would serve as a central LUC reference source to assist Naval Station Great Lakes personnel with completing periodic inspections, review, and certifications. The periodic inspections would consist of annual visual inspections for the purpose of verifying that the necessary LUCs have been implemented and are being properly maintained with the submittal of an annual report certifying the continued retention of the implemented LUCs (Naval Station Great Lakes, September 2003).

Component 2: MNR

MNR would consist of regularly collecting samples of sediment and surface water and analyzing these samples for COCs. Samples would be collected both in the areas of known contamination to assess expected natural recovery over time and immediately outside of these areas to detect additional contaminant migration from any upstream source(s).

For the purpose of this FS, it is assumed that a total of 12 sediment samples and 12 surface water samples would be collected for each round of monitoring. Samples would be analyzed for PAHs, PCBs, pesticides, and metals. Monitoring would be performed with annual sampling for a period of 30 years. If monitoring results from two consecutive sampling rounds establish that cleanup goals have been met the site would be deemed to be remediated.

Every 5 years, the status of the site would be formally reviewed and evaluated to determine the continued effectiveness of this alternative.

4.3.2.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 2 would be protective of human health with the implementation of the LUCs. Natural recovery might eventually reduce concentrations of COCs to less than the PRGs which would be protective of the environment. Monitoring conducted as part of this alternative would verify that no migration of COCs is occurring.

Institutional controls would be protective of human health. Restricting access to contaminated areas and future development of the site and fish consumption warnings and catch and release requirements would limit the occurrence of unacceptable human health risks. However, the ecological risks at the site would remain with the direct exposure to contaminants in the sediment for the benthic invertebrates and fish and exposure to contaminants by consumption of contaminated sediment invertebrates and fish by piscivorous birds until natural recovery reduces concentrations of COCs to less than the PRGs.

Monitoring would determine if MNR is protective of the environment (benthic invertebrates and fish along with the piscivorous birds consuming contaminated benthic invertebrates and fish) by assessing the progress of natural recovery and detecting potential migration of COCs so that appropriate contingency measures can be taken, if required.

Some short-term risks could be incurred by workers from exposure to contamination during implementation of this alternative. However, the potential for such exposure would be minimized by the wearing of appropriate personal protective equipment (PPE) and compliance with site-specific health and safety procedures.

No adverse short-term or cross-media effects are anticipated as a result of implementing this alternative.

<u>Compliance with ARARs and TBCs</u>

Alternative 2 would comply with location- and action-specific ARARs and TBCs. Alternative 2 would not comply with chemical-specific ARARs in the short-term, but long-term compliance could be achieved through natural recovery.

<u>Long-Term Effectiveness and Permanence</u>

Alternative 2 would provide long-term effectiveness and permanence. Although no removal or treatment of contaminated sediment would occur and COCs might migrate, risks to human health would be controlled and monitored and risks to the environment would be monitored.

Site access restrictions, fish consumption warnings and catch and release requirements, and LUCs would effectively limit the occurrence of unacceptable human health risks until PRGs have been achieved.

Long-term monitoring would be an effective means to assess the progress of natural recovery and to detect the potential migration of COCs.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 2 would not reduce the toxicity, mobility, or volume of COCs through treatment. However, the toxicity, mobility, and volume of several COCs could eventually be reduced over time through natural recovery processes. No treatment residuals would be produced if Alternative 2 was implemented.

Short-Term Effectiveness

Alternative 2 would have minimal short-term effectiveness concerns. Exposure of workers to contamination during monitoring activities would be minimized by compliance with site-specific health and safety procedures, including the wearing of appropriate PPE. Alternative 2 would also not adversely impact the surrounding community or the environment.

The RAOs for human health would be achieved immediately upon implementation of institutional controls and monitoring. Implementation of Alternative 2 might eventually result in compliance with PRGs through natural recovery, but the timeframe for compliance cannot be accurately estimated. As additional site-specific data becomes available, modeling might be performed to predict this timeframe.

Implementability

Alternative 2 would be readily implementable. Implementation of site access restrictions, fish consumption warnings and catch and release requirements, LUCs, sampling and analysis of sediment and surface water, and performance of five-year site reviews could readily be accomplished. The resources, equipment, and materials required to implement these activities are readily available.

The administrative aspects of Alternative 2 would be relatively simple to implement. No construction permits would be required for this alternative. Deed restrictions would make sure of continued implementation of LUCs in case of change of ownership of the contaminated areas.

Cost

The estimated costs for Alternative 2 are:

- Capital Cost: $25,000
- 30-Year net present worth (NPW) of O&M Costs: $419,000
- 30-Year NPW: $444,000

The above figures have been rounded to the nearest $1,000 to reflect the very preliminary nature of these estimates. A detailed breakdown of these costs is provided in Appendix B.

4.3.3 Alternative 3: Partial Excavation and Disposal of North Branch of Pettibone Creek Sediment, Excavation of Lower Boat Basin Sediment, In-Situ Capping of the Upper Boat Basin, Surface Water Controls, Institutional Controls, and MNR

4.3.3.1 Description

Alternative 3 is illustrated on Figure 4-2 and would consist of seven major components: (1) excavation of North Branch of Pettibone Creek sediment, (2) on-site dewatering of excavated Pettibone Creek Sediment, (3) off-base disposal of dewatered Pettibone Creek sediment, (4) excavation of Lower Boat Basin sediment and consolidation with the Upper Boat Basin sediment, (5) in-situ capping of Upper Boat Basin, (6) surface water controls, (7) institutional controls, and (8) MNR.

Component 1: Excavation of North Branch of Pettibone Creek Sediment

Sediment with concentrations of COCs greater than PRGs would be excavated from the North Branch of Pettibone Creek; however, a site-specific study could be conducted to develop less restrictive PRGs based on toxicity data to minimize costs of dredging or excavating the sediment in the North Branch of Pettibone Creek. As discussed in Section 2, it is estimated that a total of approximately 5,800 yd^3 of contaminated sediment would be excavated.

For the purpose of this FS, it is assumed that sediment of the North Branch of Pettibone Creek would be excavated with a Gradall-type excavator, starting at the most upstream end and proceed downstream in incremental sections, each approximately 100 feet long.

During excavation, surface water would be diverted from the areas of sediment removal as described under Component 5 of this alternative.

Following excavation, the excavated areas would be sampled to verify that sediment containing COCs in excess of the PRGs have been removed and the excavated areas would be backfilled with clean material and restored to pre-excavating conditions. Excavated sediment would be loaded onto trucks for transportation and off-site disposal (Component 3). The trucks would be lined with plastic sheeting or have gasketed tailgates to prevent free liquid from leaking from the trucks.

Component 2: On-Site Dewatering of Excavated Pettibone Creek Sediment

This component would consist of dewatering the excessively wet excavated sediment by temporary stockpiling in a dedicated area near the Boat Basin or near the area of excavation. This area would be graded and surrounded by silt fences to allow drained free water to return to the Boat Basin or North Branch of Pettibone Creek while containing contaminated sediment. For the purpose of this FS, it is assumed that approximately half of the excavated sediment, or 2,900 yd^3, would require dewatering prior to off-site transportation. It is also assumed that stockpile dewatering would result in a reduction of approximately one third in the volume of sediment, which corresponds to the drainage and removal of approximately 1,933 yd^3 (390,389 gallons) of free water.

Once drained, the stockpiled sediment would be loaded onto trucks and transported to a permitted off-base TSDF as discussed under Component 3 of this alternative.

Component 3: Off-Base Disposal of Dewatered Pettibone Creek Sediment

This component would consist of transporting the excavated and dewatered sediment to a permitted off-base TSDF that would dispose of it by landfilling, with pre-treatment of the high-lead-content sediment with chemical stabilization/fixation.

For the purpose of this FS and taking into consideration the volume reduction achieved through stockpile dewatering, it is assumed that a total of approximately 4,880 yd^3 of sediment would require off-base disposal. Also, as previously discussed in Section 3, it is assumed that approximately 10 percent of that volume of sediment, or 483 yd^3, would require chemical stabilization/fixation. Because chemical stabilization/fixation typically results in an increase of approximately 10 percent in the volume of treated material, the total volume of material to be landfilled would be approximately 4,880 yd^3 (4,350 yd^3 as non-hazardous Subtitle D and 530 yd^3 as chemical stabilized non-hazardous Subtitle D).

If characterization of the removed sediment indicates excessive concentrations of PAHs and PCBs, a portion of the sediment may also have to be pre-treated with incineration. However, as previously discussed, site characterization data do not indicate such excessive concentrations and therefore it is assumed for the purpose of this FS that incineration pre-treatment would not be required. This component would also include the manifesting of the waste materials to be transported.

Component 4: Excavation of Lower Boat Basin Sediment and Consolidation with the Upper Boat Basin Sediment

For the purpose of this FS, it is assumed that sediment (approximately 6,000 yd^3) from the Lower Boat Basin would be excavated with an all-terrain, long-arm excavator. Excavated sediment from the Lower Boat Basin would be consolidated in the Upper Boat Basin.

Component 5: In-Situ Capping of Upper Boat Basin

In-situ capping would consist of installing a 75,000 ft^2 cover system over the contaminated sediment of the Upper Boat Basin. A concrete dam measuring 65 feet wide by 10 feet deep by 5 feet thick at the end of the Upper Boat Basin and beginning of the Lower Boat Basin (at the back end of Building 13) would be constructed in order to contain the contaminated sediment in the Upper Boat Basin. As required, site clearing and grading would be performed prior to capping by excavating peripheral areas and bringing the material from these areas into the main area to be capped. For the purpose of this FS, it is assumed that the cover system would consist of the following layers in ascending order: a permeable geotextile layer, a 2-foot-thick main layer of clean fine sand or sediment, and an 18-inch-thick armor layer of rip-rap stones. This cover system would be installed with normal construction equipment including front-end loader and graders.

Another option to the 18-inch-thick armor layer of rip-rap stones could be to design and construct a wetland system within the Boat Basin to enhance the natural setting at the site.

Component 6: Surface Water Controls

Surface water controls would consist of isolating the work areas (excavation or capping) with sand bag dikes and diverting water around these areas with mobile centrifugal pumps and fire or irrigation hoses. Surface water controls would also consist of installing silt screens or turbidity screens downstream of the work areas to capture potentially contaminated sediment particles that may have migrated as a result of remedial activities. A silt curtain/screen or turbidity screen, vertical barrier, or other means of surface water controls would be installed at the end of the Boat Basin and beginning of the Inner Harbor to minimize the migration of contaminated sediment into the Inner Harbor.

Component 7: Institutional Controls

This component would include similar institutional controls (Component 1) as those for Alternative 2 including adding Site 17 to the Navy's LUCMOA. In addition, institutional controls would include regular inspection, maintenance, and repair of the Upper Boat Basin cover system to make sure of its continued structural integrity.

Component 8: MNR

This component would be similar to Component 2 of Alternative 2 with the difference that each round of monitoring would consist of collecting four sediment samples and four surface water samples the Upper Boat Basin area.

4.3.3.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 3 would be protective of human health and the environment; however, there would be a temporary impact to benthic invertebrates. Excavation of the North Branch of Pettibone Creek and Lower Boat Basin sediment and the capping activities of the Upper Boat Basin would destroy the benthic invertebrate population that is present in these areas; however, it is expected that after some time, benthic invertebrates would again repopulate Pettibone Creek and Boat Basin with less chance of adverse consequences from chemical concentrations. Studies by the UK Marine Special Areas of Conservation indicate recovery of dredge habitats occur within months for muddy sediment to years for sandy/gravel sediment (http://www.ukmarinesac.org.uk/ activities/ports/ph5_2_2.htm). Consolidation of the Lower Boat Basin sediment under a cap covering the Upper Boat Basin and excavation and off-base disposal of the contaminated sediment from the North Branch of Pettibone Creek would significantly reduce risks from exposure of human and future ecological receptors to COCs. This remedial action would also protect human health and the environment by minimizing the potential for future migration of COCs.

Institutional controls would be protective of human health by restricting access to Site 17, preventing future development of the site, warning of consumption and catch and release requirements for fish caught in Pettibone Creek and the Boat Basin, and confirming continued structural integrity of the cover system.

Monitoring would be protective of human health and the environment by assessing the progress of natural recovery processes and by verifying that COCs are not migrating from the capped areas. Also, during monitoring events the repopulation of the benthic community would be observed to ensure return of these receptors to the area.

Some short-term risks could be incurred by workers from exposure to contamination during the implementation of this alternative. However, the potential for this exposure would be minimized by compliance with site-specific health and safety procedures, including the wearing of appropriate PPE.

Other than destruction of the current benthic population (although benthic invertebrates are expected to repopulate Pettibone Creek and the Boat Basin) no adverse short-term or cross-media effects are anticipated as a result of implementing this alternative.

Compliance with ARARs and TBCs

Alternative 3 would comply with chemical-, location-, and action-specific ARARs and TBCs. This alternative would not comply with chemical-specific ARARs in the short-term, but long-term compliance could be achieved through natural recovery.

Long-Term Effectiveness and Permanence

Alternative 3 would provide long-term effectiveness and permanence. Although no treatment would be used to reduce COCs concentrations in the contaminated sediment, these COCs would be effectively contained to limit exposure of human and ecological receptors and to minimize the potential for migration by the in-situ capping (Boat Basin) or the sediment with COCs will be excavated and disposed (North Branch Pettibone Creek).

Site access and land use restrictions and fish consumption warning and catch and release requirements would effectively limit unacceptable risk from exposure of human receptors to the potentially contaminated fish. Inspection, maintenance, and repair of the in-situ cover system would effectively confirm its continued structural integrity and effectiveness.

Monitoring would be a means to assess the effectiveness of natural recovery processes and to verify that COCs are not migrating from the capped areas.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 3 would reduce the mobility and volume of COCs through permanent removal and off-base disposal of approximately 5,800 yd^3 of North Branch Pettibone Creek sediment with concentrations of COCs greater than PRGs. Although toxicity and volume of contaminated sediment in the Boat Basin would not be reduced by treatment through this alternative, the mobility of the Boat Basin sediment would be reduced by the cap. The toxicity and volume of several COCs in the Boat Basin sediment could eventually be reduced over time through natural recovery processes. Alternative 3 would also achieve some reduction in the mobility of COCs through consolidation and in-situ capping. The cap reduces the mobility by physical isolation of the contaminated sediment from the aquatic environment; stabilization/erosion protection of contaminated sediment, preventing resuspension and transport from the Boat Basin; and chemical isolation/reduction of the movement of dissolved and colloidally transported contaminants. Residuals associated with the implementation of Alternative 3 would include site clearing and cap installation debris.

Short-Term Effectiveness

Alternative 3 would have some short-term effectiveness concerns. Exposure of workers to contamination during remediation and monitoring activities would be minimized by implementation of engineering controls (e.g., spill prevention) and compliance with the requirements of Occupational Safety and Health Administration and adherence to site-specific health and safety procedures, including the wearing of appropriate PPE. Alternative 3 would result in the destruction of ecological habitat in the areas to be excavated and capped. However, this destruction would be mitigated through post-excavation restoration of Pettibone Creek and the Boat Basin, which would provide habitat supportive of returning benthic populations. Alternative 3 would have no adverse impact on the surrounding community.

The RAOs are expected to be achieved immediately upon completion of the excavation and in-situ capping and implementation of institutional controls and MNR. Implementation of Alternative 3 might eventually result in compliance with PRGs through natural recovery, but the timeframe for compliance cannot be accurately estimated. As additional site-specific data becomes available, modeling might be performed to predict this timeframe.

Implementability

Alternative 3 would be readily implementable. The technical component of Alternative 3 would be implementable. Excavation of the North Branch of Pettibone Creek and the Lower Boat Basin, installation of an in-situ cover system in the Upper Boat Basin, sampling and analysis of sediment and surface water, and performance of five-year site reviews could readily be accomplished. The resources, equipment, and materials required to implement these activities are readily available; however, the Navy will not commit resources until it has been determined that the sources of upstream contamination have been eliminated.

The administrative aspects of Alternative 3 would also be relatively simple to implement. Preparation and implementation of LUCs and fish consumption warnings and catch and release requirements would be easy, because Site 17 is under military control. Construction permits would be needed for installation of excavation and capping activities, but these could be acquired with relative ease.

Cost

The estimated costs for Alternative 3 using a rip rap cap are:

- Capital Cost: $2,407,000
- 30-Year NPW of O&M Cost: $358,000
- 30-Year NPW: $2,765,000

The estimated costs for Alternative 3 using a wetland cap are:

- Capital Cost: $2,294,000
- 30-Year NPW of O&M Cost: $358,000
- 30-Year NPW: $2,652,000

A detailed breakdown of these costs is provided in Appendix B.

4.3.4 Alternative 4: Partial Excavation of North Branch of Pettibone Creek Sediment, Excavation of Upper and Lower Boat Basin Sediment, Surface Water Controls, On-Site Dewatering, and Off-Base Disposal of Excavated Sediment

4.3.4.1 Description

Alternative 4 is illustrated on Figure 4-3 and would consist of four major components: (1) excavation of contaminated sediment, (2) surface water controls, (3) on-site dewatering, and (4) off-base disposal of removed sediment.

Component 1: Excavation

Under this alternative, sediment with concentrations of COCs greater than PRGs would be excavated from the North Branch of Pettibone Creek and the Upper and Lower Boat Basin. However, a site-specific study could be conducted to develop less restrictive PRGs based on toxicity data to minimize costs of dredging or excavating the sediment in the North Branch of Pettibone Creek and the Boat Basin. As discussed in Section 2, it is estimated that a total of approximately 39,400 yd^3 of contaminated sediment would be excavated as follows:

AREA	Estimated Depth (feet)	Estimated Volume (yd^3)
Pettibone Creek North Branch	2	5,800
Upper Boat Basin	10	27,600
Lower Boat Basin	8	6,000
Total	-	**39,400**

For the purpose of this FS, it is assumed that sediment of the North Branch of Pettibone Creek would be excavated with a Gradall-type excavator and that sediment from the Boat Basin would be excavated with an all-terrain, long-arm excavator. For the purpose of this FS, it is also assumed that the excavation of the North Branch of Pettibone Creek would occur starting at the most upstream end and proceed downstream in incremental sections, each approximately 100 feet long. When the excavation of the North Branch has been completed, the Boat Basin would then be excavated.

During excavation, surface water would be diverted from the areas of sediment removal as described under Component 2 of this alternative.

Following excavation, the excavated areas would be sampled to verify that sediment containing COCs in excess of the PRGs have been removed. Also following excavation, the North Branch of Pettibone Creek would be backfilled with clean material and restored to pre-excavating conditions.

Excavated sediment would be loaded onto trucks for transportation to a permitted off-base TSDF as discussed under Component 4 of this alternative. As required, excess free water would be removed from the excavated sediment prior to loading onto trucks by temporary stockpiling and drainage in a dedicated area as discussed under Component 3 of this alternative. The trucks would be lined with plastic sheeting or have gasketed tailgates to prevent free liquid from leaking from the trucks.

Component 2: Surface Water Controls

This component would be similar to Component 6 of Alternative 3.

Component 3: On-Site Dewatering

This component would consist of dewatering the excessively wet excavated sediment by temporary stockpiling in a dedicated area near the Boat Basin. This area would be graded and surrounded by silt fences to allow drained free water to return to the Boat Basin while containing contaminated sediment. For the purpose of this FS, it is assumed that approximately half of the excavated sediment, or 19,700 yd^3, would require dewatering prior to off-base transportation. It is also assumed that stockpile dewatering would result in a reduction of approximately one third in the volume of sediment, which corresponds to the drainage and removal of approximately 6,600 yd^3 (1,300,000 gallons) of free water.

Once drained, the stockpiled sediment would be loaded onto trucks and transported to a permitted off-base TSDF as discussed under Component 4 of this alternative.

Component 4: Off-Base Disposal

This component would consist of transporting the excavated and dewatered sediment to a permitted off-base TSDF that would dispose of it by landfilling, with pre-treatment of the high-lead-content sediment with chemical stabilization/fixation.

For the purpose of this FS and taking into consideration the volume reduction achieved through stockpile dewatering, it is assumed that a total of approximately 32,800 yd^3 of sediment would require off-base disposal. Also, as previously discussed in Section 3, it is assumed that approximately 10 percent of that volume of sediment, or 3,300 yd^3, would require chemical stabilization/fixation. Because chemical stabilization/fixation typically results in an increase of approximately 10 percent in the volume of treated material, the total volume of material to be landfilled would be approximately 33,100 yd^3.

If characterization of the removed sediment indicates excessive concentrations of PAHs and PCBs, a portion of the sediment may also have to be pre-treated with incineration. However, as previously discussed, site characterization data do not indicate such excessive concentrations and therefore it is assumed for the purpose of this FS that incineration pre-treatment would not be required.

This component would also include the manifesting of the waste materials to be transported.

4.3.4.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 4 would be protective of human health and the environment; however, there would be a temporary impact to benthic invertebrates. Excavation of the North Branch of Pettibone Creek and Boat Basin sediment would destroy the benthic invertebrate population that is present in these areas; however, it is expected that after some time, benthic invertebrates would again repopulate Pettibone Creek and Boat Basin with less chance of adverse consequences from chemical concentrations. Removal of contaminated sediment from its present location and off-base disposal of this material would eliminate human health and environmental risk from exposure of human and future ecological receptors. These remedial activities would also protect human health and the environment by removing the potential for future off-site migration of COCs.

Some short-term risks could be incurred by workers from exposure to contamination during the implementation of this alternative. However, the potential for this exposure would be minimized by the wearing of appropriate PPE and compliance with site-specific health and safety procedures.

Other than destruction of the current benthic population (although benthic invertebrates are expected to repopulate) no adverse short-term or cross-media effects are anticipated as a result of implementing this alternative.

Compliance with ARARs and TBCs

Alternative 4 would comply with chemical-, location-, and action-specific ARARs and TBCs.

Long-Term Effectiveness and Permanence

Alternative 4 would provide long-term effectiveness and permanence. Contaminated sediment would be removed from their present locations and permanently and irreversibly disposed off base. COCs would be securely contained by landfilling and, as required, chemical stabilization/fixation.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4 would reduce the mobility and volume of COCs through permanent removal and off-base disposal of approximately 32,800 yd^3 of sediment with concentrations of COCs greater than PRGs.

Within that volume, the mobility of the inorganic COCs contained in approximately 3,300 yd^3 of high-lead-content sediment would be permanently and irreversibly reduced through chemical stabilization/fixation.

Alternative 4 would generate a wastewater residual from the on-site sediment dewatering operations, but it is anticipated that this wastewater could be discharged back to the Boat Basin without treatment.

Short-Term Effectiveness

Alternative 4 would have some short-term effectiveness concerns. Exposure of workers to contamination during remediation activities would be minimized by implementation of engineering controls (e.g., spill prevention) and compliance with site-specific health and safety procedures, including the wearing of appropriate PPE. Alternative 4 would result in a significant destruction of ecological habitat in the areas to be excavated. However, this destruction would be mitigated through post-excavation restoration that would provide habitat supportive of returning benthic populations. The transportation of contaminated sediment to the off-base disposal facility could impact the surrounding community. This impact would be minimized through the implementation of truck decontamination, spill prevention, and traffic control measures.

The RAOs and PRGs would be achieved immediately upon completion of the excavation of contaminated sediment.

Implementability

Alternative 4 would be readily implementable. Excavation of contaminated sediment, implementation of surface water controls, on-site dewatering of sediment, and off-base transportation of removed sediment could readily be accomplished. Several permitted off-base TSDFs are available for the pre-treatment and landfilling of the removed sediment. The resources, equipment, and materials required to implement these activities are readily available; however, the Navy will not commit resources until it has been determined that the sources of upstream contamination have been eliminated.

Implementation of Alternative 4 would require multiple administrative tasks. Construction permits would have to be obtained, authorizations would have to be secured for acceptance of the contaminated sediment by an off-base TSDF, and manifests would have to be prepared for waste transportation. However, these tasks could be accomplished with relative ease. If Alternative 4 is used, the design would include reconstruction activities to correct the slope stability and erosion issues as discussed in the

Environmental Assessment for Erosion Control for Pettibone Creek (Maguire Group Inc., 1993) and the Comprehensive Slope Stability and Erosion Study (STS Consultants LTD., 1988).

Cost

The estimated costs for Alternative 4 are:

- Capital Cost: $4,689,000
- O&M Cost: $0
- NPW: $4,689,000

A detailed breakdown of these costs is provided in Appendix B.

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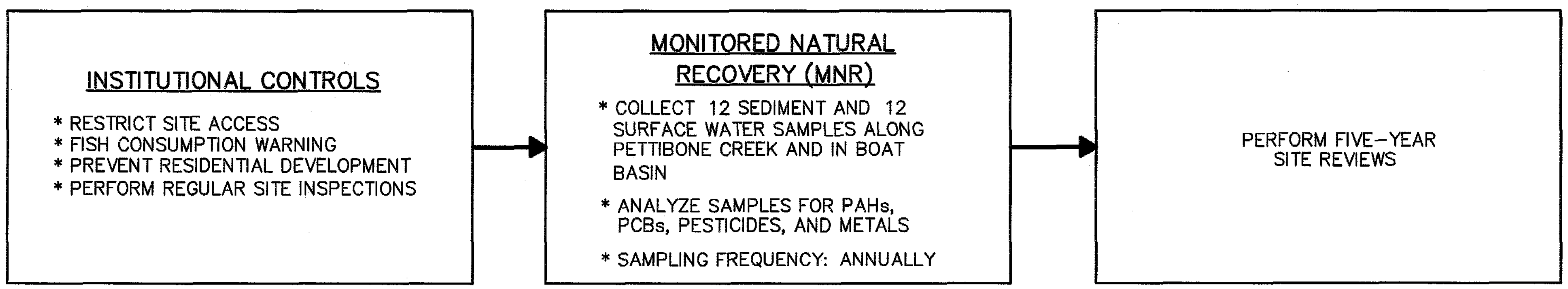
INSTITUTIONAL CONTROLS AND MONITORED NATURAL RECOVERY (MNR)



NOTES:

PCBs POLYCHLORINATED BIPHENYLS

PAHs POLYNUCLEAR AROMATIC HYDROCARBONS

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ALTERNATIVE 2 BLOCK FLOW DIAGRAM
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

FORM CADD NO. SDIV-BH.DWG - REV 1 - 9/10/98

PARTIAL EXCAVATION AND DISPOSAL OF NORTH BRANCH OF PETTIBONE CREEK SEDIMENT, EXCAVATION OF LOWER BOAT BASIN SEDIMENT, IN-SITU CAPPING OF THE UPPER BOAT BASIN, SURFACE WATER CONTROLS, INSTITUTIONAL CONTROLS, AND MONITORED NATURAL RECOVERY (MNR)

EXCAVATION OF LOWER BOAT BASIN AND SURFACE WATER CONTROLS

EXCAVATE A TOTAL OF 6,000 YD^3 SEDIMENT
* DIVERT PETTIBONE CREEK TO INNER HARBOR
* EXCAVATE TO A DEPTH OF 8 FT WITH WITH ALL-TERRAIN, LONG-ARM EXCAVATOR
* COLLECT POST-EXCAVATION SAMPLES AND ANALYZE FOR PAHs, PCBs, PESTICIDES, & METALS

→

IN-SITU CAPPING OF UPPER BOAT BASIN AND SURFACE WATER CONTROLS

UPPER BOAT BASIN
* CONSOLIDATE SEDIMENT EXCAVATED FROM LOWER BOAT BASIN
* CONSTRUCT DAM
* CLEAR AND GRADE SITE
* INSTALL CAP CONSISTING OF IN ASCENDING ORDER: GEOTEXTILE LAYER, 24 INCHES OF SAND, 18 INCHES OF RIP-RAP

→

INSTITUTIONAL CONTROLS

* RESTRICT SITE ACCESS
* FISH CONSUMPTION WARNING
* PREVENT RESIDENTIAL DEVELOPMENT
* PERFORM REGULAR SITE INSPECTIONS

→

MONITORED NATURAL RECOVERY (MNR)

* COLLECT SEDIMENT AND SURFACE WATER SAMPLES IN UPPER BOAT BASIN
* ANALYZE SAMPLES FOR PAHs, PCBs, PESTICIDES, AND METALS
* SAMPLING FREQUENCY: ANNUALLY

→

PERFORM FIVE-YEAR SITE REVIEWS

PARTIAL EXCAVATION OF NORTH BRANCH PETTIBONE CREEK AND SURFACE WATER CONTROLS

EXCAVATE A TOTAL OF 5,800 YD^3 SEDIMENT FROM 20 SECTIONS, EACH 100 FT LONG
* DIVERT STREAM AROUND SECTION
* EXCAVATE TO A DEPTH OF 24 INCHES WITH GRADE-ALL EXCAVATOR
* COLLECT POST-EXCAVATION SAMPLES AND ANALYZE FOR PAHs, PCBs, PESTICIDES, & METALS
* BACKFILL WITH CLEAN MATERIAL AND RESTORE SITE

→

ON-SITE DEWATERING

* CLEAR AND GRADE DEWATERING AREA ALONG NORHTERN EDGE OF UPPER BOAT BASIN OR ALONG EDGE OF PETTIBONE CREEK
* INSTALL SILT FENCE TO ISOLOATE DEWATERING AREA
* STOCKPILE SEDIMENT EXCAVATED FROM PETTIBONE CREEK (5,800 YD^3) IN DEWATERING AREA
* LET FREE WATER (1,933 YD^3) DRAIN THROUGH SILT FENCE INTO BOAT BASIN OR PETTIBONE CREEK

→

OFF-BASE DISPOSAL

* TRANSPORT TOTAL OF 4,350 YD^3 SEDIMENT TO OFF-BASE PERMITTED TSDF
* PREPARE MANIFESTING FOR SEDIMENT
* CHEMICALLY FIXATE 483 YD^3 SEDIMENT WITH HIGH LEAD CONTENT
* DISPOSE 4,880 YD^3 SEDIMENT IN NON-HAZARDOUS LANDFILL

NOTES:

FT	FOOT/FEET
PCBs	POLYCHLORINATED BIPHENYLS
PAHs	POLYNUCLEAR AROMATIC HYDROCARBONS
YD^3	CUBIC YARD(s)

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ALTERNATIVE 3 BLOCK FLOW DIAGRAM
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

FORM CADD NO. SDIV-BH.DWG - REV 1 - 9/10/98

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PARTIAL EXCAVATION OF NORTH BRANCH OF PETTIBONE CREEK SEDIMENT, EXCAVATION OF UPPER AND LOWER BOAT BASIN, SURFACE WATER CONTROLS, ON-SITE DEWATERING AND OFF-BASE DISPOSAL OF EXCAVATED SEDIMENT

EXCAVATION AND SURFACE WATER CONTROLS

PETTIBONE CREEK NORTH BRANCH
EXCAVATE A TOTAL OF 5,800 YD^3 SEDIMENT FROM 20 SECTIONS, EACH 100 FT LONG

* DIVERT STREAM AROUND SECTION
* EXCAVATE TO A DEPTH OF 24 INCHES WITH GRADE-ALL EXCAVATOR
* COLLECT POST-EXCAVATION SAMPLES AND ANALYZE FOR PAHs, PCBs, PESTICIDES, & METALS
* BACKFILL WITH CLEAN MATERIAL AND RESTORE SITE

BOAT BASIN
EXCAVATE A TOTAL OF 33,600 YD^3 SEDIMENT

* DIVERT PETTIBONE CREEK TO INNER HARBOR
* EXCAVATE UPPER BASIN TO A DEPTH OF 10 FT AND LOWER BASIN TO A DEPTH OF 8 FT WITH ALL-TERRAIN, LONG-ARM EXCAVATOR
* COLLECT POST-EXCAVATION SAMPLES AND ANALYZE FOR PAHs, PCBs, PESTICIDES, & METALS

→

ON-SITE DEWATERING

* CLEAR AND GRADE 10,000-FT^2 DEWATERING AREA ALONG NORTHERN EDGE OF UPPER BOAT BASIN
* INSTALL SILT FENCE TO ISOLATE DEWATERING AREA
* STOCKPILE HALF OF SEDIMENT EXCAVATED FROM PETTIBONE CREEK AND BOAT BASIN (19,700 YD^3) IN DEWATERING AREA
* LET FREE WATER (6,600 YD^3) DRAIN THROUGH SILT FENCE INTO BOAT BASIN

→

OFF-BASE DISPOSAL

* TRANSPORT TOTAL OF 32,800 YD^3 SEDIMENT TO OFF-BASE PERMITTED TSDF
* PREPARE MANIFESTING FOR SEDIMENT
* CHEMICALLY FIXATE 3,300 YD^3 SEDIMENT WITH HIGH LEAD CONTENT
* DISPOSE 33,100 YD^3 SEDIMENT IN NON-HAZARDOUS LANDFILL

KEY:

FT	FOOT/FEET
FT^2	SQUARE FOOT/FEET
PCBs	POLYCHLORINATED BIPHENYLS
PAHs	POLYNUCLEAR AROMATIC HYDROCARBONS
TSDF	TREATMENT, STORAGE, AND DISPOSAL FACILTY
YD^3	CUBIC YARD(s)

DRAWN BY HJB / DATE 7/13/05	NAVFAC	ALTERNATIVE 4 BLOCK FLOW DIAGRAM SITE 17 FEASIBILITY STUDY NAVAL STATION GREAT LAKES, ILLINOIS	CONTRACT NO. 7303
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FORM CADD NO. SDIV-BH.DWG - REV 1 - 9/10/98

5.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

This section compares the analyses that were presented for each of the remedial alternatives in Section 4.0 of this FS. The criteria for comparison are identical to those used for the detailed analysis of individual alternatives.

5.1 COMPARISON OF REMEDIAL ALTERNATIVES BY CRITERIA

The following remedial alternatives are compared in this section:

- Alternative 1: No Action
- Alternative 2: Institutional Controls and MNR
- Alternative 3: Partial Excavation and Disposal of North Branch of Pettibone Creek Sediment, Excavation of Lower Boat Basin Sediment, In-Situ Capping of the Upper Boat Basin, Surface Water Controls, Institutional Controls, and MNR
- Alternative 4: Partial Excavation and Disposal of North Branch of Pettibone Creek Sediment, Excavation of Upper and Lower Boat Basin Sediment, Surface Water Controls, On-Site Dewatering, and Off-Base Disposal of Excavated Sediment

5.1.1 Overall Protection of Human Health and the Environment

Alternative 1 would not provide for protection of human health and the environment because COCs would remain in shallow sediment in excess of PRGs which could pose unacceptable risk to potential human and ecological receptors. Neither possible direct human exposures to contaminated sediment through swimming or wading nor indirect exposures through fish consumption would be restricted. Also, no warnings (other than the Lake Michigan Fish Advisories) would be posted in order to minimize possible human exposures to fish potentially contaminated with COCs above safe consumption levels.

Although Alternative 2 would allow COCs to remain in sediment at concentrations greater than PRGs and possibly migrate off site, it would be protective of human health by reducing risk from exposure to COCs through restrictions on site usage, specific fish consumption warnings and catch and release requirements, periodic monitoring of the expected natural recovery process, and warning of potential

COC migration. However, the limited ecological risks at the site would remain with benthic invertebrate exposure to contaminants in the sediment and potential fish and piscivorous bird exposures to contaminants by consumption of contaminated sediment invertebrates until such time as natural recovery reduces concentrations of COCs to less than the PRGs.

Alternative 3 would be more protective than Alternative 2 by further reducing known or potential human health and ecological risks from direct and/or indirect exposures through consolidation and in-situ capping of contaminated sediment in the Upper Boat Basin and excavation and off-base disposal of the contaminated sediment from the North Branch of Pettibone Creek. However, there would be a temporary impact to benthic invertebrates from the excavation and capping activities.

Alternative 4 would provide the highest level of protection by further minimizing known or potential human health and ecological risks from direct and/or indirect exposures from COCs through removal and off-base disposal of contaminated sediment above PRGs from the Boat Basin and portions of the North Branch of Pettibone Creek. However, there would be a temporary impact to benthic invertebrates from the excavation activities.

5.1.2 Compliance with ARARs and TBCs

Alternative 1 would not comply with chemical- and location-specific ARARs. Action-specific ARARs or TBCs would not apply.

In the short-term, Alternative 2 would not comply with chemical-specific ARARs and TBCs, but this alternative might eventually achieve compliance in attaining the PRGs through natural recovery. Alternative 2 would comply with location- and action-specific ARARs and TBCs.

Alternatives 3 and 4 would comply with chemical-, location-, and action-specific ARARs and TBCs.

5.1.3 Long-Term Effectiveness and Permanence

Alternative 1 would have very limited long-term effectiveness and permanence because no COCs would be removed through treatment although, over time, some reduction in COC concentrations might occur through natural recovery. Because site access and development would be unrestricted and fish consumption would not be regulated, the potential would also exist for unacceptable human health and ecological risk to develop due to exposure to COCs. Since there would be no monitoring, potential off-site migration of COCs would remain undetected.

Alternative 2 would provide some long-term effectiveness and permanence because it would minimize human health risk from exposure to COCs through restrictions to be placed upon swimming in the Boat Basin, the imposition of fish catch and release requirements within the Boat Basin area and posting of on-site signs and periodic publishing of fish consumption warnings. Alternative 2 would also effectively assess the progress of natural recovery and the timeframe for potential termination of institutional controls and would warn of potential off-site migration of COCs and/or contamination from upstream sources. Ecological risks at the site would be addressed to the extent that natural recovery would result in reduced potential exposures by invertebrates, fish and birds over time with additional sedimentation and the biodegradation of contaminants.

Alternative 3 could provide more long-term effectiveness and permanence than Alternative 2 because, in addition to the same remedial measures, a portion of the contaminated sediment would be excavated and disposed off-base from North Branch of Pettibone Creek and would be permanently removed from the Lower Boat Basin and consolidated with the remaining contaminated sediment under an in-situ cap in the Upper Boat Basin that would provide a permanent barrier between contaminated sediment and surface water and human and ecological receptors. It should be noted; however, that implementation of Alternative 3 would result in destruction of the current benthic population. This is expected to be a short-term impact; because over a period of time it is anticipated that benthic invertebrates will repopulate Pettibone Creek and the Boat Basin.

Alternative 4 could provide the most long-term effectiveness and permanence remedy because it would permanently remove contaminated sediment from the site in an environmentally safe manner. However, as with the other alternatives, the true long term effectiveness or at least significant reduction in future contaminant migration is dependent on both known and presently unknown upstream source(s). As with Alternative 3, implementation of Alternative 4 would result in the destruction of the current benthic population of Pettibone Creek and the Boat Basin. Although this is considered a short-term impact only, the long-term consequence of destruction of the current benthic population and repopulation by new individuals is that the population will be different than it was originally.

5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 1 and 2 would not reduce the toxicity, mobility, or volume of COCs through treatment. These two alternatives might eventually reduce toxicity, mobility, and volume through natural recovery; however, this reduction would only be verified and quantified with Alternative 2. There would be no treatment residuals associated with Alternatives 1 and 2.

Alternative 3 would reduce the mobility and volume of COCs through permanent removal and off-base disposal of North Branch Pettibone Creek sediment with concentrations of COCs greater than PRGs. Alternative 3 would not reduce the toxicity or volume of COCs in the Boat Basin through treatment but the alternative would provide some reduction of mobility of the contaminants due to the in-situ capping portion of the remedy. The cap reduces the mobility by physical isolation of the contaminated sediment from the aquatic environment; stabilization/erosion protection of contaminated sediment, preventing resuspension and transport from the Boat Basin; and chemical isolation/reduction of the movement of dissolved and colloidally transported contaminants. This alternative might eventually reduce toxicity and volume through natural recovery; however, this reduction would only be verified and quantified. Some residuals from site clearing and cap installation will be generated with the implementation of Alternative 3.

Alternative 4 would reduce the mobility and volume of COCs through removal and off-base disposal of approximately 33,100 yd^3 of sediment with concentrations of COCs greater than PRGs. Within that volume, the mobility of the inorganic COCs contained in approximately 3,300 yd^3 of high-lead-content sediment would be permanently and irreversibly reduced through chemical stabilization/fixation. Alternative 4 would generate a wastewater residual from the on-site sediment dewatering operations, but it is anticipated that this wastewater could be discharged back to Pettibone Creek or the Boat Basin without treatment.

5.1.5 Short-Term Effectiveness

Implementation of Alternative 1 would not result in risks to site workers or adversely impact the surrounding community or environment because no remedial activities would be performed. Alternative 1 would not achieve the RAOs in the short term and although the PRGs might eventually be attained through natural recovery, this would not be verified through sediment monitoring.

Implementation of Alternative 2 would result in a slight possibility of exposing site workers to contamination during monitoring activities. However, this risk of exposure would be effectively controlled through compliance with applicable Occupational Safety and Health Act regulations and proper site-specific health and safety procedures. Implementation of Alternative 2 would not adversely impact the surrounding community or environment. Alternative 2 would be expected to achieve the human health RAOs immediately upon implementation of institutional controls and monitoring. It is expected that PRGs would be attained through natural recovery, and this would be verified through monitoring. At this time, the timeframe for attainment of PRGs cannot be accurately estimated.

Implementation of Alternatives 3 and 4 would result in the possibility of exposing construction workers to contamination during remedial activities. However, the risk of exposure could be effectively controlled by the implementation of engineering controls (e.g., spill prevention) and compliance with applicable Occupational Safety and Health Act regulations and proper site-specific health and safety procedures. Implementation of Alternative 3 would not adversely impact the surrounding community, but implementation of Alternative 4 potentially could because contaminated sediment would be transported over public roads. However, the potential for adverse impact would be effectively addressed through implementation of such appropriate measures as decontamination of transport vehicles, traffic control, and spill prevention and emergency response.

Alternatives 3 and 4 would achieve short-term effectiveness upon the respective completion of the in-situ cap and removal of contaminated sediment. It is expected that Alternative 3 would attain the PRGs through natural recovery, but the required timeframe cannot be accurately estimated. Additionally, Alternatives 3 and 4 would attain the PRGs upon completion of the removal of contaminated sediment.

5.1.6 Implementability

Alternative 1 would be extremely simple to implement because no action would occur.

The technical implementability of Alternative 2 would be fairly simple, because it would require implementation of selective institutional controls and sediment monitoring. The necessary equipment and materials are available should the appropriate authority later be obtained through Navy channels to proceed.

The technical implementability of Alternative 3 would be significantly more difficult than that of Alternative 2. In addition to institutional controls and sediment monitoring, this alternative would require the excavation and off-base disposal of contaminated sediment from the North Branch of Pettibone Creek, the excavation and consolidation for the Lower Boat Basin sediment with the Upper Boat Basin sediment and installation of an in-situ cap, and the implementation of interim surface water controls. However, these activities would be technically implementable and the necessary resources, equipment and materials are readily available should the appropriate authority be obtained through Navy channels to proceed. The Navy will not commit resources until it has been determined that the sources of upstream contamination have been eliminated.

The technical implementability of Alternative 4 would be comparable or slightly easier to that of Alternative 3. Alternative 4 would not require in-situ capping, but it would require on-site dewatering and off-base transportation and disposal. The necessary resources, equipment, and materials are readily available should the appropriate authority be obtained through Navy channels to proceed. The Navy will not commit resources until it has been determined that the sources of upstream contamination have been eliminated.

Administratively, Alternatives 2 and 3 would require the development and implementation of institutional controls and the performance of long-term monitoring and five-year site reviews. Alternative 3 could also require a construction permit(s) for the excavation of sediment and installation of an in-situ cap. Alternative 4 would not require institutional controls, long-term monitoring, or five-year reviews, but it would require a construction/dredging permit(s) for the excavation and on-site dewatering of sediment. Alternatives 3 and 4 would also require manifesting for transportation of the removed sediment, as well as acceptance of that sediment by an off-base TSDF. These administrative requirements could readily be met.

5.1.7 Cost

The capital and O&M costs and NPW of the alternatives are summarized as follows:

Alternative	Capital ($)	NPW of O&M ($)	NPW ($)
1	0	0	0
2	25,000	419,000 (30-Year)	444,000 (30-Year)
3 rip rap cap	2,407,000	358,000 (30-Year)	2,765,000 (30-Year)
3 wetland cap	2,294,000	358,000 (30-Year)	2,652,000 (30-Year)
4	4,689,000	0	4,689,000 (1-Year)

Detailed cost estimates are provided in Appendix B.

5.2 SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

Table 5-1 summarizes the comparative analysis of the four remedial alternatives.

TABLE 5-1

SUMMARY OF COMPARATIVE EVALUATION OF REMEDIAL ALTERNATIVES
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Evaluation Criteria	Alternative 1: No Action	Alternative 2: Institutional Controls and MNR	Alternative 3: Partial Excavation and Disposal of North Branch of Pettibone Creek Sediment, Excavation of Lower Boat Basin Sediment, In-Situ Capping of the Upper Boat Basin, Surface Water Controls, Institutional Controls, and MNR	Alternative 4: Partial Excavation and Disposal of North Branch of Pettibone Creek Sediment, Excavation of Upper and Lower Boat Basin Sediment, Surface Water Controls, On-Site Dewatering, and Off-Base Disposal of Excavated Sediment
Overall Protection of Human Health and Environment	Would not be protective because there would be a continued risk from exposure to COCs. Also, potential COC migration would remain unchecked and unreported.	Would be protective of human health by reducing risk from exposure to COCs by restricting site access and development, posting fish consumption warnings and catch and release requirements, assessing natural recovery, and warning of potential COC migration. However, the ecological risks at the site would remain.	Would be more protective of human health and the environment than Alternative 2 by further reducing risk from exposure to COCs by excavation and off-base disposal and excavation, consolidation, and in-situ capping of contaminated sediment areas. However, there would be a temporary impact to benthic invertebrates from the excavation and capping activities.	Would be most protective by eliminating human health and ecological risk from exposure to COCs through removal and off-base disposal of contaminated sediment. However, there would be a temporary impact to benthic invertebrates from the excavation activities.
Compliance with ARARs and TBCs: Chemical-Specific Location-Specific Action-Specific	 Would not comply Would not comply Not applicable	 Might eventually comply Would comply Would comply	 Might eventually comply Would comply Would comply	 Would comply Would comply Would comply
Long-Term Effectiveness and Permanence	Would not be long-term effective and permanent because COCs would remain on-site with no protective measure against exposure and potential off-site migration.	Would be long-term effective and permanent. Site access and development restrictions and fish consumption warnings and catch and release requirements would effectively prevent unacceptable human health risk from exposure to COCs. Monitoring would assess natural recovery and warn of potential COCs migration.	Would be more long-term effective and permanent than Alternative 2 because, in addition to the same remedial measures, contaminated sediment would be removed from several areas. Some of the contaminated sediment would be disposed off-base and some would be consolidated and a clean buffer zone placed between the remaining area of contaminated sediment and surface water that would reduce the risks from exposure and potential off-site migration. The true long term effectiveness or at least significant reduction in future contaminant migration is dependent on both known and presently unknown upstream source(s).	Would be most long-term effective and permanent because contaminated sediment would be removed from the site, thereby eliminating risk from exposure. In addition, COCs would be contained by landfilling and, as required, chemical stabilization/fixation. The true long term effectiveness or at least significant reduction in future contaminant migration is dependent on both known and presently unknown upstream source(s).
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Would not achieve reduction of toxicity, mobility, or volume of contamination through treatment. Might achieve reduction of toxicity and volume through natural recovery, but the timeframe is unknown.	Would not achieve reduction of toxicity, mobility, or volume of COCs through treatment. Might achieve reduction of toxicity, mobility, and volume through natural recovery, but the timeframe is unknown.	Would achieve reduction of COC toxicity and volume through excavation and disposal of the North Branch of Pettibone Creek sediment. Would achieve reduction of COC mobility through consolidation and in-situ capping of the Boat Basin sediment. Reduction of toxicity, mobility, and volume might also be achieved through natural recovery, but the timeframe is unknown.	Would achieve reduction of COC toxicity, mobility, and volume through removal and treatment. Approximately 33,100 yd^3 of contaminated sediment would be permanently removed from the site and within that volume the COCs contained in approximately 3,300 yd^3 would be chemically fixated.

TABLE 5-1

SUMMARY OF COMPARATIVE EVALUATION OF REMEDIAL ALTERNATIVES
SITE 17 FEASIBILITY STUDY
NAVAL STATION GREAT LAKES, ILLINOIS

Evaluation Criteria	Alternative 1: No Action	Alternative 2: Institutional Controls and MNR	Alternative 3: Partial Excavation and Disposal of North Branch of Pettibone Creek Sediment, Excavation of Lower Boat Basin Sediment, In-Situ Capping of the Upper Boat Basin, Surface Water Controls, Institutional Controls, and MNR	Alternative 4: Partial Excavation and Disposal of North Branch of Pettibone Creek Sediment, Excavation of Upper and Lower Boat Basin Sediment, Surface Water Controls, On-Site Dewatering, and Off-Base Disposal of Excavated Sediment
Short-Term Effectiveness	Would not result in short-term risks to site workers or adversely impact the surrounding community, but would also not achieve RAOs or meet the PRGs.	Would result in slight risk of exposure to site workers during monitoring with no risk to surrounding community. Risk would be adequately controlled through compliance with site-specific health and safety procedures. RAOs would be achieved immediately upon implementation. PRGs might be attained through natural recovery, but the timeframe is unknown.	Would result in significant risk of exposure to workers with no risk to surrounding community during remedial activities. Risks would be adequately controlled by engineering controls (e.g., spill prevention) and compliance with site-specific health and safety procedures. Implementation would result in the destruction of the current benthic population; however, it is expected that benthic invertebrates will repopulate Pettibone Creek and Boat Basin with time. RAOs would be achieved immediately upon implementation. PRGs might be attained through natural recovery, but the timeframe is unknown.	Would result in significant risk of exposure to workers and slight risk of impact to surrounding community during remedial activities. These risks would be adequately controlled by engineering controls (e.g., spill prevention) and compliance with site-specific health and safety procedures. Implementation would result in the destruction of the current benthic population; however, it is expected that benthic invertebrates will repopulate Pettobone Creek and Boat Basin with time. RAOs would be expected to be achieved immediately upon implementation. PRGs would be attained within 1 year.
Implementability	Not applicable	Would be technically simple to implement. Necessary resources, equipment, and materials are readily available. Administratively, would require LUCs and five-year reviews but no construction permit.	Would be technically more difficult to implement than Alternative 2 because it would require significant construction activities in addition to institutional controls and monitoring. However, the components would be technically feasible, and the necessary resources, equipment, and materials are readily available. Administratively, would require construction permits, LUCs, and five-year reviews, which are achievable. The Navy will not commit resources until it has been determined that the sources of upstream contamination have been eliminated.	Would be technically comparable or slightly easier to implement as Alternative 3. The components would be technically feasible, and the necessary resources, equipment, and materials are readily available. Administratively, would require construction permits, transportation manifesting, and acceptance from an off-base TSDF. These would be readily achievable. The Navy will not commit resources until it has been determined that the sources of upstream contamination have been eliminated.
Costs: Capital NPW of O&M NPW	 $0 $0 $0	 $25,000 $419,000 (30 years) $444,000 (30 years)	Rip Rap Cap / Wetland Cap $2,407,000 / $2,294,000 $358,000 $ (30 years) / $358,000 (30 years) $2,765,000 (30 years) / $2,652,000 (30 years)	 $4,689,000 $0 $4,689,000 (1 year)

NOTES:

ARAR	Applicable or Relevant and Appropriate Requirement	MNR	Monitored Natural Recovery	PRG	Preliminary Remedial Goal
COC	Chemical of Concern	NPW	Net Present Worth	RAO	Remedial Action Objective
LUC	Land Use Control	O&M	Operation and Maintenance	TSDF	Treatment, Storage, and Disposal Facility

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APPENDIX A

CONTAMINATED SEDIMENT VOLUMES COMPUTATIONS

CLIENT: Naval Training Center Great Lakes		JOB NUMBER: CTO 341 N7303.SC0110100
SUBJECT: Site 17 - Area and Volume Calculations		
BASED ON:		DRAWING NUMBER:
BY: TJR Date: 3-31-04 & 5-3-05	CHECKED BY: Date:	APPROVED BY: DATE:

Pettibone Creek

Creek's length measured from Navy General Development Map - #787793
Creek's width assumed from information provided by sampling crews
Excavation depth assumed at 1 foot & 2 foot

	Length (ft)	Width (ft)	Area (sf)	Vol 1' (cy)	Vol 2' (cy)
Boat Basin to N/S Branch of Creek	920	25	23,000	852	1,704
N/S Branch of Creek to West Branch	1,450	20	29,000	1,074	2,148
West Branch to Culvert under Sheridan	920	15	13,800	511	1,022
West Branch	800	15	12,000	444	889
	4,090		77,800	2,881	5,763
		Area (sy)	8,644		

Boat Basin

Basin's area planimetered from Navy Base Maps - #80091: L5 & M5
Excavation depth (sediment removal) in Upper Basin at 8 foot & 10 foot
Excavation depth (sediment removal) in Lower Basin at 6 foot & 8 foot

	Map (in sq)	Area (sf)	Vol 6' (cy)	Vol 8' (cy)	Vol 10' (cy)
Upper Basin	29.74	74,350		22,030	27,537
Lower Basin	8.11	20,275	4,506	6,007	

Summary

Areas:	Pettibone Creek	77,800 sq ft	or	8,644 sq yd
	Upper Basin	74,350 sq ft	or	8,261 sq yd
	Lower Basin	20,275 sq ft	or	2,253 sq yd

Volumes:	Pettibone Creek: 1'	2,881 cubic yards
	Pettibone Creek: 2'	5,763 cubic yards
	Upper Basin: 8'	22,030 cubic yards
	Upper Basin: 10'	27,537 cubic yards
	Lower Basin: 6'	4,506 cubic yards
	Lower Basin: 8'	6,007 cubic yards

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Alternative 2

Number of signs
Assume one sign every 100 feet on both sides of creek and around basin.

Length of creek =	4,090	feet	
	100	feet between signs	
	41	signs x 2 sides =	82 signs
Length around basin =	1,360	feet	
	100	feet between signs	
	14	signs	14 signs
			96 total signs

Annual Inspection
Assume 1 day to inspect with 2 people

2 people @ $55.00 per hour for 10 hours =	$	1,100
car for one day =	$	100
report @ $55.00 per hour for 4 hours =	$	220
Misc supplies, copying, etc. =	$	150
	$	1,570

Sampling per round (Labor & Materials)
Assume 4 1/2 days to sample with 2 people

2 people @ $55.00 per hour for 10 hours per for 4.5 days =	$	4,950
car in field for three days =	$	300
report @ $55.00 per hour for 4 hours =	$	220
Misc supplies, copying, etc. =	$	150
	$	5,620

Sampling per round (Analytical)
Collect 12 sediment & 12 water samples and analyze for PAHs, PCB, pesticides, metals

type	cost each	number	total
sediment PAHs	$ 250	12	$ 3,000
water PAHs	$ 250	12	$ 3,000
sediment PCB & pesticides	$ 125	12	$ 1,500
water PCB & pesticides	$ 125	12	$ 1,500
sediment metals	$ 150	12	$ 1,800
water metals	$ 150	12	$ 1,800
			$ 12,600
40% QA/QC & Data Validation			$ 5,040
			$ 17,640

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5-Year Review
Assume 5-year review includes review of past data and additional at-depth sediments sampling

5-year review & report	$	15,000
at-depth sampling with sub-contractor	$	7,520
	$	22,520

Alternative 3 (Annual Cost)

Annual Inspection
Assume 1 day to inspect with 2 people

2 people @ $55.00 per hour for 10 hours =	$	1,100
car for one day =	$	100
report @ $55.00 per hour for 4 hours =	$	220
Misc supplies, copying, etc. =	$	150
	$	1,570

Sampling per round (Labor & Materials)
Assume 2 days to sample with 2 people

2 people @ $55.00 per hour for 10 hours per for 2 days =	$	2,200
car for two days =	$	200
report @ $55.00 per hour for 4 hours =	$	220
Misc supplies, copying, etc. =	$	150
	$	2,770

Sampling per round (Analytical)
Collect 4 sediment & 4 water samples and analyze for PAHs, PCB, pesticides, metals

type	cost each		number	total	
sediment PAHs	$	250	4	$	1,000
water PAHs	$	250	4	$	1,000
sediment PCB & pesticides	$	125	4	$	500
water PCB & pesticides	$	125	4	$	500
sediment metals	$	150	4	$	600
water metals	$	150	4	$	600
				$	4,200
40% QA/QC & Data Validation				$	1,680
				$	5,880

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5-Year Review

Assume 5-year review includes review of past data and additional at-depth sediments sampling

5-year review & report	$	15,000
at-depth sampling with sub-contractor	$	7,520
	$	22,520

Cap Inspection

Inspection of cap included with annual inspection

Cap Repair and Maintenance (annually)

Assume 2 days with 2 people

2 people @ $55.00 per hour for 10 hours per for 2 days =	$	2,200
Replacement sand, geotextile and rock =	$	7,000
Skid loader and tools =	$	500
	$	9,700

Alternative 3 (Capital Cost)

Site Survey

Area: Pettibone Creek	77,800	sf	
Upper Boat Basin	74,350	sf	
Lower Boat Basin	20,275	sf	
	172,425	sf	
times	2	for areas outside construction	
	344,850	sf or	7.9 acres

<u>Excavation of Pettibone Creek</u>

Assume: 5 days to clear trees

excavation, transport to dewatering area, backfill to be completed in 1 month (21 days)

one-half of excavated material (2,900 cy) requires dewatering & results in one-third reduction of volume. Disposal volume 2,900 + 1,933 = 4,833 cy.

geotextile 8,644 sy plus add 15% for overlaps and folds = 9,941 sy

rock (riprap) equal to volume removed = 5,763 cy

install 75 gabions along sides & in midcreek for erosion control

use 200 sand bags with 2 pumps for temporary stream diversion

Dewatering and Off-Site Disposal

Construct dewatering area 100' by 270' for excavated sediments

Dispose of 4,350 cy as non-hazardous (subtitle D) @ $50 per cy

Dispose of 483 cy as hazardous @ $75 per cy including required treatment

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Sampling for post-excavation verification. Analytical only
Collect 82 samples and analyze for PAHs, PCB, pesticides, metals

type	cost each	number	total
sediment PAHs	$ 250	1	$ 250
sediment PCB & pesticides	$ 125	1	$ 125
sediment metals	$ 150	1	$ 150
			$ 525
2x for fast lab turn-a-round			$ 525
			$ 1,050
40% QA/QC & Data Validation of normal pricing			$ 210
cost per sample			$ 1,260

<u>Excavation of Lower Boat Basin</u>

Assume: Sheet pile across Boat Basin next to the boat repair building
Add another row of sheet piles 5' downstream
Excavate between sheet piles to remove sediment
Place concrete between sheet pile walls to form a "dam" to be used with the capped basin
Drive sheet piles 15' deep by 65' wide by 2 rows = 1,950 sf
Concrete volume = 65' wide by 10' deep by 5' thick = 120 cy
Time to complete "dam" say 10 days
Excavation of Lower Boat Basin say 3 days
Install a turbidity curtain across channel during excavation (including during capping of basin)
Use 40 sand bags with 2 pumps for temporary stream diversion

Sampling for post-excavation verification. Analytical only
Collect 8 samples and analyze for PAHs, PCB, pesticides, metals
Cost per sample is the same as above.

<u>Capping of Upper Boat Basin</u>

Purchase sand to cover basin 2' deep =	5,556	cy
Geotextile 75,000 sf plus 15% for overlap =	9,583	sy
Rock 18" thick =	4,167	cy

Assume: Regrade material in basin with dozer about 5 days.
Place sand in basin with dozer about 10 days.
Install geotextile during time to place sand & rock.
Place rock in basin about 20 days.

Number of signs
Assume one sign every 100 feet around basin.

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Length around basin = 1,360 feet
100 feet between signs
14 signs

Time to complete Alternative 3

Mobilization	10	days
Excavation, T/D of Pettibone Creek	21	days
Excavation of Lower Boat Basin	13	days
Capping of Upper Boat Basin	35	days
Demobilization	5	days
	84	days or
	4	months

Alternative 4 (Capital Cost)

Site Survey

Area:	Pettibone Creek	77,800	sf
	Upper Boat Basin	74,350	sf
	Lower Boat Basin	20,275	sf
		172,425	sf
	times	2	for areas outside construction
		344,850	sf or 7.9 acres

Excavation of Pettibone Creek

Assume: 5 days to clear trees
excavation, transport for off-site disposal, backfill to be completed in 1 month (21 days)
geotextile 8,644 sy plus add 15% for overlaps and folds = 9,941 sy
rock (riprap) equal to volume removed = 5,763 cy
install 75 gabions a long sides & in midcreek for erosion control
use 200 sand bags with 2 pumps for temporary stream diversion

Sampling for post-excavation verification. Analytical only
Collect 82 samples and analyze for PAHs, PCB, pesticides, metals

type	cost each	number	total
sediment PAHs	$ 250	1	$ 250
sediment PCB & pesticides	$ 125	1	$ 125
sediment metals	$ 150	1	$ 150
			$ 525
		2x for fast lab turn-a-round	$ 525
			$ 1,050
		40% QA/QC & Data Validation of normal pricing	$ 210
		cost per sample	$ 1,260

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Excavation of Boat Basin

Assume: Install two turbidity curtains across Lower Boat Basin channel during excavation
Sheet pile across Boat Basin next to the boat repair building to control water from lake
Time to setup basin to excavate basin say 4 days
Excavate within basin using one long-arm excavator & one excavator
Stock pile wet material inside basin to allow dewatering
Sand bag and pump creek around basin
Remove sheet piles after basin is excavated

Time to complete excavation say 30 trucks per day with 16 cy each = 76 days
Drive sheet piles 15' deep by 65' wide = 975 sf

Sampling for post-excavation verification. Analytical only
Collect 40 samples and analyze for PAHs, PCB, pesticides, metals
Cost per sample is the same as above.

Off-Site Disposal

Dispose of 33,100 cy as non-hazardous (subtitle D) @ $50 per cy
Dispose of 3,300 cy as hazardous @ $75 per cy including required treatment

Time to complete Alternative 4

Mobilization	10	days
Excavation of Pettibone Creek	21	days
Setup for excavation	4	days
Excavation of Boat Basin	76	days
Demobilization	5	days
	116	days or
approximately	5.5	months

APPENDIX B

DETAILED COST ESTIMATES

APPENDIX B.1

ALTERNATIVE 2

NAVAL TRAINING CENTER GREAT LAKES
Great Lakes, Illinois
Site 17 - Pettibone Creek and Boat Basin
Alternative 2: Institutional Controls and Monitored Natural Recovery (MNR)
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT DOCUMENTS											
1.1 Prepare Land Use Control Remedial Design (LUCRD)	250	hour			$27.50		$0	$0	$6,875	$0	$6,875
2 MISCELLANEOUS											
2.1 Warning Signs	96	ea	$88.50				$8,496	$0	$0	$0	$8,496
Subtotal							$8,496	$0	$6,875	$0	$15,371
Local Area Adjustments							100.0%	94.7%	90.5%	90.5%	
							$8,496	$0	$6,222	$0	$14,718
Overhead on Labor Cost @ 30%									$1,867		$1,867
G & A on Labor Cost @ 10%									$622		$622
G & A on Material Cost @ 10%								$0			$0
G & A on Equipment Cost @ 10%										$0	$0
G & A on Subcontract Cost @ 10%							$850				$850
Total Direct Cost							$9,346	$0	$8,711	$0	$18,056
Indirects on Total Direct Cost @ 10%											$1,806
Profit on Total Direct Cost @ 10%											$1,806
Subtotal											$21,667
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$21,667
Contingency on Total Field Costs @ 10%											$2,167
Engineering on Total Field Cost @ 5%											$1,083
TOTAL COST											**$24,918**

NAVAL TRAINING CENTER GREAT LAKES
Great Lakes, Illinois
Site 17 - Pettibone Creek and Boat Basin
Alternative 2: Institutional Controls and Monitored Natural Recovery (MNR)
ANNUAL COST

Item	Item Cost Years 1 - 30	Item Cost Every 5 Years	Notes
Site Inspection & Report	$1,570		One-day inspection with 2 people for LUCRD
Sampling	$5,620		Labor, Field Supplies (local)
Analysis	$17,640		Analyze 12 surface water samples and 12 sediment samples for PAHs, PCB, pesticides, and metals. Annually years 1 through 30.
Sampling & Analysis Report	$5,000		Document sampling events and results
Site Review		$22,520	Perform 5-year review including additional at-depth sediment samples.
TOTALS	$29,830	$22,520	

NAVAL TRAINING CENTER GREAT LAKES
Great Lakes, Illinois
Site 17 - Pettibone Creek and Boat Basin
Alternative 2: Institutional Controls and Monitored Natural Recovery (MNR)
PRESENT WORTH ANALYSIS

Year	Capital Cost	Annual Cost	Annual Discount Rate at 7%	Present Worth
0	$24,918		1.000	$24,918
1		$29,830	0.935	$27,891
2		$29,830	0.873	$26,042
3		$29,830	0.816	$24,341
4		$29,830	0.763	$22,760
5		$52,350	0.713	$37,326
6		$29,830	0.666	$19,867
7		$29,830	0.623	$18,584
8		$29,830	0.582	$17,361
9		$29,830	0.544	$16,228
10		$52,350	0.508	$26,594
11		$29,830	0.475	$14,169
12		$29,830	0.444	$13,245
13		$29,830	0.415	$12,379
14		$29,830	0.388	$11,574
15		$52,350	0.362	$18,951
16		$29,830	0.339	$10,112
17		$29,830	0.317	$9,456
18		$29,830	0.296	$8,830
19		$29,830	0.277	$8,263
20		$52,350	0.258	$13,506
21		$29,830	0.242	$7,219
22		$29,830	0.226	$6,742
23		$29,830	0.211	$6,294
24		$29,830	0.197	$5,877
25		$52,350	0.184	$9,632
26		$29,830	0.172	$5,131
27		$29,830	0.161	$4,803
28		$29,830	0.150	$4,475
29		$29,830	0.141	$4,206
30		$52,350	0.131	$6,858
			TOTAL PRESENT WORTH	**$443,631**

APPENDIX B.2

ALTERNATIVE 3

NAVAL STATION GREAT LAKES
Great Lakes, Illinois
Site 17 - Pettibone Creek and Boat Basin
Alternative 3: Excavation, In-Situ Capping, Surface Water Controls, Institutional Controls and MNR
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING AND MOBILIZATION/DEMOBILIZATION											
1.1 Prepare Documents & Plans including Permits	150	hour			$27.50		$0	$0	$4,125	$0	$4,125
1.1 Prepare Land Use Control Remedial Design (LUCRD)	250	hour			$27.50		$0	$0	$6,875	$0	$6,875
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	4	mo				$286.00	$0	$0	$0	$1,144	$1,144
2.2 Storage Trailer	4	mo				$105.00	$0	$0	$0	$420	$420
2.3 Trailers Mob/Demo	2	ea				$225.00	$0	$0	$0	$450	$450
2.4 Field Office Support	4	mo		$139.00			$0	$556	$0	$0	$556
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,500.00				$1,500	$0	$0	$0	$1,500
2.6 Site Utilities (phone & electric)	4	mo		$327.00			$0	$1,308	$0	$0	$1,308
2.7 Mobilization/Demobilization Construction Equipment	4	ea			$141.00	$336.00	$0	$0	$564	$1,344	$1,908
2.8 Construction Survey	7.9	acre	$1,850.00				$14,615	$0	$0	$0	$14,615
3 DECONTAMINATION											
3.1 Decontamination Services	4	mo		$375.00	$1,200.00	$900.00	$0	$1,500	$4,800	$3,600	$9,900
3.2 Pressure Washer	4	mo				$1,100.00	$0	$0	$0	$4,400	$4,400
3.3 Equipment Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.4 Decon Water Storage Tank, 6,000 gallon	4	mo				$635.00	$0	$0	$0	$2,540	$2,540
3.5 Clean Water Storage Tank, 4,000 gallon	4	mo				$570.00	$0	$0	$0	$2,280	$2,280
3.6 Disposal of Decon Waste (liquid & solid)	4	mo	$900.00				$3,600	$0	$0	$0	$3,600
4 PETTIBONE CREEK EXCAVATION & RESTORATION											
4.1 Clear & Chip Light, Trees to 6" diam,	5	day			$673.20	$222.50	$0	$0	$3,366	$1,113	$4,479
4.2 Dozer, 105 H. P.	21	day			$269.20	$434.00	$0	$0	$5,653	$9,114	$14,767
4.3 Gradall, 1 cy capacity	21	day			$278.40	$958.80	$0	$0	$5,846	$20,135	$25,981
4.4 Dump Truck, 12 cy	21	day			$211.60	$325.00	$0	$0	$4,444	$6,825	$11,269
4.5 Labor (2)	21	day			$416.00		$0	$0	$8,736	$0	$8,736
4.6 Geotextile Underlayment	9,941	sy		$0.86	$0.53	$0.03	$0	$8,549	$5,269	$298	$14,116
4.7 Rock (riprap)	5,763	cy		$19.15	$8.25	$7.08	$0	$110,361	$47,545	$40,802	$198,708
4.8 Gabion (3' wide by 3' high by 6' long)	75	ea		$98.00	$121.00	$48.00	$0	$7,350	$9,075	$3,600	$20,025
4.9 Sand Bags	200	ea		$0.47			$0	$94	$0	$0	$94
4.10 Pumps (2), 4" dia.	21	day				$196.00	$0	$0	$0	$4,116	$4,116
4.11 Post-Excavation Conformation Samples	82	ea	$1,260.00	$30.00	$50.00	$20.00	$103,320	$2,460	$4,100	$1,640	$111,520
5 PETTIBONE CREEK SEDIMENTS DEWATERING AND OFF-SITE DISPOSAL											
5.1 Dewatering Pad, 100' by 270'	27,000	sf	$1.87				$50,490	$0	$0	$0	$50,490
5.2 Excavator, 1.5 cy	21	day			$278.40	$683.40	$0	$0	$5,846	$14,351	$20,198
5.3 Transport & Dispose of Non-Hazardous Materials	4,350	cy	$50.00				$217,500	$0	$0	$0	$217,500
5.4 Waste Characterization Testing (TCLP), 1 per 1000 cy	5	ea	$820.00				$4,100	$0	$0	$0	$4,100
5.5 Transport & Dispose of Hazardous Materials	483	cy	$75.00				$36,225	$0	$0	$0	$36,225
5.6 Waste Characterization Testing (TCLP), 1 per 1000 cy	1	ea	$820.00				$820	$0	$0	$0	$820
6 LOWER BOAT BASIN EXCAVATION											
6.1 Sheet Pile, 15' deep	1,950	sf	$13.29				$25,916	$0	$0	$0	$25,916
6.2 Concrete "Dam"	120	cy		$92.00	$47.00	$0.34	$0	$11,040	$5,640	$41	$16,721
6.3 Gradall, 1 cy capacity	13	day			$278.40	$958.80	$0	$0	$3,619	$12,464	$16,084
6.4 Dump Truck, 12 cy	13	day			$211.60	$325.00	$0	$0	$2,751	$4,225	$6,976
6.5 Labor (2)	13	day			$416.00		$0	$0	$5,408	$0	$5,408
6.6 Sand Bags	30	ea		$0.47			$0	$14	$0	$0	$14
6.7 Pumps (2), 4" dia.	13	day				$196.00	$0	$0	$0	$2,548	$2,548
6.8 Post-Excavation Conformation Samples	8	ea	$1,260.00	$30.00	$50.00	$20.00	$10,080	$240	$400	$160	$10,880
6.9 Turbidity Curtain	1	ls		$500.00			$0	$500	$0	$0	$500

NAVAL STATION GREAT LAKES
Great Lakes, Illinois
Site 17 - Pettibone Creek and Boat Basin
Alternative 3: Excavation, In-Situ Capping, Surface Water Controls, Institutional Controls and MNR
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
7 UPPER BOAT BASIN REGRADING & CAPPING											
7.1 Grade existing material with Dozer, 105 H. P.	5	day			$269.20	$434.00	$0	$0	$1,346	$2,170	$3,516
7.2 Sand Cover	5,556	cy		$7.50			$0	$41,670	$0	$0	$41,670
7.3 Grade & compact sand with Dozer, 105 H. P.	10	day			$269.20	$434.00	$0	$0	$2,692	$4,340	$7,032
7.4 Labor (2)	10	day			$416.00		$0	$0	$4,160	$0	$4,160
7.5 Geotextile Underlayment	9,583	sy		$0.86	$0.53	$0.03	$0	$8,241	$5,079	$287	$13,608
7.6 Rock Cover	4,167	cy		$19.15	$8.25	$7.08	$0	$79,798	$34,378	$29,502	$143,678
7.7 Sand Bags	40	ea		$0.47			$0	$19	$0	$0	$19
7.8 Pumps (2), 4" dia.	35	day				$196.00	$0	$0	$0	$6,860	$6,860
7.9 Warning Signs	14	ea	$88.50				$1,239	$0	$0	$0	$1,239
8 MISCELLANEOUS											
8.1 Construction Oversight (2 p * 4 month * 21 days/month)	168	day			$200.00		$0	$0	$33,600	$0	$33,600
8.2 Post Construction Documents	250	hr			$27.50		$0	$0	$6,875	$0	$6,875
Subtotal							$469,405	$274,201	$222,642	$180,925	$1,147,172
Local Area Adjustments							100.0%	94.7%	90.5%	90.5%	
							$469,405	$259,668	$201,491	$163,737	$1,094,301
Overhead on Labor Cost @ 30%									$60,447		$60,447
G & A on Labor Cost @ 10%									$20,149		$20,149
G & A on Material Cost @ 10%								$25,967			$25,967
G & A on Equipment Cost @ 10%										$16,374	$16,374
G & A on Subcontract Cost @ 10%							$46,940				$46,940
Total Direct Cost							$516,345	$285,635	$282,087	$180,111	$1,264,178
Indirects on Total Direct Cost @ 35%											$442,462
Profit on Total Direct Cost @ 10%											$126,418
Subtotal											$1,833,059
Health & Safety Monitoring @ 1%											$18,331
Total Field Cost											$1,851,389
Contingency on Total Field Costs @ 20%											$370,278
Engineering on Total Field Cost @ 10%											$185,139
TOTAL COST											**$2,406,806**

NAVAL STATION GREAT LAKES
Great Lakes, Illinois
Site 17 - Pettibone Creek and Boat Basin
Alternative 3: Excavation, In-Situ Capping, Surface Water Controls, Institutional Controls and MNR
ANNUAL COST

Item	Item Cost Years 1 - 30	Item Cost Every 5 Years	Notes
Site Inspection & Report	$1,570		One-day inspection with 2 people for LUCRD
Sampling	$2,770		Labor, Field Supplies (local)
Analysis	$5,880		Analyze 4 surface water samples and 4 sediment samples for PAHs, PCB, pesticides, and metals. Annually years 1 through 30.
Cap Repair	$9,700		Two-days with 2 people, including materials & equipment
Sampling & Analysis Report	$5,000		Document sampling events and results
Site Review		$22,520	Perform 5-year review including additional at-depth sediment samples.
TOTALS	$24,920	$22,520	

NAVAL STATION GREAT LAKES
Great Lakes, Illinois
Site 17 - Pettibone Creek and Boat Basin
Alternative 3: Excavation, In-Situ Capping, Surface Water Controls, Institutional Controls and MNR
PRESENT WORTH ANALYSIS

Year	Capital Cost	Annual Cost	Annual Discount Rate at 7%	Present Worth
0	$2,406,806		1.000	$2,406,806
1		$24,920	0.935	$23,300
2		$24,920	0.873	$21,755
3		$24,920	0.816	$20,335
4		$24,920	0.763	$19,014
5		$47,440	0.713	$33,825
6		$24,920	0.666	$16,597
7		$24,920	0.623	$15,525
8		$24,920	0.582	$14,503
9		$24,920	0.544	$13,556
10		$47,440	0.508	$24,100
11		$24,920	0.475	$11,837
12		$24,920	0.444	$11,064
13		$24,920	0.415	$10,342
14		$24,920	0.388	$9,669
15		$47,440	0.362	$17,173
16		$24,920	0.339	$8,448
17		$24,920	0.317	$7,900
18		$24,920	0.296	$7,376
19		$24,920	0.277	$6,903
20		$47,440	0.258	$12,240
21		$24,920	0.242	$6,031
22		$24,920	0.226	$5,632
23		$24,920	0.211	$5,258
24		$24,920	0.197	$4,909
25		$47,440	0.184	$8,729
26		$24,920	0.172	$4,286
27		$24,920	0.161	$4,012
28		$24,920	0.150	$3,738
29		$24,920	0.141	$3,514
30		$47,440	0.131	$6,215

TOTAL PRESENT WORTH **$2,764,591**

APPENDIX B.3

ALTERNATIVE 3 WETLANDS OPTION

NAVAL TRAINING CENTER GREAT LAKES
Great Lakes, Illinois
Site 17 - Pettibone Creek and Boat Basin
Alternative 3: Excavation, In-Situ Capping (WETLAND), Surface Water Controls, Institutional Controls and MNR
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING AND MOBILIZATION/DEMOBILIZATION											
1.1 Prepare Documents & Plans including Permits	150	hour			$27.50		$0	$0	$4,125	$0	$4,125
1.1 Prepare Land Use Control Remedial Design (LUCRD)	250	hour			$27.50		$0	$0	$6,875	$0	$6,875
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	4	mo				$286.00	$0	$0	$0	$1,144	$1,144
2.2 Storage Trailer	4	mo				$105.00	$0	$0	$0	$420	$420
2.3 Trailers Mob/Demo	2	ea				$225.00	$0	$0	$0	$450	$450
2.4 Field Office Support	4	mo		$139.00			$0	$556	$0	$0	$556
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,500.00				$1,500	$0	$0	$0	$1,500
2.6 Site Utilities (phone & electric)	4	mo		$327.00			$0	$1,308	$0	$0	$1,308
2.7 Mobilization/Demobilization Construction Equipment	4	ea			$141.00	$336.00	$0	$0	$564	$1,344	$1,908
2.8 Construction Survey	7.9	acre	$1,850.00				$14,615	$0	$0	$0	$14,615
3 DECONTAMINATION											
3.1 Decontamination Services	4	mo		$375.00	$1,200.00	$900.00	$0	$1,500	$4,800	$3,600	$9,900
3.2 Pressure Washer	4	mo				$1,100.00	$0	$0	$0	$4,400	$4,400
3.3 Equipment Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.4 Decon Water Storage Tank, 6,000 gallon	4	mo				$635.00	$0	$0	$0	$2,540	$2,540
3.5 Clean Water Storage Tank, 4,000 gallon	4	mo				$570.00	$0	$0	$0	$2,280	$2,280
3.6 Disposal of Decon Waste (liquid & solid)	4	mo	$900.00				$3,600	$0	$0	$0	$3,600
4 PETTIBONE CREEK EXCAVATION & RESTORATION											
4.1 Clear & Chip Light, Trees to 6" diam,	5	day			$673.20	$222.50	$0	$0	$3,366	$1,113	$4,479
4.2 Dozer, 105 H. P.	21	day			$269.20	$434.00	$0	$0	$5,653	$9,114	$14,767
4.3 Gradall, 1 cy capacity	21	day			$278.40	$958.80	$0	$0	$5,846	$20,135	$25,981
4.4 Dump Truck, 12 cy	21	day			$211.60	$325.00	$0	$0	$4,444	$6,825	$11,269
4.5 Labor (2)	21	day			$416.00		$0	$0	$8,736	$0	$8,736
4.6 Geotextile Underlayment	9,941	sy		$0.86	$0.53	$0.03	$0	$8,549	$5,269	$298	$14,116
4.7 Rock (riprap)	5,763	cy		$19.15	$8.25	$7.08	$0	$110,361	$47,545	$40,802	$198,708
4.8 Gabion (3' wide by 3' high by 6' long)	75	ea		$98.00	$121.00	$48.00	$0	$7,350	$9,075	$3,600	$20,025
4.9 Sand Bags	200	ea		$0.47			$0	$94	$0	$0	$94
4.10 Pumps (2), 4" dia.	21	day				$196.00	$0	$0	$0	$4,116	$4,116
4.11 Post-Excavation Conformation Samples	82	ea	$1,260.00	$30.00	$50.00	$20.00	$103,320	$2,460	$4,100	$1,640	$111,520
5 PETTIBONE CREEK SEDIMENTS DEWATERING AND OFF-SITE DISPOSAL											
5.1 Dewatering Pad, 100' by 270'	27,000	sf	$1.87				$50,490	$0	$0	$0	$50,490
5.2 Excavator, 1.5 cy	21	day			$278.40	$683.40	$0	$0	$5,846	$14,351	$20,198
5.3 Transport & Dispose of Non-Hazardous Materials	4,350	cy	$50.00				$217,500	$0	$0	$0	$217,500
5.4 Waste Characterization Testing (TCLP), 1 per 1000 cy	5	ea	$820.00				$4,100	$0	$0	$0	$4,100
5.5 Transport & Dispose of Hazardous Materials	483	cy	$75.00				$36,225	$0	$0	$0	$36,225
5.6 Waste Characterization Testing (TCLP), 1 per 1000 cy	1	ea	$820.00				$820	$0	$0	$0	$820
6 LOWER BOAT BASIN EXCAVATION											
6.1 Sheet Pile, 15' deep	1,950	sf	$13.29				$25,916	$0	$0	$0	$25,916
6.2 Concrete "Dam"	120	cy		$92.00	$47.00	$0.34	$0	$11,040	$5,640	$41	$16,721
6.3 Gradall, 1 cy capacity	13	day			$278.40	$958.80	$0	$0	$3,619	$12,464	$16,084
6.4 Dump Truck, 12 cy	13	day			$211.60	$325.00	$0	$0	$2,751	$4,225	$6,976
6.5 Labor (2)	13	day			$416.00		$0	$0	$5,408	$0	$5,408
6.6 Sand Bags	30	ea		$0.47			$0	$14	$0	$0	$14
6.7 Pumps (2), 4" dia.	13	day				$196.00	$0	$0	$0	$2,548	$2,548
6.8 Post-Excavation Conformation Samples	8	ea	$1,260.00	$30.00	$50.00	$20.00	$10,080	$240	$400	$160	$10,880
6.9 Turbidity Curtain	1	ls		$500.00			$0	$500	$0	$0	$500

NAVAL TRAINING CENTER GREAT LAKES
Great Lakes, Illinois
Site 17 - Pettibone Creek and Boat Basin
Alternative 3: Excavation, In-Situ Capping (WETLAND), Surface Water Controls, Institutional Controls and MNR
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
7 UPPER BOAT BASIN REGRADING & CAPPING (WETLAND)											
7.1 Grade existing material with Dozer, 105 H. P.	5	day			$269.20	$434.00	$0	$0	$1,346	$2,170	$3,516
7.2 Sand Cover	4,167	cy		$7.50			$0	$31,253	$0	$0	$31,253
7.3 Grade & compact sand with Dozer, 105 H. P.	8	day			$269.20	$434.00	$0	$0	$2,154	$3,472	$5,626
7.4 Labor (2)	8	day			$416.00		$0	$0	$3,328	$0	$3,328
7.5 Geotextile Underlayment	9,167	sy		$0.86	$0.53	$0.03	$0	$7,884	$4,859	$275	$13,017
7.6 Rock Apron	33	cy		$19.15	$8.25	$7.08	$0	$632	$272	$234	$1,138
7.7 Common Fill	4,167	cy		$9.25			$0	$38,545	$0	$0	$38,545
7.8 Grade & compact fill with Dozer, 105 H. P.	8	day			$269.20	$434.00	$0	$0	$2,154	$3,472	$5,626
7.9 Labor (2)	8	day			$416.00		$0	$0	$3,328	$0	$3,328
7.10 Topsoil, 6" thick	8,333	sy		$3.23	$0.46	$0.29	$0	$26,916	$3,833	$2,417	$33,165
7.11 Wetland Planting	750	csf		$18.23	$10.08		$0	$13,673	$7,560	$0	$21,233
7.12 Sand Bags	40	ea		$0.47			$0	$19	$0	$0	$19
7.13 Pumps (2), 4" dia.	35	day				$196.00	$0	$0	$0	$6,860	$6,860
7.14 Warning Signs	14	ea	$88.50				$1,239	$0	$0	$0	$1,239
8 MISCELLANEOUS											
8.1 Construction Oversight (2 p * 4 month * 21 days/month)	168	day			$200.00		$0	$0	$33,600	$0	$33,600
8.2 Post Construction Documents	250	hr			$27.50		$0	$0	$6,875	$0	$6,875
Subtotal							$469,405	$263,393	$203,820	$156,664	$1,093,282
Local Area Adjustments							100.0%	94.7%	90.5%	90.5%	
							$469,405	$249,433	$184,457	$141,781	$1,045,076
Overhead on Labor Cost @ 30%									$55,337		$55,337
G & A on Labor Cost @ 10%									$18,446		$18,446
G & A on Material Cost @ 10%								$24,943			$24,943
G & A on Equipment Cost @ 10%										$14,178	$14,178
G & A on Subcontract Cost @ 10%							$46,940				$46,940
Total Direct Cost							$516,345	$274,376	$258,240	$155,959	$1,204,921
Indirects on Total Direct Cost @ 35%											$421,722
Profit on Total Direct Cost @ 10%											$120,492
Subtotal											$1,747,135
Health & Safety Monitoring @ 1%											$17,471
Total Field Cost											$1,764,606
Contingency on Total Field Costs @ 20%											$352,921
Engineering on Total Field Cost @ 10%											$176,461
TOTAL COST											**$2,293,988**

NAVAL TRAINING CENTER GREAT LAKES
Great Lakes, Illinois
Site 17 - Pettibone Creek and Boat Basin
Alternative 3: Excavation, In-Situ Capping (WETLAND), Surface Water Controls, Institutional Controls and MNR
ANNUAL COST

Item	Item Cost Years 1 - 30	Item Cost Every 5 Years	Notes
Site Inspection & Report	$1,570		One-day inspection with 2 people for LUCRD
Sampling	$2,770		Labor, Field Supplies (local)
Analysis	$5,880		Analyze 4 surface water samples and 4 sediment samples for PAHs, PCB, pesticides, and metals. Annually years 1 through 30.
Cap Repair	$9,700		Two-days with 2 people, including materials & equipment
Sampling & Analysis Report	$5,000		Document sampling events and results
Site Review		$22,520	Perform 5-year review including additional at-depth sediment samples.
TOTALS	$24,920	$22,520	

NAVAL TRAINING CENTER GREAT LAKES
Great Lakes, Illinois
Site 17 - Pettibone Creek and Boat Basin
Alternative 3: Excavation, In-Situ Capping (WETLAND), Surface Water Controls, Institutional Controls and
PRESENT WORTH ANALYSIS

Year	Capital Cost	Annual Cost	Annual Discount Rate at 7%	Present Worth
0	$2,293,988		1.000	$2,293,988
1		$24,920	0.935	$23,300
2		$24,920	0.873	$21,755
3		$24,920	0.816	$20,335
4		$24,920	0.763	$19,014
5		$47,440	0.713	$33,825
6		$24,920	0.666	$16,597
7		$24,920	0.623	$15,525
8		$24,920	0.582	$14,503
9		$24,920	0.544	$13,556
10		$47,440	0.508	$24,100
11		$24,920	0.475	$11,837
12		$24,920	0.444	$11,064
13		$24,920	0.415	$10,342
14		$24,920	0.388	$9,669
15		$47,440	0.362	$17,173
16		$24,920	0.339	$8,448
17		$24,920	0.317	$7,900
18		$24,920	0.296	$7,376
19		$24,920	0.277	$6,903
20		$47,440	0.258	$12,240
21		$24,920	0.242	$6,031
22		$24,920	0.226	$5,632
23		$24,920	0.211	$5,258
24		$24,920	0.197	$4,909
25		$47,440	0.184	$8,729
26		$24,920	0.172	$4,286
27		$24,920	0.161	$4,012
28		$24,920	0.150	$3,738
29		$24,920	0.141	$3,514
30		$47,440	0.131	$6,215

TOTAL PRESENT WORTH **$2,651,774**

APPENDIX B.4

ALTERNATIVE 4

NAVAL TRAINING CENTER GREAT LAKES
Great Lakes, Illinois
Site 17 - Pettibone Creek and Boat Basin
Alternative 4: Excavation, Surface Water Controls, On-Site Dewatering and Off-Base Disposal
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING AND MOBILIZATION/DEMOBILIZATION											
1.1 Prepare Documents & Plans including Permits	150	hour			$27.50		$0	$0	$4,125	$0	$4,125
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	5.5	mo				$286.00	$0	$0	$0	$1,573	$1,573
2.2 Storage Trailer	5.5	mo				$105.00	$0	$0	$0	$578	$578
2.3 Trailers Mob/Demo	2	ea				$225.00	$0	$0	$0	$450	$450
2.4 Field Office Support	5.5	mo		$139.00			$0	$765	$0	$0	$765
2.5 Utility Connection/Disconnection (phone/electric)	1	ls	$1,500.00				$1,500	$0	$0	$0	$1,500
2.6 Site Utilities (phone & electric)	5.5	mo		$327.00			$0	$1,799	$0	$0	$1,799
2.7 Mobilization/Demobilization Construction Equipment	5	ea			$141.00	$336.00	$0	$0	$705	$1,680	$2,385
2.8 Construction Survey	7.9	acre	$1,850.00				$14,615	$0	$0	$0	$14,615
3 DECONTAMINATION											
3.1 Decontamination Services	5.5	mo		$375.00	$1,200.00	$900.00	$0	$2,063	$6,600	$4,950	$13,613
3.2 Pressure Washer	5.5	mo				$1,100.00	$0	$0	$0	$6,050	$6,050
3.3 Equipment Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.4 Decon Water Storage Tank, 6,000 gallon	5.5	mo				$635.00	$0	$0	$0	$3,493	$3,493
3.5 Clean Water Storage Tank, 4,000 gallon	5.5	mo				$570.00	$0	$0	$0	$3,135	$3,135
3.6 Disposal of Decon Waste (liquid & solid)	5.5	mo	$900.00				$4,950	$0	$0	$0	$4,950
4 PETTIBONE CREEK EXCAVATION & RESTORATION											
4.1 Clear & Chip Light, Trees to 6" diam,	5	day			$673.20	$222.50	$0	$0	$3,366	$1,113	$4,479
4.2 Dozer, 105 H. P.	21	day			$269.20	$434.00	$0	$0	$5,653	$9,114	$14,767
4.3 Gradall, 1 cy capacity	21	day			$278.40	$958.80	$0	$0	$5,846	$20,135	$25,981
4.4 Labor (2)	21	day			$416.00		$0	$0	$8,736	$0	$8,736
4.5 Geotextile Underlayment	9,941	sy		$0.86	$0.53	$0.03	$0	$8,549	$5,269	$298	$14,116
4.6 Rock (riprap)	5,763	cy		$19.15	$8.25	$7.08	$0	$110,361	$47,545	$40,802	$198,708
4.7 Gabion (3' wide by 3' high by 6' long)	75	ea		$98.00	$121.00	$48.00	$0	$7,350	$9,075	$3,600	$20,025
4.8 Sand Bags	200	ea		$0.47			$0	$94	$0	$0	$94
4.9 Pumps (2), 4" dia.	21	day				$196.00	$0	$0	$0	$4,116	$4,116
4.10 Post-Excavation Conformation Samples	82	ea	$1,260.00	$30.00	$50.00	$20.00	$103,320	$2,460	$4,100	$1,640	$111,520
5 BOAT BASIN EXCAVATION											
5.1 Temporary Sheet Pile, 15' deep (drive & extract)	975	sf	$10.28				$10,023	$0	$0	$0	$10,023
5.2 Excavator, long-arm, 2 cy	76	day			$278.40	$1,109.00	$0	$0	$21,158	$84,284	$105,442
5.3 Excavator, 2 cy	76	day			$278.40	$887.20	$0	$0	$21,158	$67,427	$88,586
5.4 Labor (2)	76	day			$416.00		$0	$0	$31,616	$0	$31,616
5.5 Sand Bags	50	ea		$0.47			$0	$24	$0	$0	$24
5.6 Pumps (2), 4" dia.	76	day				$196.00	$0	$0	$0	$14,896	$14,896
5.7 Post-Excavation Conformation Samples	40	ea	$1,260.00	$30.00	$50.00	$20.00	$50,400	$1,200	$2,000	$800	$54,400
5.8 Turbidity Curtain	1	ls		$1,000.00			$0	$1,000	$0	$0	$1,000
6 Off-SITE DISPOSAL											
6.1 Transport & Dispose of Non-Hazardous Materials	33,100	cy	$50.00				$1,655,000	$0	$0	$0	$1,655,000
6.2 Waste Characterization Testing (TCLP), 1 per 1000 cy	34	ea	$820.00				$27,880	$0	$0	$0	$27,880
6.3 Transport & Dispose of Hazardous Materials	3,300	cy	$75.00				$247,500	$0	$0	$0	$247,500
6.4 Waste Characterization Testing (TCLP), 1 per 1000 cy	4	ea	$820.00				$3,280	$0	$0	$0	$3,280
7 MISCELLANEOUS											
7.1 Construction Oversight (2 p * 5.5 month * 21 days/month)	231	day			$200.00		$0	$0	$46,200	$0	$46,200
7.2 Post Construction Documents	250	hr			$27.50		$0	$0	$6,875	$0	$6,875
Subtotal							$2,118,468	$136,164	$230,478	$270,288	$2,755,397

NAVAL TRAINING CENTER GREAT LAKES
Great Lakes, Illinois
Site 17 - Pettibone Creek and Boat Basin
Alternative 4: Excavation, Surface Water Controls, On-Site Dewatering and Off-Base Disposal
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
Local Area Adjustments							100.0%	94.7%	90.5%	90.5%	
							$2,118,468	$128,947	$208,582	$244,610	$2,700,608
Overhead on Labor Cost @ 30%									$62,575		$62,575
G & A on Labor Cost @ 10%									$20,858		$20,858
G & A on Material Cost @ 10%								$12,895			$12,895
G & A on Equipment Cost @ 10%										$24,461	$24,461
G & A on Subcontract Cost @ 10%							$211,847				$211,847
Total Direct Cost							$2,330,315	$141,842	$292,015	$269,071	$3,033,244
Indirects on Total Direct Cost @ 35%			(not including off-site transportation and disposal)								$395,760
Profit on Total Direct Cost @ 10%											$303,324
Subtotal											$3,732,328
Health & Safety Monitoring @ 0.5%											$18,662
Total Field Cost											$3,750,990
Contingency on Total Field Costs @ 20%											$750,198
Engineering on Total Field Cost @ 5%											$187,549
TOTAL COST											**$4,688,737**