First Five-Year Review Report for Site 4 - Old Landfill

Marine Corps Base (MCB) Quantico, Virginia

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0806

March 2003

Navy Five-Year Review Signature Cover

Key Review Information

Site Identification			
Site Name: Marine Corps Base (MCB) Quantico (Site 4-Old Landfill)			**EPA ID:** *VA1170024722*
Region: 3	**State:** VA	**City/County:** Quantico	
Site Status			
NPL Status: Final			
Remediation Status {under construction, operating, complete): Complete (Interim Remedy for Site 4)			
Multiple Operable Units (highlight): Y		**Number of Sites/OUs:** 1/NA	
Construction Completion Date: *October 1997*			
Fund/PRP/Federal Facility Lead: Federal Facility		**Lead Agency:** Department of the Navy Engineering Field Activity Chesapeake	
Has site been put into reuse? (highlight): Y			
Review Status			
Who conducted the review (EPA Region, State, Federal Agency): Engineering Field Activity Chesapeake			
Author Name: Andrew Gutberlet		**Author Title:** Remedial Project Manager	
Author Affiliation: Department of the Navy, Engineering Field Activity Chesapeake			
Review Period: September 2002		**Date(s) of Site Inspection:** September 2002	
Highlight:	Policy Type (name): 1. Pre-SARA 2. 3. Removal Only 4. Regional Discretion	Review Number (1, 2, etc) 1	
Triggering Action Event: Initiation of the remedial action for Site 4 - Old Landfill			
Trigger Action Date: *May 1996*			
Due Date: *May 2001*			

This five-year review only applies to the interim remedial action implemented at Site 4 - Old Landfill.

Issues:

The only issue is the presence of the invasive species phragmites in the constructed wetland. The presence of this invasive species does not affect the potential for release of contaminants from the site and does not affect the current or future protectiveness of the interim remedy.

Recommendations and Required Actions:

MCB Quantico has been advised of the above issue and plans to apply herbicide to eliminate/control the invasive species, which is the recommendation.

Protectiveness Statement(s):

The interim remedial action for Site 4 is protective of human health and the environment. The interim remedy is functioning as intended.

This five-year review shows that the Navy is meeting the requirements of the ROD for the interim remedial action for Site 4.

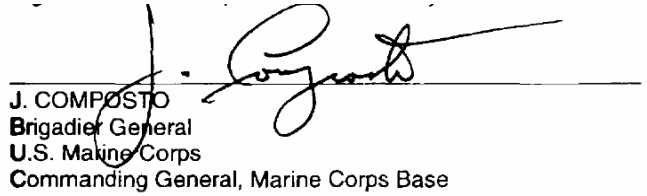
Other Comments:

None.

Next Review:

The next five-year review of Site 4 will be completed in March 2008.

Signature of U.S. Department of the Navy and Date



J. COMPOSTO
Brigadier General
U.S. Marine Corps
Commanding General, Marine Corps Base

3/31/03
Date

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLES

FIGURES

ACRONYMS

ug/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
AWQC	ambient water quality criteria
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
CFR	Code of Federal Regulations
COE	Corps of Engineers
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DEQ	Department of Environmental Quality
DRMO	Defense Reutilization and Marketing Office
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
FFS	Focused Feasibility Study
IAS	Initial Assessment Study
IRA	interim remedial action
MCB	Marine Corps Base MCL maximum contaminant level
mg/kg	milligram per kilogram
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOV	Notice of Violation
NPL	National Priorities List
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RF&P	Richmond, Fredricksburg, and Potomac
RD	remedial design
Rl	remedial investigation
ROD	Record of Decision
RPM	Remedial Project Manager
SVOC	semivolatile organic compound
TBC	to be considered

TSCA	Toxic Substances Control Act
TtNUS	Tetra Tech NUS, Inc.
USFWS	U.S. Fish and Wildlife Service
VHWMR	Virginia Hazardous Waste Management Regulations
VPDES	Virginia Pollutant Discharge Elimination System
VMRC	Virginia Marine Resources Commission
VOC	volatile organic compound

EXECUTIVE SUMMARY

The interim remedial action (IRA) for Site 4 - Old Landfill at Marine Corps Base (MCB) Quantico, Virginia, included the following:

- Excavation and off-site disposal of soil and drainage swale sediment contaminated with polychlorinated biphenyls (PCBs) in excess of 10 milligrams per kilogram (mg/kg).

- Excavation and on-site disposal of landfill material and sediment from the Potomac River shoreline adjacent to the site.

- Installation of a 23-acre permeable soil barrier layer over the landfill

- Shoreline stabilization.

- Wetland mitigation.

- Institutional controls.

The completion of construction activities for the interim remedy was achieved in October 1997. The trigger for this five-year review was the actual start of construction in May 1996.

The assessment of this five-year review found that the interim remedy was constructed in accordance with the requirements of the Record of Decision (ROD). The interim remedy is functioning as designed. The immediate threats have been addressed, and the interim remedy is protective of human health and the environment. Subsequent actions are being conducted to fully address the potential threats posed by exposure to other media at the site (i.e., on-site groundwater, off-site surface water, and off-site sediment).

SITE 4 - OLD LANDFILL
MARINE CORPS BASE QUANTICO, VIRGINIA
FIRST FIVE-YEAR REPORT

1.0 INTRODUCTION

The purpose of the five-year review report is to determine whether the interim remedy at the site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and identify recommendations to address them.

The Navy is preparing this Five-Year Review report pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §121 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section 104 or 106, the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The Navy interpreted this requirement further in the NCP: 40 Code of Federal Regulations (CFR) §300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such actions no less often that every five years after the initiation of the selected remedial action.*

The Engineering Field Activity Chesapeake, Naval Facilities Engineering Command conducted the five-year review of the interim remedy implemented at Site 4 - Old Landfill at the MCB in Quantico, Virginia. Tetra Tech NUS, Inc. (TtNUS) conducted an analysis of the available information in support of the five-year review in September 2002 in response to Contract Task Order 0806 under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62467-94-D-0888. Representatives of the Navy, MCB Quantico, U.S.

Environmental Protection Agency (EPA) Region 3, and TtNUS conducted a site inspection on September 12, 2002. This report documents the results of the review.

This is the first five-year review for Site 4 at MCB Quantico. The triggering action for this statutory review is the initiation of the interim remedial action on May 19, 1996. The five-year review is required due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure.

2.0 SITE CHRONOLOGY

The site chronology lists all important site events and relevant dates and is shown in Table 1.

3.0 BACKGROUND

3.1 Physical Characteristics

Site 4 (Old Landfill) is a 24-acre landfill located on the banks of the Potomac River in the Mainside Area of MCB Quantico (see Figure 1). Site 4 is bound to the north and west by industrialized portions of MCB Quantico. The base sewage treatment plant borders the site to the north. The Richmond, Fredricksburg, and Potomac (RF&P) railroad tracks, steam generation plant, barracks, and several offices are located along the western site boundary. The southern edge of the site is surrounded partially by wetlands and barracks used by airfield personnel. The site also contains a constructed wetland that was created in the area of an unnamed tributary to replace wetlands that were destroyed during implementation of the IRA. There are no residential properties or areas near the site. During the IRA, the site was significantly regraded, and all existing structures were removed. Currently, the surface of Site 4 slopes gently from the access road near the railroad tracks to the Potomac River. The shoreline has been covered with riprap revetment to prevent further erosion. Chain-link fencing has been installed around the perimeter, except along the river.

3.2 Land and Resource Use

Landfill operations at Site 4 began in the early 1920s near the RF&P railroad tracks and continued to expand eastward until 1971. Operations at Site 4 have extended the original shoreline an additional 600 to 1,200 feet eastward to create a new Potomac River bank, consisting of artificial fill. The Defense Reutilization and Marketing Office (DRMO) Scrapyard (known as Site L-03) and Building 669 (known as Site B-08) were located within the landfill area. The scrap yard was constructed in the 1950s on the northeastern portion of Site 4 and covered an area of approximately 2.5 acres. Building 669 was located near the Potomac River and was used to store electrical transformers until 1979. The site has been inactive since the IRA was completed in 1997.

The site is currently an open, grass-covered field. The site is currently fenced, except along the river, and the landfill waste is contained beneath a soil barrier layer. The current land use for the surrounding area is military. The future land use for the surrounding area is expected to be military.

The Potomac River is not used for domestic or agricultural uses within the vicinity of MCB Quantico; however, it is used for recreational and commercial fishing near the base. The base has a fish advisory posted for waters in the Quantico Embayment, which is adjacent to the site. The advisory warns against ingesting fish and shellfish species that are caught in the Quantico Embayment.

Groundwater underlying the site is currently not used as a drinking water source. Groundwater is not expected to be a future source of drinking water because potable water at the base is provided by three surface reservoirs (Brackenridge Reservoir. Gray's Reservoir, and Lunga Reservoir).

The surficial aquifer beneath the site consists of river deposits (alluvium and river terrace deposits) that overlay the Potomac Group. The river deposits consist of sand, silt, and organic clay, interlayered with peat in the southwest portion of the site. In northern portion of the site, this material consisted of gravel, sand, silt, and clay mixtures. A 4- to 12-foot thick clay layer was encountered at the top of the Potomac Group, ranging from 40 to 61 feet below the ground surface. Cohesive, dense sand with silt, clay, and gravel, also part of the Potomac Group was encountered at depths ranging from 50 to 66 feet below the ground surface. The depth to groundwater generally varied from 3 to 20 feet below the ground surface depending on the season and amount of precipitation. The dominant groundwater flow direction at the site is east toward the Potomac River.

3.3 History of Contamination

Wastes reportedly disposed at Site 4 included municipal refuse, construction debris, paints and thinners, transformers, dielectric fluids, batteries, and compressors. Wastes were burned prior to burial until the mid-1960s. The estimated volume of fill material at Site 4 is 281,000 cubic yards. The fill material was observed to be approximately 2 to 13 feet thick and generally thickens toward the south and east, toward the Potomac River. Site 4 was used until 1971, when another municipal landfill was opened at the base. Electrical transformers were stored in the eastern portion of the DRMO area and the transformer storage area at Building 669. The transformers were reportedly opened to recover the copper wire and steel casings. Consequently, transformer oil, possibly containing PCBs, was released onto the ground. No information exists concerning quantities of contaminants spilled in the DRMO area in the past.

During the Initial Assessment Study (IAS) in 1984, Site 4 was recommended for further study because of the potential impacts to groundwater and surface water. The 1988 Confirmation Study and preliminary remedial investigation (Rl) indicated that past disposal operations at Site 4 and the DRMO area contaminated soil, groundwater, and sediment. Soil contaminants included volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), most of which are polynuclear aromatic hydrocarbons (PAHs), pesticides, PCBs, and metals. Groundwater contaminants were mostly metals, with a few detections of VOCs, SVOCs, and pesticides. Sediment contaminants were mostly PAHs, pesticides, PCBs, and metals.

The Virginia DEQ issued Notice of Violation (NOV) No. 93-06-NRO-075 on June 24, 1993. The NOV noted discharge of contaminants to state waters without authority of a National Pollutant Discharge Elimination System (NPDES) permit, thereby violating water quality standards for surface water and groundwater and causing environmental damage (i.e., PCBs were detected in fish tissue).

3.4 Initial Response

The initial responses discussed below were taken before the IRA was implemented.

A removal action was conducted from September 1990 through December 1990 to remove PCB-contaminated soil from the DRMO Scrapyard and the adjoining Building 669 Transformer Storage Area. Approximately 3,800 tons of contaminated soil, including soil from another site (Old Batch Plant Site) unrelated to Site 4, were excavated and disposed off site.

In response to the 1993 NOV, the Navy initiated immediate measures to eliminate further contaminant migration from Site 4. Activities included installation of silt fences to prevent migration of contaminated sediment, a blacktop area was scarified by breaking up the asphalt to make the area more permeable and to decrease runoff, collection of surface water samples to verify that PCBs were not migrating off site, initiation of the Focused Feasibility Study (FFS), and initiation of an ecological risk assessment (ERA) by the USF&WS.

MCB Quantico was proposed for the National Priorities List (NPL) on May 10, 1993, and finalized on the NPL on May 31, 1994. In July 1995, the FFS and Proposed Plan identifying the Navy's preferred interim remedy were presented to the public, starting the period for public comment.

3.5 Basis for Taking Interim Remedial Action

Based on information collected before implementation of the IRA, hazardous substances, pollutants, and contaminants that have been released at concentrations higher than risk-based screening levels in each site media include:

Soil

- PAHs
- PCBs
- 4,4'-DDD
- 4,4'-DDT
- Dieldrin
- Aluminum
- Arsenic
- Barium
- Beryllium
- Cadmium
- Chromium
- Cobalt
- Copper
- Lead
- Manganese
- Thallium
- Vanadium
- Cadmium

Groundwater

- Benzene
- Carbon disulfide
- Chlorobenzene
- 1,4-Dichlorobenzene
- Vinyl chloride
- Xylenes
- Benzo(a)pyrene
- Bis(2-chloroethyl)ether
- Bis(2-ethylhexyl)phthalate
- 2,4-Dinitrotoluene
- Hexachlorobenzene
- Hexachloroethane
- 1,2,4-Trichlorobenzene
- 2,4,6-Trichlorophenol
- alpha-Chlordane
- 4,4'-DDD
- 4,4'-DDE
- Aluminum
- Arsenic
- Barium
- Beryllium
- Cadmium
- Cobalt
- Copper
- Lead
- Manganese
- Mercury
- Selenium
- Thallium
- Vanadium
- Zinc

The media of concern for the IRA were soil and drainage swale sediment, which represented the highest risk exposure pathways for Site 4. Potential exposure to soil is associated with significant human health risks because of exceedance of the EPA risk management criteria for either the average or the reasonable maximum exposure scenarios. The unacceptable risks were only associated with the hypothetical future residential exposure scenario.

Unacceptable cancer risk from the soil contaminants was driven by PAHs, PCBs, and beryllium, with PCBs contributing the most to risk. There were no unacceptable noncarcinogenic hazards associated with exposure to soil. The presence of PCBs in soil and drainage swale sediment was determined to be impacting the Quantico Embayment of the Potomac River. Once in the embayment, bioaccumulation of PCBs could occur in aquatic receptors and pose a potential risk via human ingestion of contaminated fish. Studies conducted after the IRA confirmed potential risks to both ecological receptors and to humans from fish ingestion.

Risks from exposure to groundwater were also considered in the FFS during the development of IRA alternatives. Potential exposure to groundwater under the hypothetical future residential scenario is associated with unacceptable carcinogenic and noncarcinogenic risks. Unacceptable cancer risks were driven by benzo(a) pyrene, arsenic, and beryllium.

Benzene, Chlorobenzene, aluminum, arsenic, barium, manganese, thallium, and vanadium drove the unacceptable noncancer hazards.

The IRA was followed by additional Rl and FS activities for Site 4 and a Quantico Post-IRA Study to further evaluate groundwater, surface water, and sediment contamination and potential impacts to the Potomac River. These studies have yet to be completed and are currently being conducted. Groundwater will be addressed in the final remedy for Site 4, and surface water and sediment will be addressed as part of the Post-IRA study.

4.0 INTERIM REMEDIAL ACTIONS

4.1 Interim Remedy Selection

The ROD for the IRA for Site 4 was signed in September 1997. Remedial Action Objectives (RAOs) for the IRA were developed as a result of data collected during the preliminary Rl and FFS to aid in the development and screening of remedial alternatives to be considered for the ROD. The RAOs for soil and on-site sediment include the following:

- Minimize direct contact, inhalation, and ingestion of contaminants posing a carcinogenic risk.
- Reduce migration of contaminants to groundwater.
- Restrict migration of contaminants to the adjacent embayment.
- Comply with applicable or relevant and appropriate requirements (ARARs) directly associated with the action.

The major components of the IRA selected in the ROD include the following:

- Consolidation of existing berms, demolition and off-site disposal of scrap yard buildings, and incorporation of scrap yard building foundations within the landfill.
- Excavation and off-site disposal of surface soil and drainage swale sediment contaminated with PCBs in excess of 10 mg/kg.
- Excavation and on-site disposal of landfill material and sediment from the shoreline.
- Permeable soil barrier layer installation covering 23 acres, and incorporation of flood control measures and shore protection.

- Shoreline stabilization

- Mitigation for wetlands destroyed or impacted by implementation of the IRA (1.8 acres impacted versus 2.1 acres replaced), including monitoring of the replacement wetlands to ensure mitigation is effective.

- Institutional controls, to include no breaching of the barrier layer, fencing around the entire site with locked gates, and access restrictions from unauthorized personnel

- Operation and maintenance (O&M).

- Five-year reviews as required by CERCLA.

Final use restrictions for the landfill are to be addressed in the final remedy for Site 4. Until that time, the Navy will employ the above institutional controls as protection. No invasive development is to be allowed. O&M activities will include an annual inspection of the cover and includes, at a minimum, performance standards to assure integrity of the barrier layer, erosion control, wetland monitoring, and inspection and maintenance, as applicable.

4.2 Remedy Implementation

The Navy performed the remedial design (RD) and implemented the IRA. The RD was completed in July 1995. Site preparation activities for the IRA began in May 1996. The IRA was completed in October 1997. The major components of the IRA were as follows:

- Four on-site building were demolished and the landfill surface was cleared as initial steps for preparing the site for subsequent actions.

- A total of 4,986 tons of soil and drainage swale sediment with PCB concentrations higher than 10 mg/kg was excavated and hauled off site for disposal. Erosion of the riverbank had resulted in exposure of waste and debris along the shoreline from the shore to approximately 50 to 60 feet into the river. Approximately 3,500 cubic yards of waste, debris, and sediment were excavated from the river. The excavated material, which contained less than 10 mg/kg of PCBs, was placed on the landfill and covered by the soil barrier layer.

- The landfill surface was regraded, and a layer of geotextile materials was placed at the site. The barrier layer, which consists of 18 inches of common fill and 6 inches of topsoil, was placed above the geotextile layer. The area was seeded upon completion of the topsoil layer. The shoreline was stabilized with riprap to minimize erosion.

- A wetland was created to replace wetlands that were destroyed or impacted by installation of the soil barrier layer (wetland mitigation). A stream was graded and backfilled with planting soil, and the planting of new replacement wetland species was accomplished.

- Approximately 3,000 feet of chain-link fence was installed around the landfill perimeter, except along the river, to control site access. Warning signs were posted on the fence.

The remediation contractor issued the final IRA report in February 1998. The Navy, EPA, and Virginia DEQ have determined that all IRA construction activities were performed according to specifications.

4.3 System Operation/Operation and Maintenance

The ROD for the IRA states that O&M will be performed in accordance with state solid waste management regulations. The O&M is to include an annual inspection of the soil barrier layer, initiated within one year of the completion of the IRA. The remaining portions of the state O&M requirements are to be implemented as part of the final remedy for the site. O&M for the IRA is to include, at a minimum, the following items: performance standards to assure integrity of the barrier layer, erosion control, wetland monitoring, and inspection and maintenance as applicable.

MCB Quantico is conducting inspection and maintenance activities according to the maintenance manual dated November 30. 1997. The primary inspection and maintenance activities associated with O&M include the following:

- Site security, condition of gates, evidence of trespassing, evidence of vandalism, and condition of warning signs.

- Condition of landfill cover, including erosion, ponded water, burrowing animal damage, and vegetative cover.

- Condition of constructed wetland.

- Condition of monitoring wells.

- Mowing and maintenance, as needed.

The primary cleanup of Site 4 took place during the construction phase of the IRA (i.e., removal of contaminated soil and sediment and placement of soil barrier layer). Therefore, as indicated in the planned elements above, the primary O&M activities have

been geared towards inspections and maintenance of the fence, landfill cover, and constructed wetland.

5.0 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

This was the first five-year review for the site.

6.0 FIVE-YEAR REVIEW PROCESS

6.1 Administrative Components

The EPA and Virginia DEQ were notified of the initiation of the five-year review on September 4, 2002. The Site 4 five-year review team was led by Andrew Gutberlet, the Remedial Project Manager (RPM) for the Navy. TtNUS assisted in the review under contract to the Navy. Matias Santiago, the MCB Quantico RPM, assisted in the review as the representative of the base. Lisa Bradford, the EPA RPM, and Steve Mihalko, the Virginia DEQ RPM, assisted in the review as the representatives of the support agencies.

Early in September 2002, the review team established the review schedule whose components included the following:

- Community involvement
- Document review
- Data review
- Site inspection
- Five-Year Review report development and review

The schedule extended through the end of September 2002.

6.2 Community Involvement

A notice was sent to three local newspapers that a five-year review was to be conducted.

A notice was sent to local newspapers announcing the results of the five-year review and that the report was available to the public at the Chinn Park Regional Library, John Porter Memorial Library, and Marine Corps Research Center. This notice was published in the same local newspapers that announced that the five-year review report was completed for Site 4.

6.3 Document Review

The five-year review consisted of a review of relevant documents including O&M records and monitoring data. The documents reviewed include the following:

- RI/Risk Assessment Report, Old Landfill, November 1992
- FFS Report for Old Landfill, April 1995.
- ROD for Old Landfill - Site 4, Interim Remedial Action, September 1997.
- Maintenance Manual, Site 4 - Old Landfill, November 1997
- Final Report, IRA, Site 4 - Old Landfill, February 1998.
- Rl for Site 4 - Old Landfill, April 2000.
- Draft Final FS for Site 4 - Old Landfill, September 2001.
- Draft Survey Report, Quantico Watershed Study, Rapid Sediment Analysis Pilot Study, November, 2001.
- Site Inspection Checklists, Site 4 - Old Landfill, December 1997 to December 2001

6.4 Data Review

6.4.1 Groundwater Data

The data review conducted for the five-year review included a comparison of maximum detected groundwater concentrations for samples collected before and after the IRA (see Table 2). The IRA did not include a formal monitoring program to specifically evaluate remedy performance. However, groundwater samples were collected after the IRA was implemented to support the ongoing Rl and FS activities at Site 4. All available groundwater data were reviewed for this report. In general, most chemicals were detected at their highest levels before the IRA was completed, when groundwater samples were collected with bailers resulting in turbid samples. Also, some chemicals detected during the preliminary Rl or the FFS were not detected after the completion of the IRA. Higher concentrations of many chemicals (metals, PAHs, pesticides, etc.) in the pre-IRA groundwater samples are considered to be attributable to particulate matter in turbid samples. Lower concentrations in the post-IRA groundwater samples are attributable to the use of low-flow sampling techniques. Lower chemical concentrations in the post-IRA groundwater samples also may be the direct result of the IRA (i. e.. contaminated soil removal). Overall differences in chemical concentrations may also be attributable to the specific locations sampled (i.e., not all wells were sampled during each sampling event). Some monitoring wells were destroyed during the IRA and were replaced by other wells. Also, some new (post-IRA) monitoring well locations were added and only sampled after the IRA.

The following describes concentration trends for the groundwater chemicals identified in Section 3.5. There was a slight increase in the maximum concentrations of benzene. 1,4-

dichlorobenzene, manganese, and mercury. There was a decrease to slight decrease in the maximum concentrations of chlorobenzene, alpha-chlordane, 4,4'-DDD, 4,4'-DDE, aluminum, arsenic, barium, beryllium, copper, lead, vanadium, and zinc. Additional information on the magnitude of the concentration trends is shown on Table 2, which shows the maximum concentrations and frequency of detection from the pre-RI, FFS, and post-IRA groundwater samples. The other groundwater chemicals listed in Section 3.5 have not been detected since the IRA was completed.

Table 2 also presents a comparison of maximum detected concentrations in preliminary Rl, FFS, and post-IRA groundwater samples to USEPA Federal Maximum Contaminant Levels (MCLs) (USEPA, National Primary Drinking Water Standards, Office of Water, EPA 816-F-02-013, July 2002). VOCs were most frequently detected during the Preliminary Rl. Although maximum detected concentrations of chlorobenzene, methylene chloride, and vinyl chloride exceeded MCLs during the Preliminary Rl and/or FFS all VOCs detected after the IRA were present at concentrations below MCLs. Various SVOCs were detected sporadically during the Preliminary Rl and FFS. Some concentrations of bis(2-ethylhexyl)phthalate during all three phases of investigation exceeded the Federal MCL. However, this chemical is likely attributable to laboratory blank contamination, not site-related disposal practices. Additionally although, maximum concentrations of benzo(a)pyrene and hexachlorobenzene detected during the Preliminary Rl and the FFS were in excess of MCLs, these chemicals were not detected during the post-IRA sampling. No pesticides were detected at concentrations above MCLs. Aroclor 1242 and 1260 were detected during the Preliminary IRA at concentrations in excess of the MCL, but PCBs were not detected during the FFS or after the IRA. Maximum concentrations of aluminum, arsenic, chromium, iron, lead, mercury, and manganese were in excess of MCLs during all three investigations. Maximum concentrations of antinomy, barium, beryllium, cadmium, copper, thallium, and zinc were in excess of MCLs during the Preliminary Rl and FFS.

No distinguishable groundwater plumes were evident from the data collected prior to the IRA. Data collected after the IRA supports this conclusion.

6.4.2 Sediment Data

The data review conducted for the five-year review included a comparison of the sediment sampling results from the ERA and the sediment results from the Quantico Embayment Post-IRA Study (see Table 3). The IRA did not include a formal monitoring program to specifically evaluate remedy performance. However, the USF& WS collected sediment samples in 1993, 1995, and 1997 to support an ERA for the Quantico Embayment. Additional sediment samples were collected from the embayment in 2001 as part of the ongoing Quantico Embayment Post-IRA Study. Table 3 only contains results for chemicals that were reported in both the ERA and Quantico Embayment Post-IRA Study because the analytical parameter lists for these studies were not exactly the same. Both studies included analysis for PAHs, pesticides, PCBs, and metals, which are the primary contaminants of concern for

Site 4. The concentrations of all PAHs and PCBs were lower for the Quantico Embayment Post-IRA Study samples than for the ERA samples. In general, the concentrations for the pesticide 4.4'-DDT and its breakdown products were higher for the Quantico Embayment Post-IRA Study while the concentrations of other pesticides (i.e., chlordane, dieldrin. and endrin) were higher for the ERA. With the exception of aluminum and chromium, the concentrations of metals were similar for both studies (i.e., maximum concentrations within 25 percent of each other). The maximum concentration of aluminum was approximately three times higher and the maximum concentration of chromium was approximately two times higher for the Quantico Embayment Post-IRA Study than for the ERA. The larger differences for aluminum and chromium may be the result of natural variability in the sample matrix. In addition, aluminum is a major soil-forming cation and is naturally abundant in soil and sediment matrices.

An evaluation of the past and present effects of Site 4 on the Quantico Embayment will be addressed further in the Quantico Embayment Post-IRA Study and the Final FS for Site 4, which are both ongoing at the time of this five-year review.

6.5 Site Inspection

An inspection of the site was conducted on September 12, 2002 by the Navy RPM, MCB Quantico RPM, EPA RPM, and representatives of TtNUS, including a wetland specialist. The purpose of the inspection was to assess the protectiveness of the remedy, including the presence of fencing to restrict access, the integrity of the soil barrier layer and shoreline protection, and the condition of the constructed wetland. Photographs taken during the site inspection are included in Appendix A.

No significant issues were identified at any time regarding the soil barrier layer, shoreline protection, or the fence.

No significant issues were identified during the site visit regarding the constructed wetland. The vegetation planted during the IRA is healthy and dense. Some trees have emerged naturally. The only issue that was noted during the site visit was the presence of a few small clumps of phragmites, which is an invasive species. MCB Quantico personnel were notified of this issue and will apply a herbicide to the affected areas to eliminate/control the invasive species. The wetland inspection report is included in Appendix B.

The institutional controls that have been put in place by MCB Quantico include restrictions on breaching of the barrier layer, access from unauthorized personnel, and any other activities or actions that might interfere with the implemented interim remedy. No invasive development of the landfill is allowed. During the site visit, no activities were observed that would have violated the institutional controls. The soil barrier layer

was undisturbed, and no uses of groundwater were observed. Final institutional controls and use restrictions are to be addressed in the final remedy for Site 4.

6.6 Interviews

No interviews were conducted as part of this five-year review. The parties most familiar with the site are the Navy, MCB Quantico, EPA, and Virginia DEQ RPMs and TtNUS personnel. These personnel meet regularly to discuss issues with the CERCLA sites at MCB Quantico, including Site 4. Their knowledge regarding Site 4 is reflected in this five-year review report.

7.0 TECHNICAL ASSESSMENT

7.1 Question A: Is the remedy functioning as intended by the decision documents?

The review of documents, ARARs, risk assumptions, and the results of the site inspection indicates that the interim remedy is functioning as intended by the ROD. The removal of contaminated soil and drainage swale sediment, the removal of waste material and sediment from the Quantico Embayment, and the installation of the soil barrier layer have achieved the RAOs to minimize direct contact, inhalation, and ingestion of soil and sediment contaminants, reduce migration of contaminants to groundwater, and restrict migration of contaminants to the adjacent embayment. The effective implementation of institutional controls has also helped to achieve the RAO to minimize direct contact, inhalation, and ingestion of soil and sediment contaminants. Removal and off-site disposal of soil and drainage swale sediment having PCB concentrations greater than 10 mg/kg has achieved the RAO to comply with ARARs.

Inspection and maintenance of the site security controls and soil barrier layer have, on the whole, been tt effective. Areas needing repair are noted on the site inspection checklist along with the status of the repair. There are no indications of any difficulties with the interim remedy.

The maintenance and survival of the constructed wetland has been good. A few clumps of the invasive species phragmites were observed in the wetland. However, this does not affect the potential for the release of contaminants from the site and does not affect protectiveness of the interim remedy.

There were no opportunities to improve the performance and/or reduce costs of monitoring, sampling, and treatment systems because these activities are not part of the IRA.

The institutional controls that are in place include restrictions on breaching of the barrier layer, access restrictions from unauthorized personnel, and any other activities or actions that might interfere with the implemented interim remedy. No invasive development of the landfill is allowed. No activities were observed that would have violated the institutional controls. The soil barrier layer is undisturbed. The fence around the site is intact and in good repair.

7.2 Question B: Are the exposure assumptions, toxicity data, clean-up levels, and RAOs used at the time of the remedy selection still valid?

There have been no changes in the physical conditions of the site that would affect the protectiveness of the interim remedy.

7.2.1 Changes in Standards and To Be Considers (TBCs)

As the remedial work has been completed, all ARARs for PCB-contaminated soil, wetlands, and floodplains cited in the ROD have been met. A list of ARARs from the ROD for the IRA is included in Table 4. There have been no changes in these ARARs and no new standards or TBCs that would affect the protectiveness of the remedy. Almost all the ARARs and TBCs related to requirements to be met during design and construction of the IRA.

7.2.2 Changes in Exposure Pathways, Toxicity, and Other Contaminant Characteristics

The exposure assumptions used to develop the human health risk assessment for Site 4 included both current exposures (adult trespasser and construction worker) and potential future exposures (hypothetical adult and child residents). The risk assessment also included exposure of an adult recreational user that ingests fish; however, this route of exposure is not applicable to the IRA. Changes in toxicity factors for soil contaminants of concern and changes to the standardized risk assessment methodology were not evaluated for this five-year review because the only contaminant-specific remediation goal in the ROD was for PCBs. The remediation goal for PCBs (10 mg/kg) was not based on a concentration derived from the risk assessment but was based on a concentration obtained from EPA Guidance on Remedial Actions for Superfund Sites with PCB Contamination (OSWER Directive 9355.4-01, August 1990) that is still applicable. The soil barrier layer effectively eliminates exposure to landfill material and soil beneath the barrier for the evaluated potential receptors. Any changes in toxicity factors or risk assessment methodology would not affect the protectiveness of the interim remedy.

7.3 Question C: Has any other information come to light that calls into question the protectiveness of the remedy?

There is no other information that calls into question the protectiveness of the interim remedy. No on-site ecological target's were evaluated during the baseline risk assessment conducted, and none were identified during the five-year review. Therefore, monitoring of on-site ecological targets is not necessary. The site as a continuing source area (i.e., the potential for current migration of contaminants) is being evaluated further in the ongoing FS for the final remedy for Site 4. Historical migration of contaminants is being addressed in the ongoing Quantico Embayment Post-IRA Study. Additionally, no weather-related events have affected the protectiveness of the interim remedy.

7.4 Technical Assessment Summary

According to the data reviewed and the site inspection, the interim remedy is functioning as intended by the ROD. There have been no changes in the physical conditions of the site that would affect the protectiveness of the interim remedy. All ARARs for soil contamination cited in the ROD have been met. A review of changes in toxicity factors or risk assessment methodology was not conducted for this five-year review. The soil barrier layer effectively eliminates exposure to landfill material and soil beneath the barrier; therefore, any changes in toxicity or risk methodology are not relevant to the protectiveness of the interim remedy. There is no other information that calls into question the protectiveness of the interim remedy.

8.0 ISSUES

The only issue related to site operations, conditions, or activities is the presence of the invasive species phragmites in the constructed wetland. The presence of this invasive species does not affect the potential for release of contaminants from the site and does not affect current or future protectiveness of the interim remedy.

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The only issue identified during this five-year review was the presence of an invasive species phragmites in the constructed wetland. MCB Quantico has been advised of this issue and plans to apply herbicide to eliminate/control the invasive species, which is the recommendation. The Navy and MCB Quantico will be responsible for this action with oversight by EPA and Virginia DEQ. The milestone for this follow-up action is March 2003. However, it should be noted that the presence of this invasive species does not affect current or future protectiveness of the interim remedy.

10.0 PROTECTIVENESS STATEMENT

The IRA for Site 4 is protective of human health and the environment. The interim remedy is functioning as intended. The exposure assumptions, toxicity data, clean-up levels, and RAOs used at the time of the interim remedy selection are still valid. No other information has come to light that could call into question the protectiveness of the interim remedy.

11.0 NEXT REVIEW

The next five-year review for Site 4 is required by March 2008, five years from the date of this review.

TABLE 1

CHRONOLOGY OF SITE EVENTS
SITE 4 - OLD LANDFILL
MCB QUANTICO, VIRGINIA

Event	Date
Landfill operations	Early 1920s - 1971
Landfill surface used by DRMO for storage of waste fuels and solvents, electrical transformers, and out of service military vehicles.	1950s - 1979
Rupture of pipeline adjacent near the landfill spilled approximately 100,000 gallons of diesel fuel onto the landfill.	June 1980
Initial Assessment Study (equivalent to a preliminary assessment)	1984
Confirmation Study (equivalent to a site inspection)	1988
Removal action for soil contaminated with polychlorinated biphenyls (PCBs) from DRMO activities	1990
Preliminary remedial investigation (Rl)	1991
Virginia Department of Environmental Quality (DEQ) issues Notice of Violation (NOV) for discharging contaminants without a National Pollutant Discharge Elimination System (NPDES) permit	June 1993
U.S. Fish and Wildlife Service (USFWS) conducts ecological risk assessment	1993 to 1999
Final listing on EPA National Priority List	May 1994
Engineering Evaluation/Cost Analysis (EE/CA) and Focused Feasibility Study (FFS) for interim remedial action (IRA)	1994 to 1995
FFS and Proposed Plan released to the public; start of public comment period	July 1995
Remedial Design (RD) completed	July 1995
IRA activities - sediment removed from drainage channel, sediment and waste material removed from Quantico Embayment, DRMO structures and surface debris removed, soil barrier layer installed over landfill, shoreline protection installed	May 1996 to October 1997
Record of Decision (ROD) for the IRA is signed	September 1997
Rl to support final remedial action	1997 to 1999
Federal Facility Agreement signed	February 1999
FS to support final remedial action	2000 to present
Sampling to support Rapid Sediment Analysis Pilot Study for Quantico Embayment	October 2001
Draft Survey Report for Rapid Sediment Analysis Pilot Study	November 2001
Draft Post-IRA Study Work Plan	June 2002

TABLE 2

REVIEW OF GROUNDWATER DATA
SITE 4 – OLD LANDFILL
MCB QUANTICO, VIRGINIA
PAGE 1 OF 5

Chemical	Preliminary RI[1]		FFS[2]		Post-IRA[3]		U.S. EPA Federal MCL[4]
	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	
Volatile Organics (µg/L)							
1,2-Dichloroethene (total)	5/39	6	2/20	3 (cis)	0/25	---	70[5]
Acetone	12/39	180	1/5	38	3/6	150	---
Benzene	1/39	2	1/20	2	4/25	2.3	5
2-Butanone	0/39	---	0/20	---	5/8	42	---
Carbon disulfide	12/39	64	6/20	14	0/25	---	---
Chlorobenzene	12/39	160	7/20	280	4/25	35	100
Chloroform	0/39	---	0/20	---	3/25	8	80
Ethylbenzene	5/39	210	3/20	58	0/25	---	700
Methylene chloride	5/39	9	0/11	---	0/25	---	5
Toluene	4/39	14	2/20	2	4/25	2	1,000
Vinyl chloride	5/39	16	2/20	4	0/25	---	2
Xylenes (total)	6/39	1,400	4/20	580	0/25	---	10,000
Semivolatile Organics (µg/L)							
Acenaphthene	5/38	150	2/20	51	0/25	---	---
Anthracene	5/38	23	1/20	4	0/25	---	---
Benzo(a)anthracene	4/38	21	0/19	---	0/25	---	---
Benzo(a)pyrene	2/38	9	1/20	12	0/25	---	0.2
Benzo(b)fluoranthene	2/38	9	0/19	---	0/25	---	---
Benzo(g,h,i)perylene	1/38	5	0/19	---	1/25	2.7	---
Benzo(k)fluoranthene	2/38	7	0/19	---	0/25	---	---
Bis(2-chloroethyl)ether	0/38	---	1/20	59	0/25	---	---
Bis(2-ethylhexyl)phthalate	3/38	12	1/20	59	4/25	8.8	6

TABLE 2

REVIEW OF GROUNDWATER DATA
SITE 4 – OLD LANDFILL
MCB QUANTICO, VIRGINIA
PAGE 2 OF 5

Chemical	Preliminary RI[1]		FFS[2]		Post-IRA[3]		U.S. EPA Federal MCL[4]
	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	
Butylbenzyl phthalate	0/38	---	1/20	1.1	0/25		---
4-Chloro-3-methylphenol	0/38	---	1/20	2	0/25	---	---
2-Chlorophenol	0/38	---	2/20	10	0/25	---	---
Chrysene	4/38	19	0/19	---	1/25	2.2	---
Dibenzofuran	5/38	46	2/20	14	0/25	---	---
1,4-Dichlorobenzene	0/38	---	2/18	3	2/25	4	75
Diethylphthalate	1/38	15	2/20	16	0/25	---	---
2,4-Dimethylphenol	0/38	---	2/20	25	0/25	---	---
2,4-Dinitrotoluene	0/38	---	1/20	11	0/25	---	---
Fluoranthene	5/38	78	1/20	10	1/25	2	---
Fluorene	5/38	83	2/20	29	0/25	---	---
Hexachlorobenzene	0/38	---	1/20	13	0/25	---	1.0
Hexachloroethane	0/38	---	1/20	3	0/25	---	---
Indeno(1,2,3-cd)pyrene	2/38	5	0/19	---	0/25	---	---
Isophorone	0/38	---	1/20	5	0/25	---	---
2-Methylnaphthalene	4/38	46	2/20	16	0/25	---	---
4-Methylphenol	1/38	3	0/19	---	3/25	25	---
N-Nitrosodiphenylamine	0/38	---	1/20	2	1/25	1,100	---
Phenanthrene	5/38	150	2/20	36	0/25	---	---
Phenol	0/38	---	1/20	14	2/25	420	---
Pyrene	5/38	54	1/20	5	1/25	14	---
1,2,4-Trichlorobenzene	0/38	---	1/20	5	0/25	---	70
2,4,6-Trichlorophenol	0/38	---	1/20	22	0/25	---	---

TABLE 2

REVIEW OF GROUNDWATER DATA
SITE 4 – OLD LANDFILL
MCB QUANTICO, VIRGINIA
PAGE 3 OF 5

Chemical	Preliminary RI[1]		FFS[2]		Post-IRA[3]		U.S. EPA Federal MCL[4]
	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	
Pesticides/PCBs (µg/L)							
alpha-Chlordane	0/43	---	1/20	0.09	1/25	0.039	2[6]
4,4'-DDD	25/43	26	4/20	4.2	2/25	1.2	---
4,4'-DDE	20/43	3	3/20	0.22	1/25	0.03	---
4,4'-DDT	0/43	---	0/20	---	1/25	0.47	---
Dieldrin	0/43	---	0/20	---	1/25	0.26	---
Endrin aldehyde	0/43	---	0/20	---	3/25	0.048	2[7]
Endrin ketone	0/43	---	0/20	---	1/25	0.1	2[7]
gamma-Chlordane	0/43	---	0/20	---	1/25	0.048	2
Methoxychlor	0/43	---	0/20	---	1/25	0.082	40
Aroclor 1242	1/43	4.8	0/20		0/25	---	0.5
Aroclor 1260	9/43	19.8	0/20	---	0/25	---	0.5
Inorganics (µg/L)							
Aluminum	40/40	219,000	11/20	49,500	9/25	29,000	50[8]
Antimony	36/40	299	0/19	---	0/25	---	6
Arsenic	36/40	207	11/20	80.2	14/25	31	10[9]
Barium	40/40	9,220	20/20	2,220	25/25	1,560	2,000
Beryllium	22/40	93.9	4/20	15.3	1/25	3	4
Cadmium	17/40	38.2	1/20	4.6	0/25	---	5
Calcium	40/40	381,000	20/20	293,000	25/25	199,000	---
Chromium	35/40	450	3/20	98.9	4/25	194	100
Cobalt	39/40	245	6/20	42.2	5/25	37.9	----
Copper	40/40	1,810	7/20	142	5/25	60.9	1,300[10]

TABLE 2

REVIEW OF GROUNDWATER DATA
SITE 4 – OLD LANDFILL
MCB QUANTICO, VIRGINIA

Chemical	Preliminary RI[1]		FFS[2]		Post-IRA[3]		U.S. EPA Federal MCL[4]
	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	Frequency of Detection	Maximum Concentration	
Iron	40/40	343,000	20/20	148,000	24/25	105,000	300[8]
Lead	40/40	10,800	10/20	215	11/25	50	15[10]
Magnesium	40/40	83,400	20/20	80,600	25/25	90,900	---
Manganese	40/40	2,670	20/20	3,040	25/25	4,100	80[8]
Mercury	18/40	4	3/20	0.93	1/25	10	2
Nickel	36/40	400	4/20	62.2	7/25	145	---
Potassium	40/40	51,300	20/20	36,500	25/25	120,000	---
Selenium	10/40	49.9	1/20	21	0/25	---	50
Silver	24/40	85.8	1/20	12.5	0/25	---	100[8]
Sodium	40/40	246,000	20/20	220,000	25/25	453,000	---
Thallium	2/40	18.4	6/19	7	0/25	---	2
Vanadium	38/40	1,330	10/18	232	6/25	144	---
Zinc	40/40	11,400	16/20	1,530	10/25	149	5,000[8]
Cyanide	7/40	73.5	NA	---	NA	---	200

FFS - Focused Feasibility Study
IRA - Interim Remedial Action
MCL - Maximum Contaminant Level
NA - Not Analyzed
RI - Remedial Investigation

ORIGINAL (Red)

TABLE 2

REVIEW OF GROUNDWATER DATA
SITE 4 – OLD LANDFILL
MCB QUANTICO, VIRGINIA
PAGE 5 OF 5

Notes:

- Highlighted cells indicate a groundwater concentration that exceeds the Federal MCL.
- A dash in the MCL column indicates that a numerical MCL does not exist for this analyte.
- Only unfiltered groundwater data are included in this table.
- Number of sample results excludes rejected data or non-qualified data. Duplicates are consolidated into one result.
- Frequency of detection refers to number of times a chemical was detected among all samples versus total number of samples.
- Number of samples may vary based on the number of usable results.

Footnotes:

1 Preliminary RI (up to 1992)
2 FFS Investigation (1994)
3 RI and FS (1997-1999)
4 USEPA, National Primary Drinking Water Standards, Office of Water, EPA 816-F-02-013, July 2002.
5 Values for cis-1,2-Dichloroethene is presented.
6 Value for Technical Chlordane is presented.
7 Value for Endrin is presented.
8 Secondary MCL is presented.
9 The new arsenic MCL of 10 µg/L becomes effective on January 23, 2006.
10 The value presented is an action level.

ORIGINAL (Red)

TABLE 3

REVIEW OF SEDIMENT DATA
SITE 4 – OLD LANDFILL
MCB QUANTICO, VIRGINIA
PAGE 1 OF 2

Chemical	ERA		Quantico Embayment Post-IRA Study	
	Frequency of Detection	Concentration Range	Frequency of Detection	Concentration Range
Semivolatile Organics (µg/kg)				
2-Methylnaphthalene	28/28	56.3 – 212.1	6/6	10.07 – 65.23
Acenaphthene	9/28	15.6 – 51.5	6/6	2.03 – 12.37
Anthracene	18/28	17.9 – 184.3	6/6	3.04 – 16.64
Benzo(a)anthracene	27/28	19.7 - 553	6/6	10.91 – 125.56
Benzo(a)pyrene	26/28	32.5 – 322.6	6/6	8.75 – 128.95
Benzo(b)fluoranthene	27/28	19.7 – 345.6	6/6	15.66 – 151.17
Benzo(g,h,i)perylene	17/28	15.6 – 184.3	6/6	6.4 – 84.97
Benzo(k)fluoranthene	27/28	39.4 – 391.7	6/6	12.13 – 138.71
Dibenzo(a,h)anthracene	2/28	41.8 – 69.1	6/6	1.41 – 20.06
Fluoranthene	27/28	59.1 – 1,267.3	6/6	42.06 – 374.46
Fluorene	16/28	14.8 – 69.1	6/6	4.19 – 19.5
Indeno(1,2,3-cd)pyrene	16/28	15.6 – 184.3	6/6	5.75 – 93.53
Naphthalene	28/28	32.7 – 161.3	6/6	7.42 – 30.15
Perylene	28/28	42.3 – 752.7	6/6	35.3 – 420.16
Phenanthrene	27/28	13.7 – 645.2	6/6	17.44 – 156.84
Pyrene	27/28	59.1 – 1,106	6/6	39.72 – 295.39
Pesticides (µg/kg)				
2,4'-DDD	57/62	2.1 – 361.4	6/6	2.11 – 1,489.82
2,4'-DDE	21/62	3.5 – 12.3	6/6	0.19 – 14.59
2,4'-DDT	5/62	17.1 – 336.3	0/6	---
4,4'-DDD	57/62	1 – 1,606.4	6/6	11.92 – 13,278.1
4,4'-DDE	58/62	2.1 – 672.4	5/6	4.24 – 160.38
4,4'-DDT	39/62	3.2 – 662.4	6/6	1.12 – 1,240.28
Chlordane	8/62	7 – 422.1	5/6 (alpha) 3/6 (gamma)	0.25 – 0.67 0.48 – 5.3
Dieldrin	17/62	2.5 – 39	6/6	0.3 – 2.57
Endrin	1/62	2.7	0/6	---
PCBs (µg/kg)				
Aroclor 1254	34/62	35.3 – 676.7	0/6	---
Aroclor 1262	53/62	53.4 – 2,280.1	6/6	20.25 – 373.01
Metals (mg/kg)				
Aluminum	28/28	1,558 – 16,670	6/6	17,000 – 62,700
Arsenic	27/28	0.83 – 6.51	6/6	1.54 – 8.36

TABLE 3

REVIEW OF SEDIMENT DATA
SITE 4 – OLD LANDFILL
MCB QUANTICO, VIRGINIA
PAGE 2 OF 2

Chemical	ERA		Quantico Embayment Post-IRA Study	
	Frequency of Detection	Concentration Range	Frequency of Detection	Concentration Range
Cadmium	23/28	0.2735 – 0.7677	6/6	0.105 – 0.591
Chromium	28/28	8.997 – 33.6	6/6	14.2 - 73
Copper	27/28	17.09 – 66.34	6/6	12.3 – 72.6
Lead	28/28	6.821 – 66.16	6/6	27 – 45.9
Mercury	23/28	0.1124 – 0.256	6/6	0.0351 – 0.272
Nickel	27/28	5.387 – 35.71	6/6	5.21 – 43.3
Selenium	23/28	0.51 – 0.91	4/6	0.706 – 0.981
Zinc	28/28	21 – 234.4	6/6	50.1 - 201

Frequency of detection refers to number of times a chemical was detected among all samples versus the total number of samples. Duplicates are consolidated into one result.

Table only contains results for chemicals that were reported in both the ERA and the Quantico Embayment Post-IRA Study because the analytical parameter lists for these studies were not exactly the same.

TABLE 4

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SITE 4 – OLD LANDFILL
MCB QUANTICO, VIRGINIA

Medium/Authority	ARAR	Status	Requirement Synopsis	Action to be taken to Attain ARAR
Soil and Sediment/ Toxic Substances Control Act (TSCA)	EPA PCB Spill Policy (40 CFR 761)	To be considered	Remediation of non-liquids (soil, rags, debris) >50 ppm. Comparison of site concentrations with performance standards for new spills is warranted although the concentration of the initial spill(s) is unknown.	Soil or drainage swale sediment with >10 ppm PCBs will be removed/disposed based on industrial use, continued monitoring.
Soil and Sediment/ TSCA	EPA Guidance on Remedial Actions for Superfund Sites with PCB Contamination (OSWER Dir. 9355.4-01)	To be considered	This document describes the recommended approach for evaluating and remediation Superfund sites with PCB contamination.	The Old Landfill qualifies as an industrial area. Maximum site PCB soil concentrations exceed both industrial and residential recommended remediation goals for soil. PCB contamination will continue to be evaluated at each five-year review. PCB-contaminated soil and drainage swale sediment will be removed to 10 ppm to achieve the remediation goals.
Wetlands/ Clean Water Act (CWA)	Federal Dredge and Fill Regulations (33 USC 1344; 40 CFR 230.404)	Applicable	Regulates dredge and fill activities. No activity that adversely affects a wetland shall be permitted if there is a practical alternative.	Actions along the Potomac River or impacted wetlands will be coordinated with the Corps of Engineers (COE), Dumfries and Virginia Marine Resources Commission (VMRC).
Wetlands/ CWA	Federal Executive Order (EO) 11990, Protection of Wetlands	Applicable	Federal agencies are required to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance natural and beneficial values of wetlands.	Wetlands will be impacted by the action. Wetlands impact assessment and restoration will be coordinated with the COE, Dumfries and VMRC.

TABLE 4

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SITE 4 – OLD LANDFILL
MCB QUANTICO, VIRGINIA
PAGE 2 OF 5

Medium/Authority	ARAR	Status	Requirement Synopsis	Action to be taken to Attain ARAR
Shorelines/ Coastal Zone Management Act (CZMA)	16 USC 1451	Applicable	Protection of shorelines, wetlands, and runoff controls.	Alternative will impact shoreline, wetlands, and runoff controls. Alternative will comply with substantive requirements of CWA §404 and VPDES permit and local CZMA and erosion control boards.
Floodplain/ CWA	Federal EO 11988, Consideration for Floodplains	Applicable	Federal agencies are required to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial value of floodplains.	Portions of the site are in the 100-year floodplain. Flood protection will include vegetative cover and riprap.
Wetlands/ CWA	Virginia Wetlands Act (Code of VA 62.1-13.1 et seq.)	Applicable	Regulates activities in tidal wetlands.	Coordinate compliance through substantive regulations of CWA §404.
Wetlands/ CWA	Virginia Wetlands Regulations Act (Code of VA 62.1.13.1 et seq.; VR A450-01-0051/ 4 VAC 20-390-10 et seq.)	Applicable	Any activity to take place in, or impact on, a tidal wetland must meet the provisions of the Virginia Wetlands Act and regulations as applicable. Regulates activities in tidal wetlands.	Any activity to place, or impact on, the tidal wetland of the Old Landfill must meet the provisions of the Act. Coordinate compliance through substantive regulations of CWA §404.
Surface Water/ CWA	Virginia Water Protection Permit Regulations (VR-680-15-02)	Applicable	Applies to activities that affect dredge and fill of surface waters. Virginia's certification authority under CWA §401.	Permit information will be coordinated with VMRC regarding wetland disturbances coordinated through VWPP at Virginia DEQ.
Wetlands/ Resource Conservation and Recovery Act (RCRA)	Virginia Water Management Act, Siting of Hazardous Waste Facilities (Ch. 14 VWMA Article 6, 10.1-1433)	Applicable	Protects wetland from facility siting.	Alternative includes restoration. Restoration will be in accordance with this standard.

TABLE 4

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SITE 4 – OLD LANDFILL
MCB QUANTICO, VIRGINIA

Medium/Authority	ARAR	Status	Requirement Synopsis	Action to be taken to Attain ARAR
Surface Water/ Chesapeake Bay Preservation Act	Chesapeake Bay Preservation Area Designation and Management Regulations (Virginia) (Code of VA Ch. 21,§10.1-2100; VR 173-02-01)	Applicable	Limits land disturbing activities impacting state surface water quality. Chesapeake Bay Preservation Act and Regulations administered by local C-BLAD.	Requires that certain locally designated tidal and nontidal wetlands, as well as other sensitive land areas, be subject to limitations regarding land-disturbing activities, removal of vegetation, use of impervious cover, erosion and sediment control, stormwater management, and other aspects of land use that may have effects on water quality.
Hazardous Waste/ RCRA	Virginia Hazardous Waste Management Regulations (VHWMR) (VR 672-10-1/ 9 VAC 20-60-10 et seq.); Federal Hazardous Waste Regulations (40 CFR 261-266, 268, 270-271)	Applicable	Controls generation, storage, and disposal of solid and hazardous waste. Regulations mirror those developed by EPA for hazardous waste.	If the remedial response involves storage, treatment, or disposal of VHWMR/RCRA hazardous waste, various VHWMR/RCRA requirements may need to be complied with as specified in the VHWMR and/or applicable 40 CFR parts. Because Virginia administers an authorized state RCRA program, the VHWMR will serve as the governing ARAR in place of the RCRA regulations.
Hazardous Waste/ RCRA	Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities, 40 CFR 264, 265, 270, 271	To be considered	Corrective action procedures.	Will be used as guidance when developing remedial strategies.
Solid Waste/ RCRA	Virginia Solid Waste Management Regulations (VR 672-20-10/ 9 VAC 20-80-10 et seq.)	Applicable	The disposal of any soil, debris, sludge, or any other solid waste from a site must be done in compliance with these regulations.	The disposal of any soil, debris, sludge, or any other solid waste from the Old Landfill site must be done in compliance with the regulations.

Original Red

TABLE 4

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SITE 4 – OLD LANDFILL
MCB QUANTICO, VIRGINIA

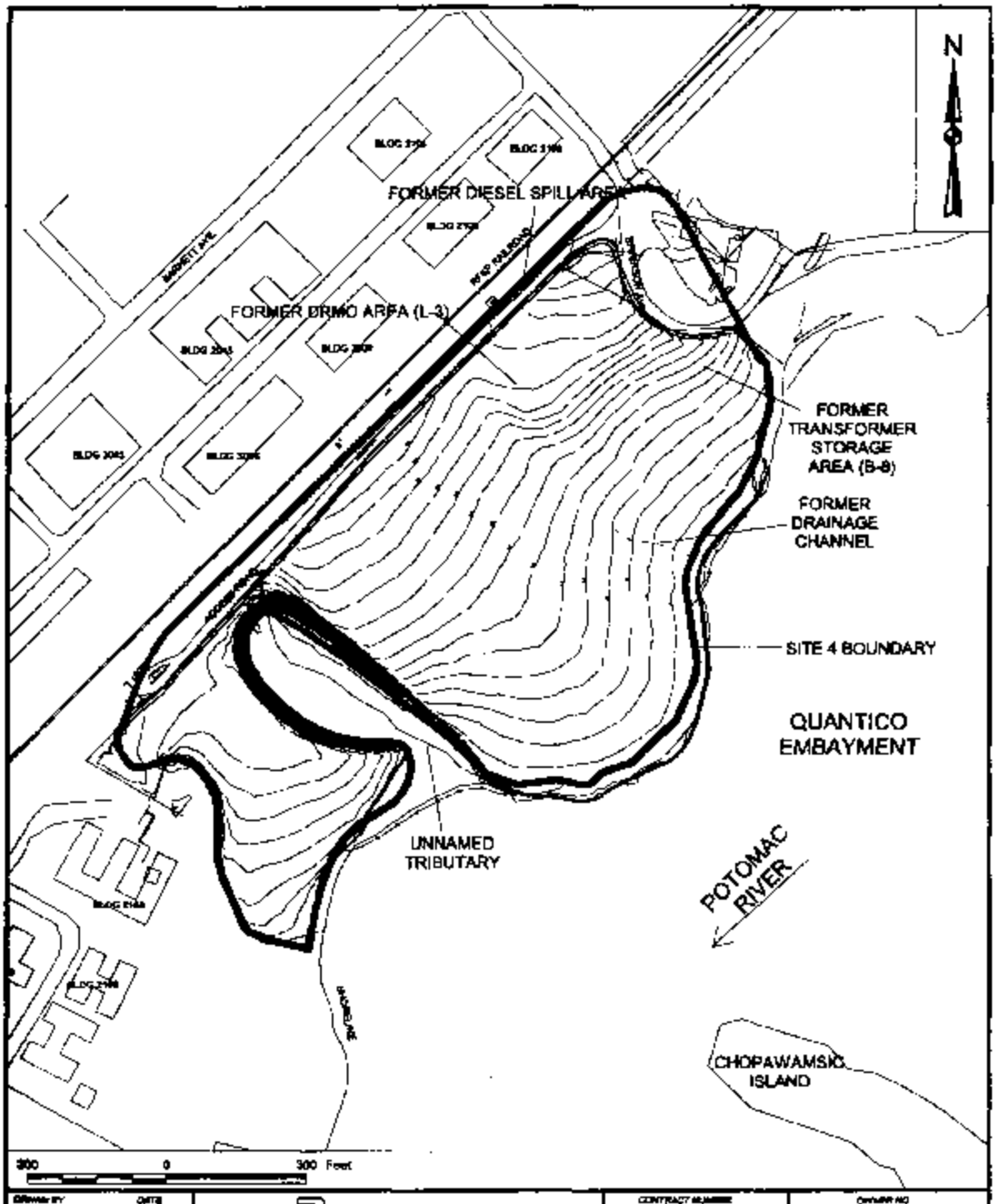
Medium/Authority	ARAR	Status	Requirement Synopsis	Action to be taken to Attain ARAR
Surface Water/ CWA	NPDES Regulations (40 CFR 122)	Applicable	Controls discharges of contaminants to surface water.	Criteria will be followed in the design and operation of any water treatment/discharge system.
Surface Water/ CWA	Federal Ambient Water Quality Criteria (AWQC) (40 CFR 131)	Applicable	AWQC may be considered for actions that involve discharges to state surface waters.	Comply with substantive requirements of NPDES and storm water regulations as identified by Virginia DEQ.
Surface Water/ CWA	Virginia Pollutant Discharge Elimination System (VPDES) Regulations (VR680-14-01/ 9 VAC 25-30-10 et seq.)	Applicable	Establishes the mechanism for permitting of discharges to state waters through VPDES.	Comply with the substantive requirements of VPDES and storm water regulations as identified by Virginia DEQ.
Surface Water/ CWA	Virginia Water Quality Standards (VR 680-21-00)	Applicable	Provides water quality standards for surface water.	Standards are used for basis to develop and comply with the substantive requirements of VPDES discharge permits for PCB hot spots and excavation activities and storm water regulations as identified by Virginia DEQ.
Surface Water/ CWA	Virginia Stormwater Management Act (Code of VA Sections 10.1-603.1 et seq.); Virginia Stormwater Management Regulations (VF 215-02-00/ 4 VAC 3-20-10 et seq.)	Applicable	All land-disturbing activities must be in compliance with local stormwater management programs, where they exist.	Comply with substantive requirements as identified by Virginia DEQ.

TABLE 4

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SITE 4 – OLD LANDFILL
MCB QUANTICO, VIRGINIA

Medium/Authority	ARAR	Status	Requirement Synopsis	Action to be taken to Attain ARAR
Air/ Clean Air Act (CAA)	National Ambient Air Quality Standards (40 CFR 50)	Applicable	Controls emission of unacceptable levels of airborne particulates to the atmosphere. The primary and secondary standards for particulate matter, expressed as PM-10 are 150 (24-hour, annual arithmetic mean) and 50 (1-year, annual arithmetic mean), respectively.	Alternative may result in emission of unacceptable levels of airborne particulates to the atmosphere. Site wetting will be used to control particulate matter and fugitive dust in compliance with Virginia DEQ air regulations.
Air/ CAA	Virginia Regulations for the Control and Abatement of Air Pollution (VR 120-01-1 through VR 120-08-065/ 9 VAC 5-10-10 through 9 VAC 5-80-350)	Applicable	Established ambient air quality goals and regulates the discharge of pollutants into the atmosphere.	Particulates may be released into the atmosphere during remediation. Site wetting will be used to control particulates and fugitive dust in compliance with Virginia DEQ air regulations.
Surface Water/ CWA	Virginia Erosion and Sediment Control Regulations (VR 625-02-00)	Applicable	Establishes minimum design and implementation standards to control erosion and sedimentation from construction sites.	An erosion and sediment control plan will be prepared and submitted for Virginia and Navy before engaging in any land disturbing activity.

ORIGINAL (Red)



DRAWN BY: A. BELLOVE	DATE: 5/9/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 8725
DESIGNED BY: KMS	DATE: 5/9/00	SITE LAYOUT SITE 4 - OLD LANDFILL MCCDC QUANTICO, VIRGINIA	APPROVED BY: Kelly M. Snow DATE: 5/9/00
COST/SCHED/AREA			APPROVED BY: DATE:
SCALE: AS NOTED			DRAWING NO.: FIGURE 1 REV: 0

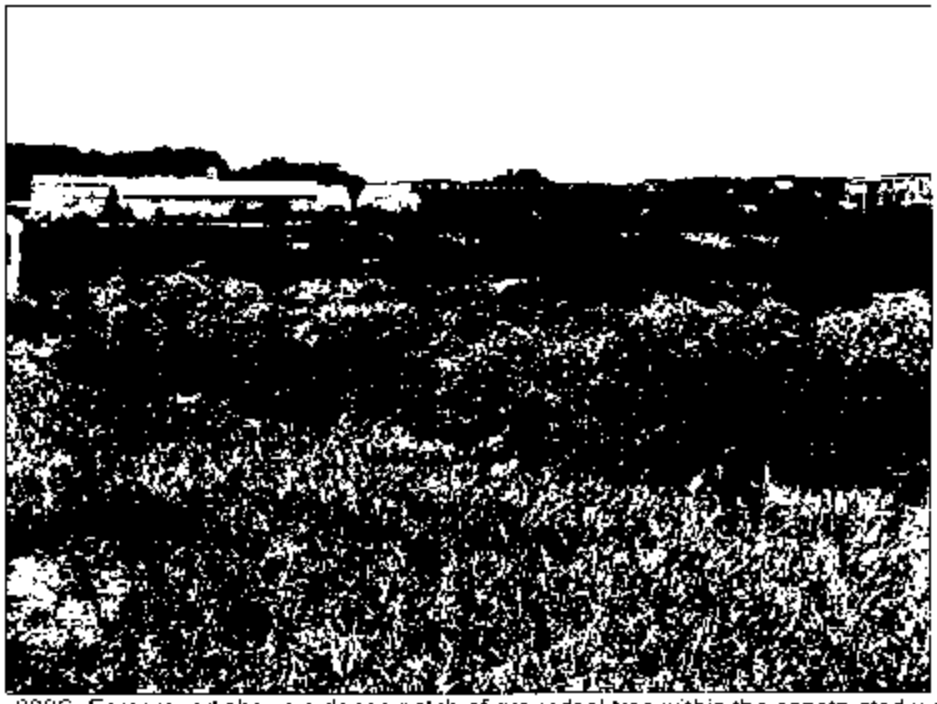
P:\GRAPHICS\QUANTICO\NTC_OLF_TASK 4\FIGURE 4 - OLF SITE - FI LAYOUT JOB 8725.0

APPENDIX A
SITE VISIT PHOTOGRAPHS

MVC – 004S: Overview of the constructed wetland, looking roughly south from the northern (upgradient) end of the wetland.

MVC – 006S: View of upper (north) end of constructed wet and showing dense emergent vegetation and frequent black willow seedlings

MVC - 007S: Overview of cap surface on the landfill.



MVC - 009S: Foreground shows a dense patch of groundsel tree within the constructed wetland. Background shows a dense thicket of black willow.

MVC 010S: One of several small patches of Phragmites within the constructed wetland.

MVC C11S: Overview of restored wetlands, looking south (downstream) from storm drain outfall towards the *Potomac River*.

MVC – 012S: View showing confluence of restored wetlands with the Potomac River.

MVC – 013S: View of Quantico Embayment, with Chopawamsic Island in background. Foreground shows riprap on the river shoreline at the edge of the landfill cap.

MVC – 015S: Riprap on the Potomac River shoreline at the edge of the landfill cap.

MVC – 018S: Dense emergent vegetation in the restored wetland.

ORIGINAL (Red)

APPENDIX B
WETLAND INSPECTION MEMORANDUM

ORIGINAL (Red)

MEMORANDUM

TO: Karen Smecker

FROM: Peyton Doub, PWS

DATE: September 18, 2002

SUBJECT: Five-year Inspection of Site 4 Old Landfill Wetland Mitigation Project
Marine Corps Base (MCB) Quantico, Virginia

The following memorandum documents a visual site inspection conducted by a wetland scientist on September 12, 2002 of wetlands constructed as mitigation to compensate for unavoidable wetland losses resulting from the remediation of Site 4, the Old Landfill, at MCB Quantico.

Background: Site 4, the Old Landfill, consists of approximately 23 acres occupied by an abandoned landfill on the shore of the Potomac River. Operations at the landfill began in the early 1920s and ceased in 1971. The landfill was constructed by incrementally filling tidal marshes and shallow waters in the river, ultimately extending the shoreline waterward into the river approximately 600 to 1,200 feet out from its original location. An interim remedial action was performed at the site in 1997. The action consisted of excavation and off-site disposal of PCB-contaminated soil, regrading the landfill, and covering the landfill with a soil barrier layer (Halliburton NUS, 1995a and b).

Wetland Delineation: A wetland delineation following procedures in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory) and appropriate supplementary guidance was conducted for Site 4 in 1995 (Halliburton NUS, 1995a). Approximately 1.8 acres of wetlands were identified on the landfill, within the proposed footprint of disturbance for the interim remedial action. After reviewing the wetland delineation, the Navy determined that it would not be possible to successfully implement the interim remedial action without permanently filling the 1.8 acres of wetlands.

Wetland Mitigation Plan: To compensate for the unavoidable loss of 1.8 acres of wetlands, the Navy designed a plan for constructing approximately 2.1 acres of onsite wetlands as part of the interim remedial action. The planned result was a net onsite wetland gain of approximately 0.3 acres. The wetlands were designed to occupy a cove that roughly divides the covered landfill into eastern and western halves. The cove allows freshwater released from a storm drain at the northern perimeter of the landfill to traverse the landfill and flow into the Potomac River. The wetlands were designed to be influenced by the same hydrology sources as the original wetlands on the site. These sources include freshwater, both from the landfill surface and the storm drain.

and the tides of the Potomac River (Halliburton NUS, 1995c). The Potomac River, although tidal at MCB Quantico, is normally fresh or nearly fresh, with salinities normally less than 5 parts per thousand during all seasons (White, 1989).

The design called for planting three zones of herbaceous vegetation keyed to elevation as follows:

- Elevations Below 1 Foot: Saltmeadow Cordgrass (*Spartina alterniflora*)
- Elevations Between 1 and 2 Feet: Common Three-square (*Scirpus americanus*)
- Elevations Between 2 and 3 Feet: Soft-stem Bulrush (*Scirpus validus*)

These species were selected because they are regionally indigenous, establish and spread rapidly, provide effective soil stabilization, and are of good value to wildlife. The design also called for planting more widely spaced accents of other herbaceous species that typically occur in similar landscape settings and are of good value to wildlife but which could not be counted on to establish and spread rapidly. Accent species used in the design include deep-water duck potato (*Sagittaria rigida*, for elevations below 1 foot), pickerelweed (*Pontederia cordata*, for elevations between 1 and 2 feet), and marsh hibiscus (*Hibiscus moscheutos*, for elevations between 2 and 3 feet). The design also called for planting a fringe of woody vegetation around the edges of the wetland, including black willow (*Salix nigra*) and red maple (*Acer rubrum*) (both trees) and elderberry (*Sambucus canadensis*) and groundsel tree (*Baccharis halimifolia*) (both shrubs) (Halliburton NUS, 1995c).

The expectation was that water in the wetland would be fresh or nearly fresh (normally with a salinity of less than 5 parts per thousand) but that at least some of the vegetation would have to be able to withstand brief, episodic incursions of weakly brackish water (with salinities as high as 7 or 8 parts per thousand).

Installation of Wetland Mitigation Plan: OHM Remediation Services Corporation (OHM) and their subcontractor, Coastal Environmental Services (Coastal), constructed the wetlands and installed the plant material called for in the wetland mitigation plan in 1997. Coastal substituted arrow arum (*Peltandra virginica*) for the deep-water duck potato. Coastal also shifted the planting of the pickerelweed 25 feet downgradient (i.e. toward the lower elevations in the center of the wetland) to provide that species with a deeper hydrological regime. Planting took place between

April and June 1997. Planting was periodically delayed during this period by incidents of high tidal flooding of the wetland (Coastal, 1997).

OHM and Coastal inspected the wetland mitigation area in November 1997 and presented their observations in a written report. The report stated that a vigorous herbaceous stand comprised predominantly of the planted soft-stem bulrush, common three-square, and saltmeadow cordgrass had become established over much of the wetland. Several volunteer herbaceous species had also reportedly begun to colonize the wetland. The volunteer species reportedly included flat sedge (*Cyperus* sp.), soft rush (*Juncus effusus*), common cattail (*Typha latifolia*), and smartweed (*Polygonum persicaria*) (Coastal, 1997).

Vegetative coverage was described as sparser in the upper (drier) fringe of the wetland. Possible explanations provided in the report included flooding, herbivory, and low rainfall during the summer of 1997. The report did not, however, recommend additional planting. It stated that tidal wetland hydrology had been successfully established throughout the wetland and areas of sparse vegetation in November 1997 would likely become colonized naturally by desirable wetland plant species (Coastal, 1997).

A Site Inspection Checklist and Repair Report prepared by OHM in July 1998 stated that OHM replanted vegetation in the wetland area (OHM, 1998). The reports did not provide information on how much of the vegetation required replanting or what vegetation was used in the replanting. It is assumed that OHM adhered to the original planting scheme when replacing vegetation.

Five-Year Inspection: September 12, 2002: Peyton Doub, PWS, CEP of Tetra Tech NUS, who prepared the wetland mitigation plan design, visited the site on Thursday, September 12, 2002 to evaluate the wetland five years following its installation. Also present were Andrew Gutberlet of Engineering Field Activity Chesapeake, Lisa Bradford of the U.S. Environmental Protection Agency, and Matias Santiago of the Natural Resources and Environmental Affairs (NREA) office of MCB Quantico.

The entire wetland mitigation area, extending to the toe of the surrounding slope, consisted of dense vegetated wetlands (Photo 1). A shallow stream of running water, fed by the storm outlet at the northern head of the wetland (Photo 2), flowed down the center of the wetland to the Potomac River. The stream was less than 10 feet wide, roughly 6-12 inches deep, and lacked emergent vegetation (Photo 3). Lower-elevation lands adjoining the stream supported dense

emergent vegetation and were saturated at the surface. Higher-elevation lands around the upper edge of the wetland were not saturated on the surface, but the vegetation displayed watermarks suggesting that this drier portion of the wetland had recently experienced as much as an inch of inundation.

Vegetation within all parts of the wetland was dense and dominated throughout by herbaceous plant species that typically grow in wetlands (i.e. hydrophytes). Most of the wetland supported dense patches of the following species: jewelweed (*Impatiens capensis*), soft rush, soft-stem bulrush, common three-square, common cattail, woolgrass (*Scirpus cyperinus*), and rice cutgrass (*Leersia oryzoides*). All of these dominant species are regionally indigenous hydrophytes (i.e., wetland-dwelling plants) with wetland indicator statuses of Facultative Wetland (FACW) or Obligate Wetland (OBL) (Reed, 1988). The soft-stem bulrush and common three-square were components of the original design; the remainder of the dominant species were not planted and therefore could have only become established as natural volunteers.

Other plant species frequently observed in the wetland include marsh hibiscus, pickerelweed, smartweed, coreopsis (*Coreopsis* sp.), and tall ironweed (*Vernonia altissima*). With the exception of the coreopsis (which could not be identified to species), all of these scattered accent plants are regionally indigenous hydrophytes with wetland indicator statuses of Facultative Wetland (FACW) or Obligate Wetland (OBL) (Reed, 1988). The marsh hibiscus and pickerelweed were components of the original design; the other species were not planted and therefore could have only become established as natural volunteers.

A dense fringe of black willow saplings was observed at the outer edge of the wetlands, at the toe of the surrounding slope (Photo 4). The original design called for planting a mixture of black willow and red maple at the fringe of the wetland. At least some of the black willows appear to be the planted specimens, while others are likely volunteers. No red maple was observed. Coastal had reported that the planted red maple had not been growing well during the November 1997 inspection (Coastal, 1997). Considering that red maple has a broad tolerance of hydrological settings, the most likely explanation for its failure at this site would be the Summer 1997 drought at the time of planting. Several volunteer tree saplings of other species were observed at widely scattered locations within the wetland, including sycamore (*Platanus occidentalis*), elm (*Ulmus americana*), and eastern cottonwood (*Populus deltoides*). All are regionally indigenous species that are ecologically desirable for wildlife.

Among the shrubs, dense patches of groundsel tree were observed, especially near the fringe of the wetland where this species was planted (Photo 5). No elderberry (the other planted shrub species) was observed. Reasons for the non-survival of elderberry in the wetland are not apparent. However, silky dogwood (*Cornus amomum*), another regionally indigenous shrub typical of wetlands with fresh or nearly fresh water, was observed to have volunteered at several locations in the wetland.

The only invasive or exotic vegetation observed in the wetland were a few small clumps of phragmites (*Phragmites australis*) (Photo 6). Phragmites does not appear to established dominance over the wetland. However, the clumps could eventually spread, especially if the other vegetation experiences new stresses in the future.

Conclusions: The following conclusions are drawn from observations made during the five-year inspection of the wetlands on September 12, 2002:

1. The entire 2.1-acre constructed wetland (wetland mitigation area) called for in the wetland mitigation plan for the Site 4 Interim Remedial Action has been successfully established as a wetland.

2. The Site 4 Interim Remedial Action resulted in the loss of approximately 1.8 acres of wetlands adjacent to the Potomac River but also resulted in the successful establishment of 2.1 acres of wetlands adjacent to the Potomac River, a net onsite wetland gain of approximately 0.3 acres.

3. The planted vegetation appears to have successfully stabilized surface soils throughout the constructed wetland in the early years, allowing a mixed community of regionally indigenous wetland plants (hydrophytes) to become established throughout most of the wetland through natural successional processes.

4. The mixture of regionally indigenous wetland herbs, shrubs, and tree saplings that have become established in the constructed wetland appears to provide high-quality wildlife habitat similar to that previously provided by the wetlands lost as a result of the Interim Remedial Action.

5. The fact that certain of the plant species planted in the constructed wetland at the time of its initial establishment are no longer is not a matter of concern. Their absence is offset by the presence of many other ecologically desirable volunteer species capable of occupying similar ecological niches.

6. A few small clumps of an invasive plant species, Phragmites, have become established at multiple widely scattered locations within the wetland. These clumps represent the only exotic and/or invasive vegetation that has established in the wetland.

Recommendations: The following recommendations are offered for future management of the wetland mitigation project:

1. Because ecologically desirable, regionally indigenous wetland vegetation has become successfully established throughout nearly the entire wetland, no supplemental planting of additional vegetation is recommended.

2. It is recommended that the Phragmites clumps be sprayed with a systemic herbicide, appropriately labeled for use in aquatic habitats, to prevent their spread. Because of the small size of the clumps and the vigor of surrounding vegetation, desirable herbaceous vegetation is expected to rapidly fill in areas of sprayed Phragmites. Planting replacement vegetation in the gaps is not recommended.

3. Other than the spot treatment of the Phragmites clumps with herbicide, no application of pesticides or fertilizers appears to be necessary at this time.

4. Because physical stresses such as herbivory and drought do not appear to be adversely affecting the vegetation in the wetland, no watering or other actions to counteract such stresses are recommended at this time.

5. Because the wetland and its vegetation appear to be well established at this time, continued monitoring of the wetland does not appear to be necessary. However, the wetland should be managed in a manner commensurate with other naturally vegetated areas on MCB Quantico.

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White, C. P. 1989. *Chesapeake Bay – A Field Guide*. Tidewater Publishers, Centreville, Maryland.

Photo 1: Overview of the constructed wetland at Site 4 Old Landfill.

Photo 2: Storm drain outfall at upgradient point in the constructed Site 4 wetland.

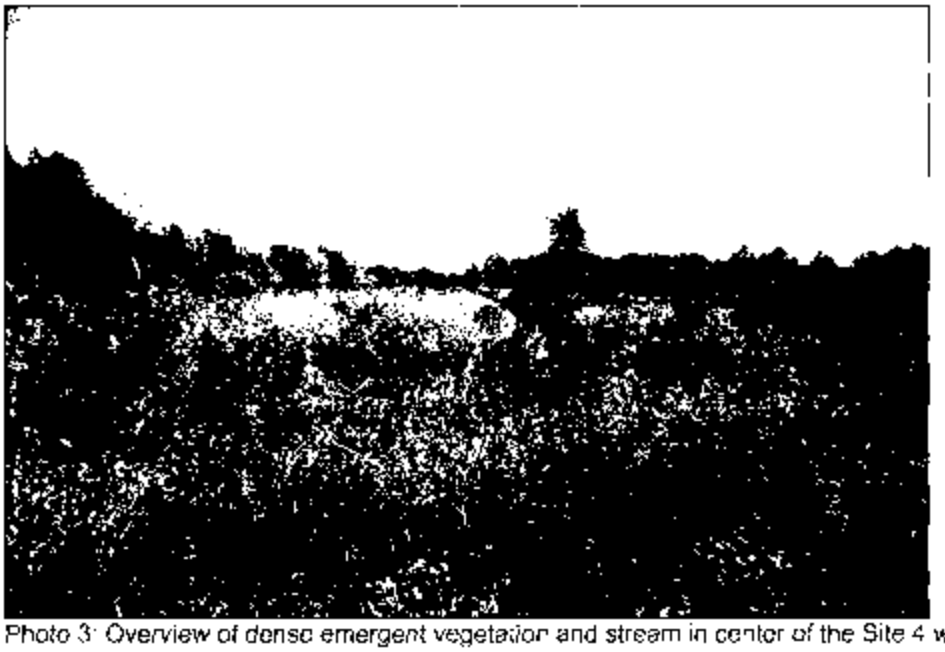

Photo 3: Overview of dense emergent vegetation and stream in center of the Site 4 wetland

Photo 4: Black Willow saplings along upper fringe to the wetland.

Photo 5: Clump of Groundsel Tree along upper fringe of the Site 4 wetland.

Photo 6: Foreground shows one of several small, widely scattered clumps of Phragmites in the Site 4 wetland.