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Corrective Measures Proposal Report for SWMU 5 - Old Burn Pit

Naval Surface Warfare Center Crane, Indiana

Contract Task Order 0256

September 2006

NAVFAC
Naval Facilities Engineering Command
Southeast
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North Charleston, South Carolina 29406

TETRA TECH NUS, Inc.

090607/P

CORRECTIVE MEASURES PROPOSAL REPORT
FOR
SWMU 5 - OLD BURN PIT

NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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ACRONYMS

°F	Degrees Fahrenheit
µg/dL	Micrograms per deciliter
µg/L	Micrograms per liter
2,4,5-T	2,4,5-Trichlorophenoxyacetic
ALPEC	Ammunition Loading and Production Engineering Center
B&RE	Brown and Root Environmental
BEHP	bis(2-Ethylhexyl) phthalate
bgs	Below ground surface
BRAC	Base Realignment and Closure
CAAA	Crane Army Ammunition Activity
CASCO	Central Ammunition Supply Control Office
CDI	Chronic Daily Intake
CEC	Cation exchange capacity
CFR	Code of Federal Regulations
Cgw	Groundwater exposure point concentration
CLEAN	Comprehensive Long-Term Environmental Action Navy
CM	Corrective measure
CMP	Corrective Measures Proposal
COC	Chemical of Concern
COPC	Chemical of Potential Concern
Cs	Soil concentration
CTE	Central Tendency Exposure
CTO	Contract Task Order
DCE	Dichloroethene
EMR	Environmental Monitoring Report
EPC	Exposure point concentration
ERA	Ecological Risk Assessment
ESI	Engineering-Science, Inc.
ft/day	feet per day
HHRA	Human Health Risk Assessment
HpCDD	Heptachlorodibenzo-p-dioxin
HpCDF	Heptachlorodibenzofuran
HQ	Hazard quotient

HSWA	Hazardous and Solid Waste Amendments
HxCDD	Hexachlorodibenzo-p-dioxin
HxCDF	Hexachlorodibenzofuran
IA	Installation Assessment
IAS	Initial Assessment Study
IDEM	Indiana Department of Environmental Management
IEUBK	Integrated Exposure Uptake Biokinetic
ILCR	Incremental Lifetime Cancer Risk
in/yr	Inches per year
IR	Installation Restoration
K_h	Hydraulic conductivity
LTM	Long-term monitoring
LUC	Land use control
MCL	Maximum Contaminant Level
MCS	Media cleanup standard
mg/kg	Milligrams per kilogram
mph	Miles per hour
msl	Mean sea level
NAD	Naval Ammunition Depot
NAVFAC SE	Naval Facilities Engineering Command Southeast
NEESA	Naval Energy and Environmental Support Activity
NFA	No further action
NOAA	National Oceanic and Atmospheric Administration
NPW	Net Present Worth
NSWC	Naval Surface Warfare Center
NWSCC	Naval Weapons Support Center Crane
O&M	Operation and Maintenance
OBP	Old Burn Pit
OCDD	Octachlorodibenzo-p-dioxin
OCDF	Octachlorodibenzofuran
OSWER	Office of Solid Waste and Emergency Response
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PeCDD	Pentachlorodibenzo-p-dioxin
PeCDF	Pentachlorodibenzofuran

PRG	Preliminary Remediation Goal
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RfD	Reference dose
RFI	RCRA Facility Investigation
RME	Reasonable Maximum Exposure
SSL	Soil Screening Level
SVOC	Semivolatile organic compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCDD	Tetrachlorodibenzo-p-dioxin
TCDF	Tetrachlorodibenzofuran
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TCR	Target cancer risk
TEQ	Toxicity Equivalent
THI	Target hazard index
TOC	Total organic carbon
TRW	Technical Review Workgroup
TSD	Treatment, storage, or disposal
TSS	Total suspended solids
TtNUS	Tetra Tech NUS, Inc.
UCL	Upper confidence limit
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compound
WES	Waterways Experiment Station

1.0 INTRODUCTION

1.1 SCOPE AND OBJECTIVES

This Corrective Measures Proposal (CMP) Report was prepared for Solid Waste Management Unit (SWMU) 5 [Old Burn Pit (OBP)] at the Naval Surface Warfare Center (NSWC) facility located in Crane, Indiana for the United States Navy, Naval Facilities Engineering Command Southeast (NAVFAC SE) under Contract Task Order (CTO) 0256 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) III Contract Number N62467-94-D-0888.

This work is part of the Navy's Installation Restoration (IR) Program, which is designed to identify contamination of Navy and Marine Corps lands/facilities resulting from past operations and to institute corrective measures (CMs) as needed. There are typically four distinct phases of work conducted for IR sites. Phase 1 is the Preliminary Assessment [formerly known as the Initial Assessment Study (IAS)]. Phase 2 is a Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA), which augments the information collected in the Preliminary Assessment. Phase 3 is the RCRA Facility Investigation (RFI)/CMP, which characterizes the contamination at a facility and develops options for remediation of the site. Phase 4 is the Corrective Measures Implementation, which results in the control or cleanup of contamination at the site. This report has been prepared under Phase 3 of the IR Program. The Indiana Department of Environmental Management (IDEM) is the lead oversight agency. However, under a work-sharing agreement, United States Environmental Protection Agency (USEPA) Region 5 is responsible for all phases of the RFI/CMP at SWMU 5.

This work was conducted in accordance with the requirements of the Indiana State RCRA Hazardous Waste Permit for the facility (IN5170023498), which went into effect on October 18, 2001.

The submittal of a CMP is appropriate for SWMU 5 based upon the following:

- NSWC Crane is a fenced military installation controlled by the Navy.
- NSWC Crane was not included in the 2005 Base Realignment and Closure (BRAC) process and will remain a military installation for the indefinite future.
- Foreseeable land uses are military (i.e., industrial).

- Residential land uses occur only in very limited areas, none of which are located within or adjacent to SWMU 5.

- Unique topography at SWMU 5 generally prevents future groundwater contaminant plume migration.

The objectives of the CMP for SWMU 5 are as follows:

- Identify risk-based action levels that are protective of current human health receptors and the environment.
- Identify and screen CMs technologies.
- Develop CMs.

1.2 ORGANIZATION OF THE CORRECTIVE MEASURES PROPOSAL

The CMP consists of four sections. Section 1.0 is this introduction. Section 2.0 provides a description of the current situation and presents the media cleanup standards (MCSs) for SWMU 5. Section 3.0 describes the CMs recommendations. Section 4.0 provides the details of the CMs evaluations for the CMs that were considered and the conclusions of the evaluations.

1.3 BACKGROUND INFORMATION

1.3.1 Facility Location

NSWC Crane is located in a rural, sparsely populated area of south-central Indiana, approximately 75 miles southwest of Indianapolis and 71 miles northwest of Louisville, Kentucky, immediately east of Crane Village and Burns City (Figure 1-1).

NSWC Crane encompasses 62,463 acres (approximately 98 square miles), most of which are located in the northern portion of Martin County. Smaller portions are located in Greene, Daviess, and Lawrence Counties.

NSWC Crane provides naval support for equipment, shipboard weapons systems, and ordnance. In addition, NSWC Crane supports the Crane Army Ammunition Activity (CAAA) with production, renovation, storage, shipment, demilitarization, and disposal of conventional ammunition.

There is no State or local planning within the vicinity of NSWC Crane. The only zoning and land use regulations are found in the municipalities within the region. None of these municipalities are close enough to have an impact on NSWC Crane. None of the areas adjacent to NSWC Crane are zoned, and zoning is not anticipated in the near future. There are no known land use or community actions under consideration or proposed at this time.

1.3.2 SWMU 5 Location

SWMU 5 is located in the northwestern corner of NSWC Crane (Figure 1-1). The site occupies approximately 25 acres and is bounded on the west by Highway 331, on the south by a gravel lot south of the burn pit, and on the east by the power line running along a ridge north of Lake Oberline. Additional site information and the approximate boundaries of the site can be obtained from Figure 1-2.

1.3.2 Facility History

This section provides general information on the history of NSWC Crane and its activities.

1.3.2.1 History of Ownership and Operation

In 1940, Congress authorized construction of a Naval Ammunition Depot (NAD) in southern Indiana; NAD Burns City was commissioned in late 1941. In 1943, NAD Burns City was renamed NAD Crane, and the Town of Crane was built to house the rapidly growing number of civil service employees. NAD Crane's overall mission was to load, prepare, renovate, receive, store, and issue ammunition to the fleet.

During World War II, NAD Crane's mission expanded to include pyrotechnics production, mine filling, rocket assembly, field storage, torpedo storage, and ordnance spare parts and mobile equipment storage. During the 1950s, several new departments were created. The Ammunition Loading and Production Engineering Center (ALPEC) was transferred to NSWC Crane, and the Central Ammunition Supply Control Office (CASCO) was established. NAD Crane supplied ammunition to the fleet during the Korean and Vietnam Conflicts. During the Vietnam Conflict, the number of full-time employees at NAD Crane increased to 6,800.

In 1975, NAD Crane was redesignated Naval Weapons Support Center Crane (NWSCC). Its new mission was to provide support for ships, aircraft, equipment, shipboard weapons systems, and assigned ordnance items and to perform additional functions as directed.

In 1977, the Single Manager Concept was implemented, the CAAA was created, and the Army assumed ordnance production, storage, and related responsibilities as a tenant organization. Other functions remained under Navy control, and currently the Navy retains ownership of all real estate and facilities at NSWC Crane. Responsibility for overall station safety, security, and environmental protection remains with the Commanding Officer, NSWC Crane. In 1992, the facility was designated as NSWC Crane. Currently, approximately 4,000 people are employed at NSWC Crane.

1.3.2.2 History of Regulatory Actions

Following promulgation of the USEPA RCRA hazardous waste regulatory program, NSWC Crane filed notification and application to operate as a RCRA hazardous waste treatment, storage, or disposal (TSD) facility in October 1980. Interim status was granted subject to operating requirements and applicable technical standards found in Title 40 of the Code of Federal Regulations (CFR), Part 265.

Corrective action programs established as part of the 1984 RCRA Hazardous and Solid Waste Amendments (HSWA) required NSWC Crane to address past releases of hazardous waste or hazardous constituents at SWMUs. Accordingly, NSWC Crane submitted a Hazardous Waste Management Report and an RFA was conducted to characterize the potential for releases of hazardous waste or constituents from 100 SWMUs identified during the RFA.

On December 23, 1989, USEPA issued the federal portion of the Final RCRA Part B permit for NSWC Crane to the Navy. USEPA renewed the permit in 1995. IDEM now has responsibility for the federal Corrective Action Program. IDEM renewed the Corrective Action Permit in October 18, 2001. However, certain ongoing corrective actions, including corrective actions at SWMU 5, will continue under the USEPA/IDEM Work Sharing Agreement for Corrective Action Activities at the Naval Surface Warfare Center - Crane Division.

1.3.3 Project Site

1.3.3.1 Site Description

SWMU 5 is an inactive site that was used from 1942 to 1972. Undefined amounts of rubbish including wood, paper, construction material, and industrial wastes were burned at the site in the burn pit area. Reportedly, no explosive materials or wastes were burned at the OBP. Residual ash and metal debris from the burning activities were buried in the gully north of the burn pit area. This area contains miscellaneous metal debris including decomposed drums and other metal objects that are partially buried or exposed. The burn pit area of the site has been covered with gravel and is used as a parking area for

delivery trailers. The gully north of the former burn pit area has been revegetated. SWMU 5 is located in the northwestern corner of NSWC Crane, approximately 2,000 feet east of Crane Gate No. 4. The site is bounded on the west by Highway 331, on the south by a gravel lot south of the burn pit, and on the east by a power line running along a ridge north of Lake Oberlin.

1.3.3.2 Land Usage

The current land use at SWMU 5 is truck parking in one area. Otherwise, SWMU 5 is inactive. No waste disposal activities occur at this site. Any future land uses at SWMU 5 are expected to be limited to industrial uses.

1.3.3.3 Corrective Action Stages

The RFI Report (TtNUS, 2005) has been completed, and unacceptable risk has been determined as follows:

- For the future construction worker, there is excess risk from ingestion of antimony in soils.
- For terrestrial plants and invertebrates, there is unacceptable risk from soils containing antimony, barium, cadmium, chromium, copper, iron, lead, silver, tin, and zinc.
- For mammals and birds, there is unacceptable risk to insectivorous/herbivorous mammals and birds for dioxins, cadmium, chromium, copper, lead, mercury, silver, and zinc through the food chain.

1.3.3.4 Preliminary Remedial Actions

No preliminary remedial action has occurred at SWMU 5 because 1991 Toxicity Characteristic Leaching Procedure (TCLP) test results (ESI, 1991) for surficial soil surrounding drums and for the materials within the drums located in the gully north of the burn pit were less than regulatory limits. Therefore, the soils and the material in the drums were not classified as a RCRA hazardous waste.

1.3.3.5 Site Investigations

The following is a brief description of the historical data collection activities conducted at SWMU 5.

Various investigations were completed from 1981 to 2003 at SWMU 5 as part of several multi-site investigations. The first was the IAS (NEESA, 1983a). The IAS at SWMU 5 consisted of the installation

of a total of 19 monitoring wells throughout the site. The first round of wells that were installed included one upgradient and two downgradient of the site. Upon identification of constituents in the groundwater, additional wells were installed along the anticipated perimeter of the site. During the installation of these wells, soil samples were collected and tested for various soil characteristics. After installation of the wells, groundwater samples were collected and analyzed for a comprehensive list of constituents and RCRA water-quality parameters. As part of the IAS, quarterly and semi-annual sampling of the monitoring wells was conducted at SWMU 5. Based on the initial conclusions of this groundwater study, SWMU 5 was not determined to represent an immediate human health and environmental threat. However, the site was recommended for further study to evaluate potential long-term impacts.

In response to the recommendation from the IAS, an RFI Phase II Soils Release Characterization was performed at SWMU 5 in 1990 (USACE WES, 1998). The objective of this study was to determine soil conditions around the site, to identify and characterize the material burned in the pit and the residual material buried in the gully north of the burn pit, and to characterize the potential for release of hazardous constituents into the surrounding environment. Nine soil borings were installed. Both surface and subsurface samples were collected from these borings and analyzed for a comprehensive list of constituents.

In 1991, a draft work plan for an RFI Phase III Ground Water Release Characterization was prepared by the United States Army Corps of Engineers (USACE) Waterways Experiment Station (WES) (USACE WES, 1991). The objective of this sampling effort was to determine the rate and extent of constituent migration in the groundwater. This study included the collection of samples from the existing 19 monitoring wells and the installation of additional wells. Because of funding constraints, only a portion of the work proposed in the work plan was conducted in 1992. Only one of the proposed monitoring wells (05C01) was installed, and not all groundwater samples collected were analyzed for all proposed chemical constituents or for the same list of constituents per sample. A Release Characterization Report was not generated for the sampling effort because of funding issues.

The most recent investigation was the Phase III RFI (TtNUS, 2005). The objectives of this investigation were as follows:

- To estimate the nature and extent of contamination.
- To develop information necessary to conduct a baseline Human Health Risk Assessment (HHRA) and a screening level ecological risk assessment.

The analytical program for SWMU 5 was developed on the basis of chemical categories represented by the list of detected chemicals of interest identified during various historical site investigations. Soil, sediment, surface water, and groundwater samples were collected and analyzed for the full list of Appendix IX constituents [volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and metals], and miscellaneous inorganics. Surface water samples also were analyzed for total and dissolved metals, hardness, and total suspended solids (TSS), and sediment samples were analyzed for total organic carbon (TOC) to assist in assessing the potential risks for ecological receptors. Additionally, soil characteristic parameters [cation exchange capacity (CEC), pH, and TOC] were analyzed to determine the likelihood of the potential fate and transport of contaminants at the site and the potential for risks outside the site boundaries.

1.4 PHYSICAL CHARACTERISTICS OF STUDY AREA

SWMU 5 is located in the northwestern corner of NSWC Crane, approximately 2,000 feet east of Crane Gate No. 4. SWMU 5 occupies approximately 25 acres and is bounded on the west by Highway H-331, on the south by a gravel lot, and on the east by the power line running along a ridge north of Lake Oberlin. The northern boundary (at the gully) is undetermined.

1.4.1 Climate and Meteorology

The climate in the region of NSWC Crane can be described as temperate (NOAA, 1988). Precipitation is distributed evenly throughout the year, and there is no pronounced wet or dry season for this region. Rainfall in the spring and summer is produced mostly from showers and thunderstorms. A peak rainfall of about 2½ inches in a 24-hour period can be expected about once a year. Snowfalls of 3 inches or more occur an average of two or three times per winter season.

Mean monthly temperatures for the region are shown in Table 1-1. Temperatures range from a minimum of 27.9 degrees Fahrenheit (°F) in January to a maximum of 75.7°F in July. Relative humidity for the local area is generally highest in the early morning hours of June through September and generally ranges between 80 to 88 percent on average. Historically, the lowest values of relative humidity have occurred during the period March through October, when values average between 54 and 58 percent. The mean annual temperature for the area is 52.6°F. The annual mean monthly distribution of rain and snow for the area is shown in Table 1-2. The annual rainfall total is about 40 inches per year (in/yr), with the highest mean monthly totals occurring in the late spring and early summer period of May through July. Snowfall averages about 23 in/yr, with most occurring in the winter months of December through February.

Long-term climatological records (NOAA, 1988) for the area indicate that the monthly prevailing wind direction is southwest during the month of April through December, then shifts to the northwest during the months of January through March. The annual prevailing wind direction for the region is from the southwest. The annual average wind speed for the area is about 9.6 miles per hour (mph).

1.4.2 Topography

NSWC Crane is in the unglaciated area of the Crawford Uplands Physiographic Province. This province is a rugged, highly vegetated, dissected plateau bounded by the Mitchell Plain Physiographic Province to the east and the Wabash Lowland Physiographic Province to the west (Murphy and Wade, 1988). The Mitchell Plain is a low, dissected, limestone plateau characterized by sinkholes and karst topographic features. The boundary between the Crawford Upland and the Mitchell Plain is marked by the highly irregular, eastern facing Chester Escarpment. Springs, caverns, caves, and other solution weathering features can be found along this escarpment and on the eastern edge of the NSWC Crane facility. The boundary between the Crawford Upland and the Mitchell Plain near the western boundary of NSWC Crane is gradual (Murphy and Wade, 1988).

The terrain is predominantly rolling with moderately incised stream valleys throughout and occasional flat areas in the central and northern portions of NSWC Crane. Most of the region is covered by deciduous trees and shrubs. The elevations across NSWC Crane range from about 500 feet above mean sea level (msl) at the southern drainageway to about 850 feet above msl on the ridge in the west-central portion of the facility. V-shaped drainageways in the north progress to 2,000-foot-wide floodplains in the south and rise to approximately 150 to 200 feet above msl at the ridgelines (NEESA, 1983a).

1.4.2.1 SWMU 5

The topography at SWMU 5 consists of undulating terrain dissected by many small drainageways. Several drainageways exist in the northern portion of SWMU 5 and convey surface water from the northeast to the west, toward an unnamed drainageway that flows through a culvert beneath Highway 331 and the railroad tracks that form the western border of SWMU 5. The unnamed drainageway then joins several other gullies to form a larger tributary stream that flows southward for about 700 feet and ultimately discharges into Culpepper Branch. Another drainageway is located in the southwestern corner of SWMU 5 that flows southwest toward Culpepper Branch.

Surface elevations range from slightly over 550 feet above msl along the unnamed creek to the west of SWMU 5 to 680 feet above msl on the northeastern side of SWMU 5. Thus, there is about 130 feet of relief at the SWMU.

1.4.3 Surface Water Hydrogeology

The surface drainage at NSWC Crane has formed a dense, dendritic pattern throughout the installation that flows generally to the south and southwest. Seven primary creeks in five drainage basins carry surface water off the installation, where it eventually drains into the East Fork of the White River and then to the Wabash River to the southwest. The seven creeks that drain NSWC Crane include Furst Creek, Sulphur Creek, Little Sulphur Creek, Boggs Creek, Turkey Creek, Indiana Creek, and Seed Tick Creek. Figure 1-1 shows the surface drainage features and the individual drainage basins at NSWC Crane.

Drainage Basin IV consists of Boggs and Turkey Creeks, which are the primary drainageways for the installation and drain the majority of the area. The northern and northwestern sections (Basin I) are drained by Furst Creek, the eastern portion (Basin III) is drained by the Sulphur Creek complex, the extreme eastern portion (Basin II) is drained by Indiana Creek, and the southwestern section (Basin V) is drained by Seed Tick Creek.

Also located within the installation are several small ponds and Lake Greenwood, an 800-acre man-made, spring-fed lake in the northwestern portion of the installation. Lake Greenwood is the main source of water at NSWC Crane and is also used for recreation (NEESA, 1983a). SWMU 5 drains into Culpepper Branch, which flows into Furst Creek. Furst Creek then flows westward off of NSWC Crane property.

1.4.3.1 SWMU 5

Surface water runoff from SWMU 5 drains into Culpepper Branch, a tributary of Furst Creek. Several dendritic drainageways exist in the northern portion of SWMU 5 that convey surface water from the northeast to the west, toward a stream that flows through a culvert beneath the road and railroad tracks that form the western border of SWMU 5. The stream joins with several other streams to form a larger tributary stream that flows south, ultimately discharging into Culpepper Branch. Another drainageway that flows southwestern toward Culpepper Branch is located in the southwestern corner of SWMU 5.

1.4.4 Geology and Soils

NSWC Crane is located on the eastern flank of the Illinois Basin. Beneath unconsolidated colluvial and alluvial deposits, Paleozoic-age sedimentary rocks underlying NSWC Crane have been deformed to yield a gentle dip of 50 feet per mile towards the west-southwest. The bedrock surface at NSWC Crane is made up of Lower Pennsylvanian- and Upper Mississippian-age sandstones, limestones, and shales.

In general, Mississippian-age Chester Series sandstones, shales, and limestones are exposed in the valley walls of eastern portions of NSWC Crane and in the lower elevations of deep valleys in the western portions. Pennsylvanian-age Mansfield Formation sandstone, siltstones, claystones, and shales are found at the crests of hills and ridges in eastern portions of NSWC Crane, and as the surficial bedrock unit further west (see Figure 1-3). The contact between the Mississippian units and overlying Pennsylvanian units is an unconformity formed by long-time erosion of the Mississippian surface (Murphy and Ciocco, 1990).

1.4.4.1 SWMU 5

Most of SWMU 5 is situated in the dissected alluvial valley of Culpepper Branch. Soils representing two depositional environments have been mapped at SWMU 5 (Kvale, 1992), including residual soil derived from Pennsylvanian bedrock in the SWMU 5 area and alluvium in the floodplain along the south-flowing tributary stream to Culpepper Branch located west of SWMU 5. Glacial outwash has also been mapped both southeast and further west of SWMU 5.

Two geologic cross sections (A-A' and B-B') have been developed for SWMU 5 at locations shown on Figure 1-4 and are included as Figures 1-5 (A-A') and 1-6 (B-B'). The materials include only the near-surface fill, natural unconsolidated materials, and Pennsylvanian bedrock. Fill was encountered in borings in the north-central portion of SWMU 5 and extended to a maximum depth of 10 feet below ground surface (bgs). The fill consisted of glass, metal, wood, and ash mixed with sand and silt. Natural unconsolidated materials underlie the fill and exist at the ground surface where the fill is not present. The natural unconsolidated materials consist predominantly of fine sediments including varying amounts of clay, silt, and sand derived from Pennsylvanian bedrock. The natural unconsolidated materials extend to approximately 45 feet bgs, where Pennsylvanian bedrock consisting of shale was encountered in borings advanced to this depth.

1.4.5 Hydrogeology

1.4.5.1 SWMU 5

Groundwater is present beneath SWMU 5 at depths less than 5 feet bgs in low areas near surface water bodies. Depth to groundwater increases to greater than 20 feet at the higher elevations on the eastern and northeastern sides of the SWMU. Groundwater exists in natural unconsolidated materials and was not found in the fill. Shallow groundwater flow direction in the natural unconsolidated materials is generally to the northwest toward a tributary of Culpepper Branch and to the southwest toward Culpepper Branch. The hydraulic gradient at the site is about 0.04 (ft/ft). Information on groundwater in the bedrock at this SWMU is unknown because no wells have been installed in the bedrock.

To characterize the hydraulic properties of the unconsolidated overburden materials, seven slug tests were performed. The horizontal hydraulic conductivity (K_h) values determined from these tests ranged from 0.04 to 30 feet per day (ft/day). In general, the higher K_h values (4.1 to 30 ft/day) were found in wells where the screens intersected saturated sands (e.g., 05-02, 05-04, and 05-09) on the southwestern side of SWMU 5. Low K_h values (0.04 to 0.44 ft/day) were determined in three wells (05-03, 05-07, and 05-13) on the northwestern side of SWMU 5 that are screened primarily in silt and clay. An anomalously high K_h value of 22 ft/day was determined for well 05-08 in the northwestern corner of SWMU 5.

1.4.6 Water Supply

Groundwater at SWMU 5 is not currently used and is not anticipated to be used in the future as a potable drinking water source. Lake Greenwood is the source of potable water for NSWC Crane.

1.4.7 Surrounding Land Use

NSWC Crane is located in south-central Indiana, immediately east of Crane Village and Burns City, in a rural, sparsely populated area. Most of NSWC Crane is forested, and the surrounding area is wooded or farmed land. The communities in the region are in a period of transition from an economic base of agriculture, mining, and quarrying to an economy built on manufacturing and service industries. The patterns of settlement, population statistics, and median income are similar throughout the region.

SWMU 5 is contained completely within NSWC Crane. The current and likely future land use at areas surrounding the SWMU is expected to be limited to industrial uses.

TABLE 1-1

CLIMATOLOGICAL MEAN MONTHLY TEMPERATURES[1]
CMP REPORT FOR SWMU 5 – OLD BURN PIT
NSWC CRANE,
CRANE, INDIANA

Month	Mean Monthly Temperature (°F)
January	27.9
February	30.6
March	40.3
April	52.0
May	62.5
June	71.7
July	75.7
August	73.6
September	66.8
October	55.3
November	42.0
December	31.8
Mean Annual	52.6

1 Reference: National Oceanic and Atmospheric Administration, 1988.

°F – Degrees Fahrenheit.

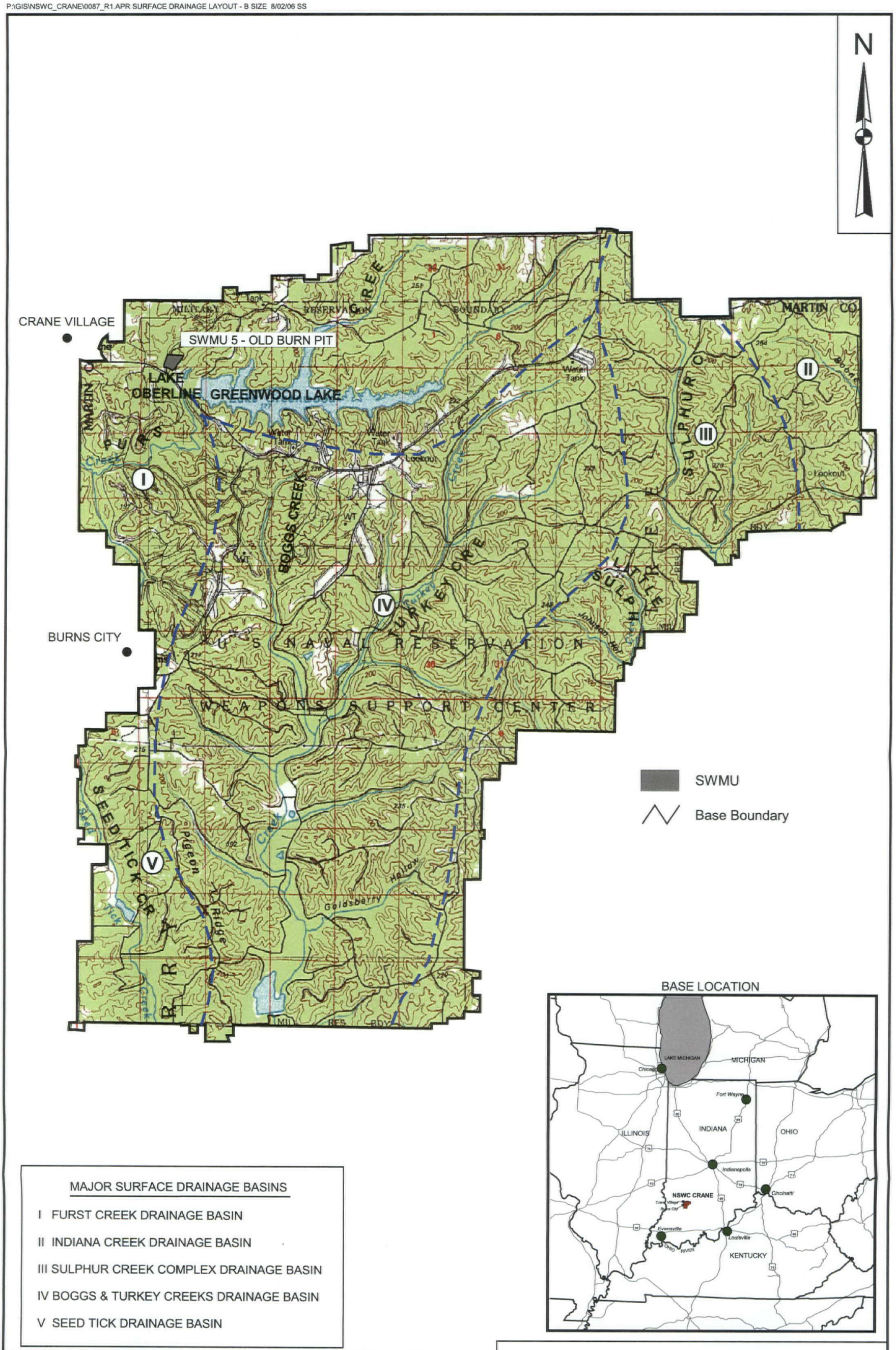
TABLE 1-2

CLIMATOLOGICAL MEAN MONTHLY RAINFALL
AND SNOWFALL AMOUNTS[1]
CMP REPORT FOR SWMU 5 – OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

Month	Mean Monthly Rainfall (inches)	Mean Monthly Snowfall (inches)
January	2.89	6.3
February	2.52	5.9
March	3.78	3.5
April	3.66	0.5
May	3.93	[2]
June	4.06	0
July	3.89	0
August	3.28	0
September	3.11	0
October	2.68	[2]
November	3.21	1.9
December	2.95	4.8
Annual	39.98	23.0

1 Reference: National Oceanic and Atmospheric Administration, 1988.
2 Indicates snowfall amounts less than 0.01 inch.

P:\GIS\NSWC_CRANE\0087_R1.APR SURFACE DRAINAGE LAYOUT - B SIZE 8/02/06 SS



BASE LOCATION

MAJOR SURFACE DRAINAGE BASINS

I FURST CREEK DRAINAGE BASIN

II INDIANA CREEK DRAINAGE BASIN

III SULPHUR CREEK COMPLEX DRAINAGE BASIN

IV BOGGS & TURKEY CREEKS DRAINAGE BASIN

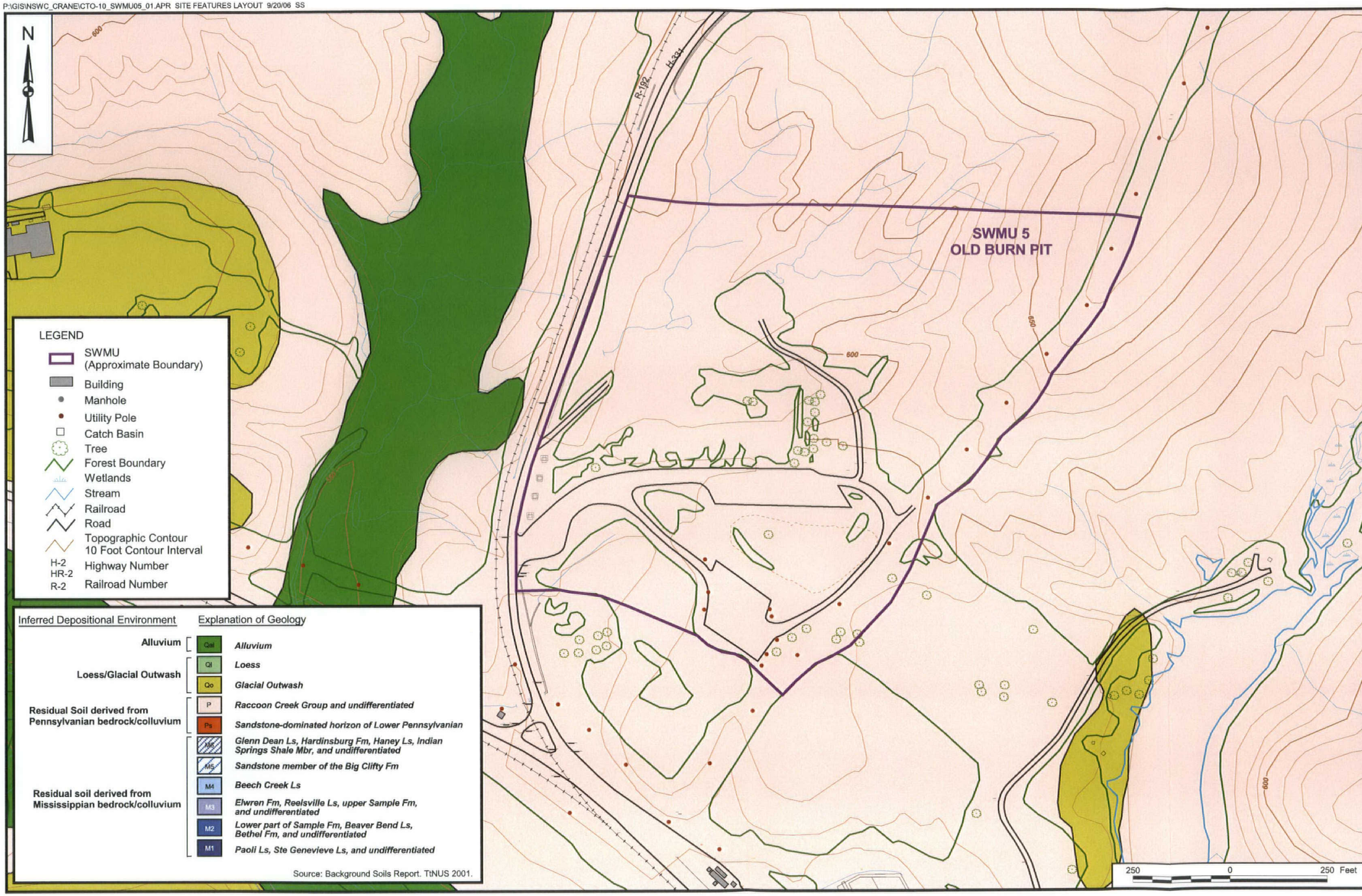
V SEED TICK DRAINAGE BASIN

SOURCE: "Initial Assessment Study of Naval Weapons Support Center Crane, Indiana." Naval Energy and Environment Support Activity, May 1983.

1.5 0 1.5 3 Miles

DRAWN BY J. LAMEY	DATE 4/19/99	SITE LOCATION AND SURFACE DRAINAGE AT THE NAVAL SURFACE WARFARE CENTER CMP REPORT FOR SWMU 5 - OLD BURN PIT NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 4267
CHECKED BY V. PLACHY	DATE 8/02/06		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED	NAVFAC		DRAWING NO. FIGURE 1 - 1 REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU05_01.APR SITE FEATURES LAYOUT 9/20/06 SS



CONTRACT NO. 4267

APPROVED BY DATE

APPROVED BY DATE

DRAWING NO. FIGURE 1 - 2

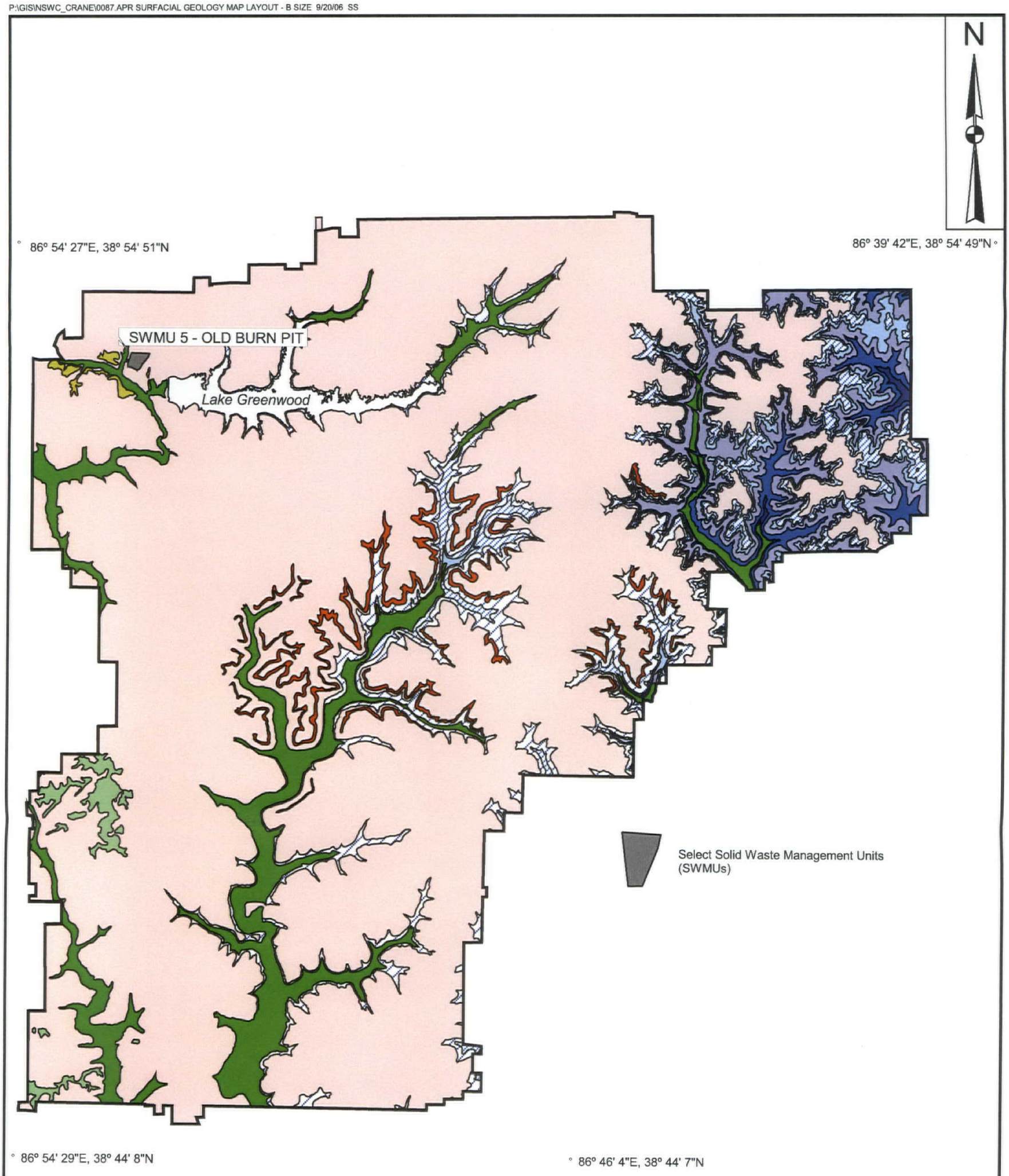
REV 0

SITE FEATURES MAP
CMP REPORT FOR SWMU 05 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

NAVFAC

DRAWN BY	DATE
A. JANOCHA	3/16/04
CHECKED BY	DATE
V. PLACHY	9/20/06
COST/SCHED-AREA	
SCALE	AS NOTED

P:\GIS\NSWC_CRANE\0087.APR SURFACIAL GEOLOGY MAP LAYOUT - B SIZE 9/20/06 SS



Inferred Depositional Environment		Explanation of Geology
Alluvium	Qal	*Alluvium*
Loess/Glacial Outwash	Ql	*Loess*
	Qo	*Glacial Outwash*
Residual Soil derived from Pennsylvanian bedrock/colluvium	P	*Raccoon Creek Group and undifferentiated*
	Ps	*Sandstone-dominated horizon of Lower Pennsylvanian*
Residual soil derived from Mississippian bedrock/colluvium	M6	*Glenn Dean Ls, Hardinsburg Fm, Haney Ls, Indian Springs Shale Mbr, and undifferentiated*
	M5	*Sandstone member of the Big Clifty Fm*
	M4	*Beech Creek Ls*
	M3	*Elwren Fm, Reelsville Ls, upper Sample Fm, and undifferentiated*
	M2	*Lower part of Sample Fm, Beaver Bend Ls, Bethel Fm, and undifferentiated*
	M1	*Paoli Ls, Ste Genevieve Ls, and undifferentiated*

Source: Background Soils Report. TtNUS 2001. (Modified from Blunck, 1995).

1.5 0 1.5 3 Miles

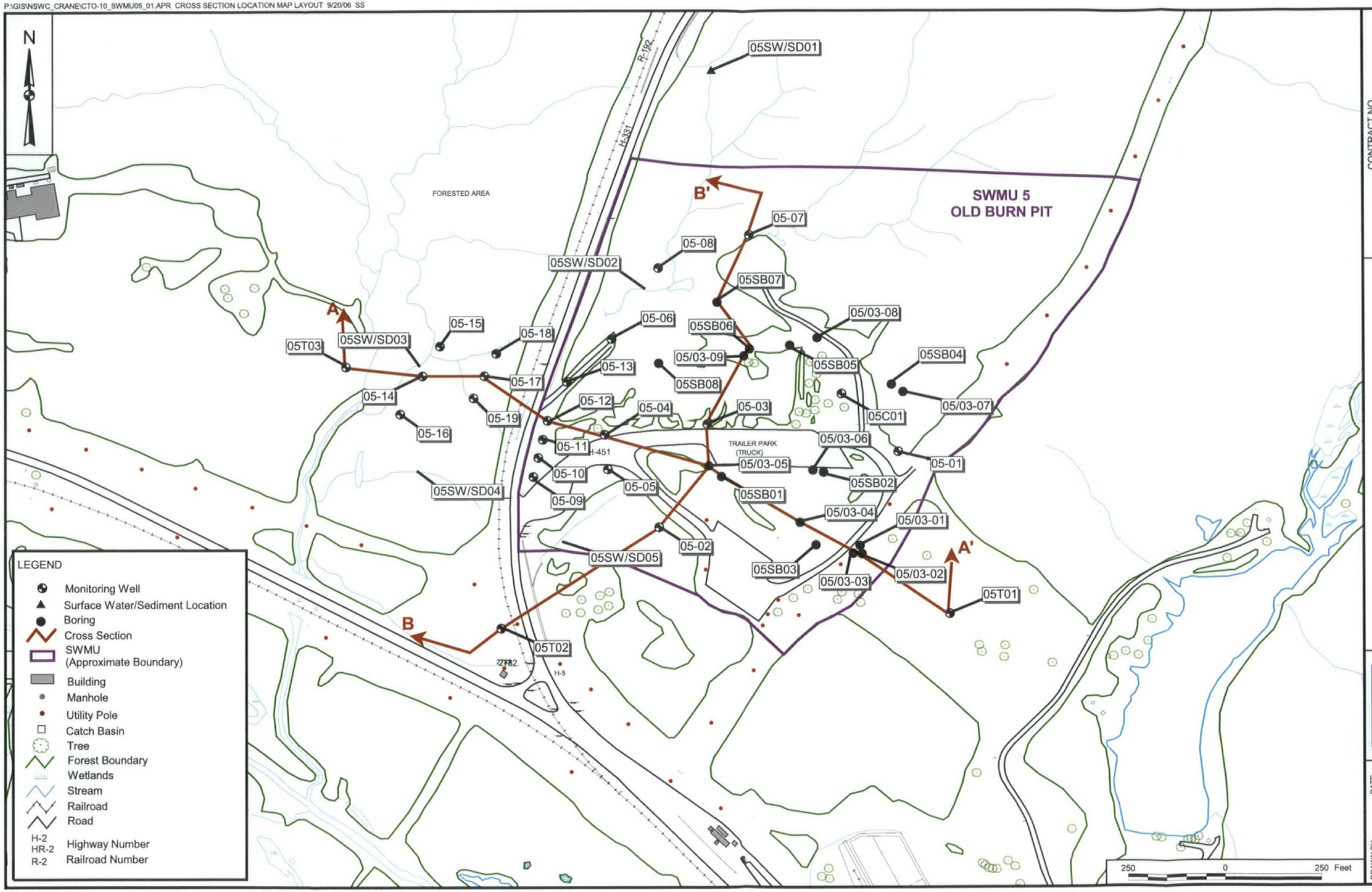
DRAWN BY	DATE
D. PERRY	3/15/99
CHECKED BY	DATE
V. PLACHY	9/20/06
COST/SCHEDULE-AREA	
SCALE	
AS NOTED	

NAVFAC

SURFICIAL GEOLOGY AND DEPOSITIONAL ENVIRONMENTS
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

CONTRACT NUMBER	
4267	
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
DRAWING NO.	REV
FIGURE 1 - 3	0

P:\GIS\NSWC_CRANE\CTO-10_SWMU05_01.APR CROSS SECTION LOCATION MAP LAYOUT 9/20/06 SS



CONTRACT NO. 4267

APPROVED BY ___ DATE ___

APPROVED BY ___ DATE ___

DRAWING NO. FIGURE 1 - 4

REV 0

CROSS SECTION LOCATION MAP
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

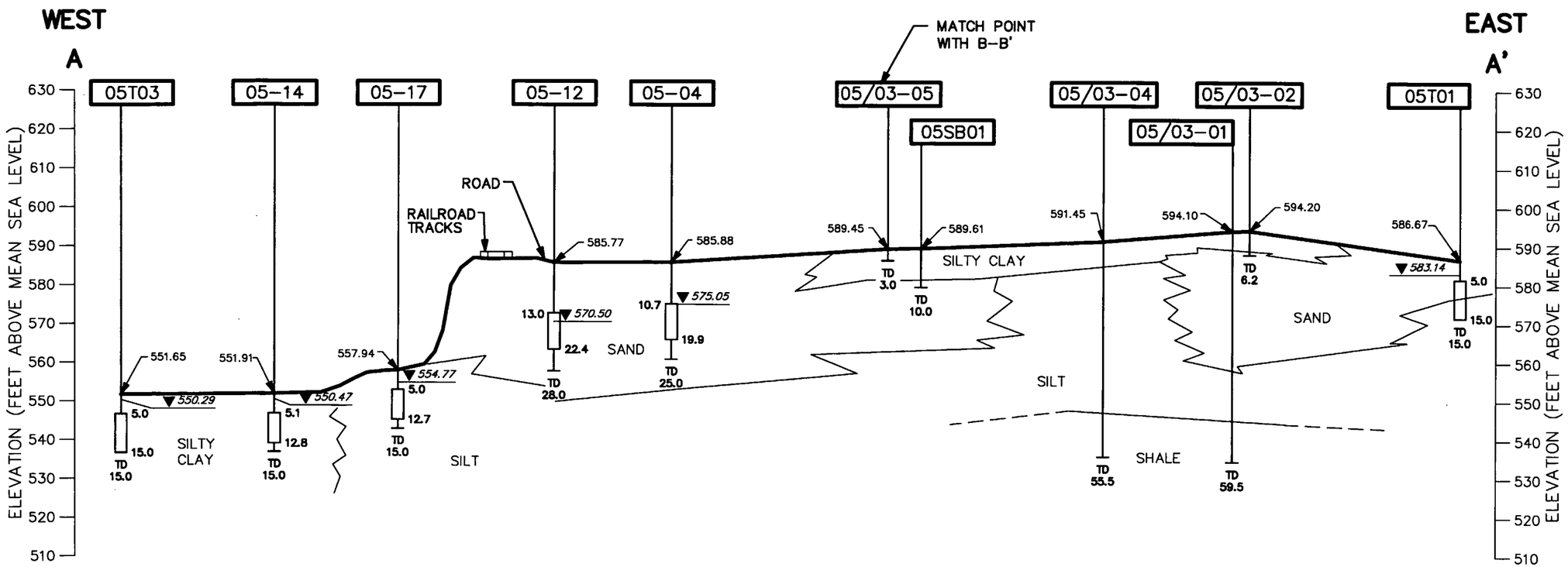
NAVFAC

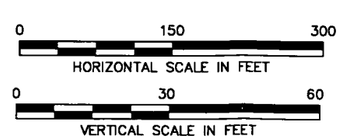
DRAWN BY K. PEILA DATE 5/21/02

CHECKED BY V. PLACHY DATE 9/20/06

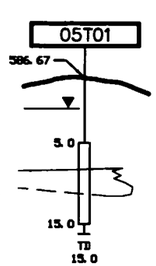
COST/SCHED-AREA

SCALE AS NOTED





LEGEND:



- MONITORING WELL OR BORING NUMBER
- GROUND SURFACE ELEVATION
- GROUND SURFACE
- POTENTIOMETRIC ELEVATION
- TOP OF MONITORED INTERVAL (FT BGS)
- LITHOLOGIC CONTACT (INFERRED BETWEEN BORINGS AND WHEN DASHED)
- BOTTOM OF MONITORED INTERVAL (FT BGS)
- TOTAL DEPTH OF WELL OR BORING (FT BGS)

CONTRACT NO. 4287
OWNER NO. 0000
APPROVED BY
DATE
REV. 0
DRAWING NO. FIGURE 1-5

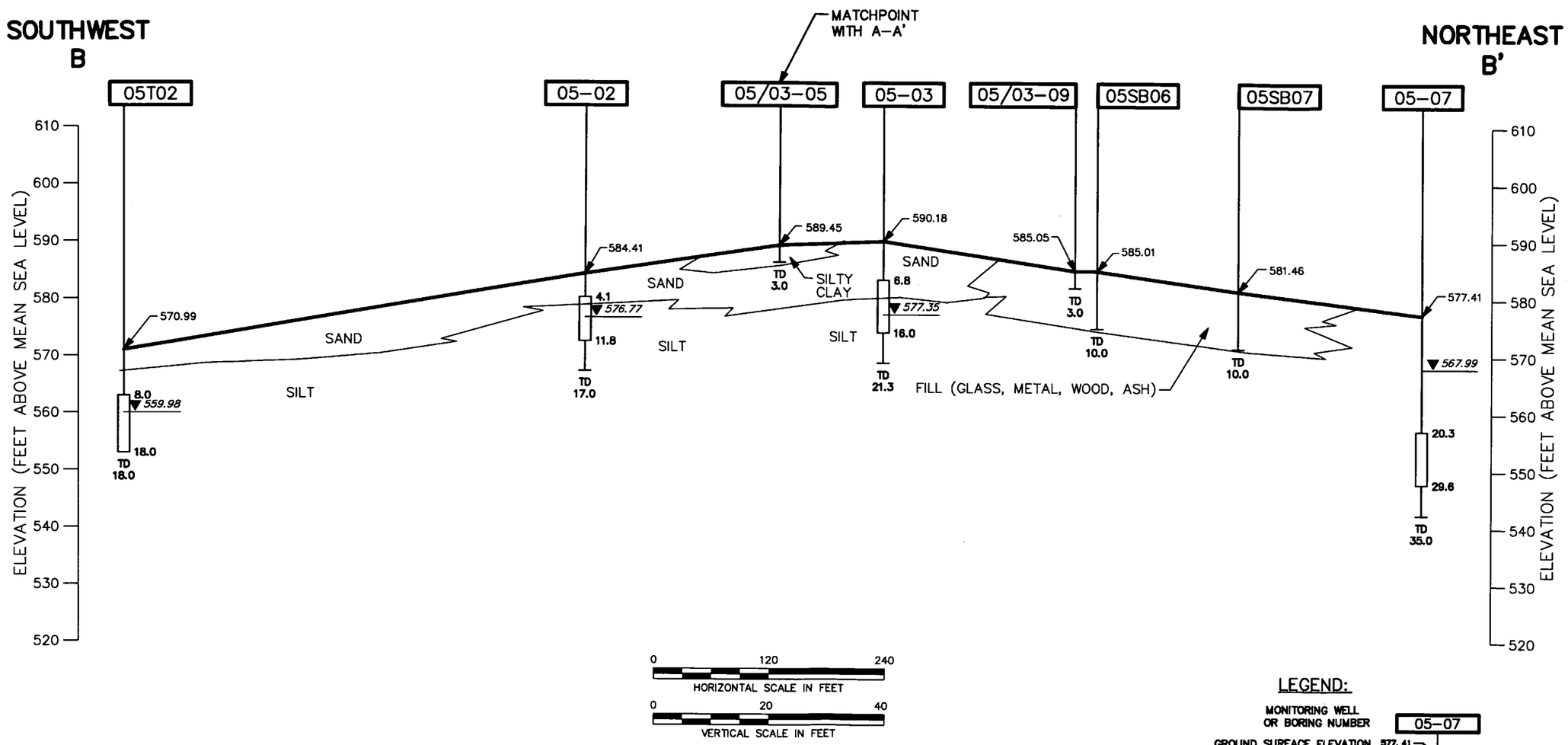
GEOLOGIC CROSS SECTION A-A'
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

NAVFAC

DRAWN BY MF DATE 8/3/06
CHECKED BY DATE
REVISED BY DATE
SCALE AS NOTED

ACAD: 4287gx01.dwg 08/03/06 MF PIT

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



CONTRACT NO. 4267
OWNER NO. 0000
APPROVED BY
DATE
REV. 0
DRAWING NO. FIGURE 1-6

GEOLOGIC CROSS SECTION B-B'
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

NAVFAC

DRAWN BY MF DATE 8/3/06
CHECKED BY DATE
REVISED BY DATE
SCALE AS NOTED

ACAD:4267GX02.dwg 09/20/06 MF PIT

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

2.0 DESCRIPTION OF CURRENT CONDITIONS AT SWMU 5 AND MEDIA CLEANUP STANDARDS

Various historical investigations and risk assessments have been conducted at SWMU 5. As a result of these studies, the following have been identified as Chemicals of Potential Concern (COPCs) for human health and ecological risk at the SWMU:

Soils (Human Health and Ecological):

- Metals
  - Antimony and iron (human health)
    Antimony, barium, cadmium, chromium, copper, iron, lead, silver, tin, and zinc (ecological – terrestrial plant and invertebrates)
  - Chromium, copper, dioxins, lead, mercury, silver, and zinc (ecological – food chain)

- Dioxins/Furans
  - Twenty-four dioxins/furans [1,2,3,4,6,7,8,9-octachlorodibenzo-p-dioxin (OCDD), 1,2,3,4,6,7,8,9-octachlorodibenzofuran (OCDF), 1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin (HpCDD), 1,2,3,4,6,7,8-heptachlorodibenzofuran (HpCDF), 1,2,3,4,7,8,9-HpCDF, 1,2,3,4,7,8-hexachlorodibenzo-p-dioxin (HxCDD), 1,2,3,4,7,8-hexachlorodibenzofuran (HxCDF), 1,2,3,6,7,8-HxCDD, 1,2,3,6,7,8-HxCDF, 1,2,3,7,8,9-HxCDD, 1,2,3,7,8-pentachlorodibenzo-p-dioxin (PeCDD), 1,2,3,7,8-pentachlorodibenzofuran (PeCDF), 2,3,4,6,7,8-HxCDF, 2,3,4,7,8-PeCDF, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), 2,3,7,8-tetrachlorodibenzofuran (TCDF), total HpCDD, total HpCDF, total HxCDD, total HxCDF, total TCDD, and total TCDF] (ecological – food chain)

Groundwater (Human Health):

- Metals
  - Manganese

- Dioxins/Furans
  - 2,3,7,8-TCDD

This section presents a summary of the current contamination conditions for SWMU 5 (TtNUS, 2005). The nature and extent of contamination and human health and ecological risk drivers are discussed, and a reassessment of the human health and ecological risks in particular areas of SWMU 5 based on sampling data for specific areas within the SWMU are also presented.

2.1 HISTORICAL INVESTIGATIONS

This section provides a general overview of the RFI and results that were used as the basis for determining which media required consideration in the CMP for one or more contaminants. Additional information can be found in the July 2005 RFI Report for SWMUs 4 (McComish Gorge), 5 (Old Burn Pit), 9 (Pesticide Control Area/R-150 Tank Area), and 10 (Rockeye) (TtNUS, 2005).

2.1.1 Surface/Subsurface Soil Contamination

Surface Soil

Eight surface soil samples were collected in support of the RFI Report (TtNUS, 2005). All eight surface soil samples were analyzed for Appendix IX VOCs, SVOCs, pesticides, PCBs, herbicides, and dioxins/furans, Target Analyte List (TAL) metals (plus tin), and cyanide. Additionally, one surface soil sample was analyzed for CEC, pH, and TOC.

Volatiles: Eight VOCs [1,1-dichloroethene (DCE), benzene, cis-1,2-DCE, methylene chloride, tetrachloroethene (PCE), trans-1,2-DCE, trichloroethene (TCE), and vinyl chloride] were detected in surface soil samples. 1,1-DCE, benzene, cis-1,2-DCE, PCE, TCE, methylene chloride, and vinyl chloride were retained as COPCs in the HHRA. No VOCs were found to present a significant risk in the HHRA. The concentration of cis-1,2-DCE exceeded the USEPA Region 5 ecological screening level and was retained as a COPC for plants, invertebrates, or terrestrial wildlife. However, cis-1,2-DCE was not found to present a significant risk in the ecological risk assessment. Ecological risk from cis-1,2-DCE was limited to one soil boring area (05SB06).

Semivolatile Organic Compounds: Seventeen polynuclear aromatic hydrocarbons (PAHs) and bis(2-ethylhexyl) phthalate (BEHP) were detected in surface soil samples. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene were retained as COPCs in the HHRA, but no SVOCs were found to present a significant risk. BEHP and naphthalene exceeded the USEPA Region 5 ecological screening levels and were retained as COPCs for the ecological risk assessment. No significant ecological risks from these compounds were found in the ecological risk assessment for plants, invertebrates, or terrestrial wildlife.

Pesticides/PCBs: 4,4'-DDE was the only pesticide detected in surface soil samples. The PCB Aroclor-1254 was retained as a COPC in the HHRA, however, Aroclor-1254 was not found to present a significant risk. Neither 4,4'-DDE nor Aroclor-1254 were retained as COPCs in the ecological risk assessment for plants, invertebrates, or terrestrial wildlife.

Herbicides: The herbicides 2,4,5-trichlorophenoxyacetic (2,4,5-T) and pentachlorophenol were detected in surface soil samples. Pentachlorophenol was retained as a COPC in the HHRA but was not found to present a significant risk. Neither 2,4,5-T nor pentachlorphenol were retained as COPCs in the ecological risk assessment for plants, invertebrates, and terrestrial wildlife.

Dioxins/Furans: Seventeen dioxin/furan congeners were detected in the eight surface soil samples analyzed; analytical results for seven dioxin/furan mixtures were also reported. Dioxins/furans were retained as COPCs in the HHRA and were found to present a significant risk. Although the maximum concentrations of dioxins/furans in soil in terms of 2,3,7,8-TCDD Toxicity Equivalents (TEQs) (0.226 µg/kg in surface soil and 0.464 µg/kg in surface/subsurface soil) exceeded risk-based screening levels, these TEQs are less than the Preliminary Remediation Goal (PRG) of 1 µg/kg established for 2,3,7,8-TCDD TEQs in USEPA Office of Solid Waste and Emergency Response (OSWER) Directive 9200.4-26, Use of Monitored Natural Attenuation at Superfund RCRA Corrective Action and Underground Storage Tank Sites (1997). Therefore, dioxins/furans are not present in soils at concentrations that would require remediation for the protection of human health (USEPA, 1998). All 24 dioxins except 1,2,3,7,8,9-HxCDF and total PeCDF exceeded Region 5 ecological screening levels and were retained as COPCs for the ecological risk assessment for plants, invertebrates, and terrestrial wildlife. None of the dioxins or total PeCDF were found to present significant ecological risk to plants, invertebrates, and terrestrial wildlife.

Use of Monitored Natural Attenuation at Superfund RCRA Corrective Action and Underground Storage Tank Sites

Metals: Twenty metals were detected in surface soil samples. Of the 20 detected metals, aluminum, arsenic, cobalt, magnesium, manganese, nickel, and vanadium were detected in all eight samples at concentrations statistically determined to be similar to background concentrations. Barium, chromium, copper, iron, lead, mercury, and zinc were detected in all eight samples at concentrations statistically determined to exceed background. Antimony, cadmium, silver, and tin were detected in at least one sample at concentrations statistically determined to exceed background. The metals antimony, barium, cadmium, chromium (total), copper, iron, lead, mercury, silver, and zinc were retained as COPCs in the HHRA. The results of the HHRA for future land use indicated that exposure to antimony, iron, and lead

presents significant risks to construction workers and future residents, and the HHRA recommended that these metals be carried forward to the CMP.

Antimony, barium, cadmium, chromium, copper, iron, lead, mercury, silver, tin, and zinc were retained as COPCs for the ecological risk assessment because maximum surface soil concentrations exceeded USEPA Region 5 screening levels (USEPA, 2003b) and because site concentrations were statistically greater than background concentrations. The ecological risk assessment found that the metals antimony, barium, cadmium, chromium, copper, iron, lead, silver, tin, and zinc could present potential risk to plants, invertebrates, and terrestrial wildlife.

Miscellaneous: Cyanide was not detected in surface soil samples.

Subsurface Soil

Fourteen subsurface soil samples were collected at seven locations to evaluate the nature and extent of contamination. All subsurface soil samples were analyzed for Appendix IX VOCs, SVOCs, pesticides, PCBs, herbicides, and dioxin/furans, TAL metals (plus tin), and cyanide. Additionally, three subsurface soil samples were analyzed for CEC, pH, and TOC.

For evaluating human health risk, subsurface soil sample results were combined with surface soil sample results. Sixteen surface/subsurface soil samples were collected at SWMU 5 from depths of 2 to 10 feet bgs (subsurface soil samples were co-located with surface soil samples). The following chemicals were retained as COPCs for surface/subsurface soil:

- Volatiles - 1,1-DCE, benzene, cis-1,2-DCE, PCE, TCE, methylene chloride, and vinyl chloride.
- PAHs - benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, 2-methylnaphthalene, and naphthalene.
- Pesticides - dieldrin.
- PCBs - Aroclor-1254 and Aroclor-1260.
- SVOCs - pentachlorophenol.
- Dioxins/furans.

- Inorganics - antimony, arsenic, barium, cadmium, chromium (total), copper, iron, lead, manganese, mercury, nickel, silver, and zinc.

The maximum concentrations for these chemicals were compared to USEPA Soil Screening Levels (SSLs) for migration from soil to air (inhalation).

2.1.2 Groundwater

Fourteen groundwater samples were collected to evaluate the nature and extent of contamination. All groundwater samples were analyzed for Appendix IX VOCs, SVOCs, pesticides, PCBs, herbicides, and dioxin/furans, total TAL metals (plus tin), and cyanide. Two groundwater samples (05GW0301 and 05GW1301) were also analyzed for dissolved TAL metals. One groundwater sample (05GW0101) was collected as the SWMU 5 upgradient groundwater sample.

The following chemicals were retained as COPCs in groundwater:

- Chloroform
- BEHP
- Dioxins/furans
- Aluminum
- Arsenic
- Iron
- Manganese

2.1.3 Surface Water

Filtered and unfiltered surface water samples were collected at four locations to evaluate the nature and extent of contamination. There was no significant difference between the filtered and unfiltered results, indicating that turbidity did not significantly impact the unfiltered sample results. All surface water samples were analyzed for Appendix IX VOCs, SVOCs, pesticides, PCBs, herbicides, and dioxin/furans, total and dissolved TAL metals (plus tin), cyanide, hardness, and TSS. Sample 05SW0101 was selected to represent the SWMU 5 upgradient surface water sample.

The following chemicals were retained as COPCs in surface water:

- Volatiles - 1,1-DCE, cis-1,2-DCE, TCE, and vinyl chloride
- Inorganics - aluminum, arsenic, iron, and manganese

2.1.4 Sediment

Four sediment samples were analyzed for Appendix IX VOCs, SVOCs, pesticides, PCBs, herbicides, and dioxin/furans, TAL metals (plus tin), cyanide, and TOC. Sample 05SD010006 (designated as the upgradient sediment sample) was analyzed for the same parameters.

The following chemicals were retained as COPCs in sediment:

- Dioxins/furans
- Aluminum
- Antimony
- Manganese

2.2 HUMAN HEALTH RISK DRIVERS

Table 2-1 presents the conclusions from the RFI Report for contaminants associated with human health risk (TtNUS, 2005). The following presents a discussion by medium regarding human health risk [Incremental Lifetime Cancer Risks (ILCRs) greater than 1E-04 and hazard quotients (HQs) greater than 1] where thresholds were exceeded and including the contaminant causing the exceedance.

2.2.1 Surface Soil

Antimony

The adult resident and child resident antimony HQs in surface soil were 1.0 and 9.6, respectively. The risks for antimony are based on the hypothetical future residential land use, but concentrations of antimony do not pose a risk under current land use.

Lead

Predicted blood lead levels in future child residents were greater than USEPA recommended levels. Risks for lead are based on hypothetical future residential land use driven by the concentration in one surface soil sample (05SB06). The sample may represent a hot spot at the site.

2.2.2 Surface/Subsurface Soil

Antimony

The construction worker HQ in surface/subsurface soil was 2.1. The risks for the construction worker are based on the concentration in one surface soil sample (05SB06). The sample may represent a hot spot at the site.

Lead

More than 5 percent of the fetuses born to construction workers are predicted to have blood lead levels greater than 10 micrograms per deciliter (µg/dL). The risks to the future construction worker are based on the average concentration in soil samples [greater than 1,000 milligrams per kilogram (mg/kg)]. Lead concentrations in approximately one-half of subsurface soil samples were greater than 1,000 mg/kg.

2.2.3 Groundwater

Dioxins/Furans

The residential ILCR for dioxins/furans in groundwater was 4.1×10^{-4}. The risks from dioxins/furans in groundwater are based on hypothetical future residential use, but concentrations of dioxins/furans do not pose a risk under current and future industrial land use. Dioxins/furans were detected in 10 of 14 groundwater samples, indicating that groundwater has been impacted by site activities. However, concentrations of dioxins/furans as TEQs in all samples were less than the Maximum Contaminant Level (MCL) for 2,3,7,8,-TCDD [3×10^{-4} micrograms per liter (µg/L)].

Manganese

The adult and child resident HQs were 2.9 and 10, respectively. The risks for manganese are based on the hypothetical future residential use of groundwater.

2.2.4 Sediment

No significant potential health risks for human receptors for sediment were determined under current or future land use.

2.3 ECOLOGICAL RISK DRIVERS

Table 2-2 presents the conclusions from the RFI Report for contaminants associated with ecological risk. The following presents a discussion by receptor regarding unacceptable ecological risks, including the contaminant causing the unacceptable risk.

2.3.1 Terrestrial Plants and Invertebrates

Surface Soil

Unacceptable risk was determined for terrestrial plants and invertebrates contacting soils containing antimony, barium, cadmium, chromium, copper, iron, lead, silver, tin, and zinc.

Sediment

There is no unacceptable ecological risk to terrestrial plants and invertebrates associated with sediment.

Surface Water

There is no unacceptable ecological risk to terrestrial plants and invertebrates associated with surface water.

2.3.2 Insectivorous/Herbivorous Mammals and Birds

Unacceptable risk was determined for insectivorous/herbivorous mammals and birds through the food chain for soils containing cadmium, chromium, copper, dioxins, lead, mercury, silver, and zinc.

2.3.3 Aquatic Organisms

Sediment

There is no unacceptable ecological risk to aquatic organisms associated with sediment.

Surface Water

There is no unacceptable ecological risk to aquatic organisms associated with surface water.

2.4 HUMAN HEALTH AND ECOLOGICAL RISK

The two future land use options associated with SWMU 5 are presented in Figure 2-1 as the flat area with the potential to be utilized for construction (i.e., constructible area) and the gully/sloped area (i.e., non-constructible area) that is not slated for future construction. The current land conditions and uses (e.g., ecological habitat) in the non-constructible area will be not be disturbed.

2.4.1 Human Health

2.4.1.1 Soils

Section 2.2 summarizes the RFI HHRA for residential and construction worker receptors. The main assumption in developing the RFI HHRA was that the entire SWMU 5 area would be available to human receptors for both residential and construction activities. However, based on the geography of SWMU 5, the non-constructible area of the SWMU will not be developed [i.e., with land use controls (LUCs), there will be no potential exposure to residential and construction activities in this area].

To determine the appropriate human health CMs associated with soils for SWMU 5, a human health risk screening evaluation for the constructible and non-constructible areas at SWMU 5 was developed.

HHRA Updated for the Constructible Area

The RFI Report identified antimony (surface soil for child residents and surface/subsurface soil for construction workers), iron (surface soil for child residents), and lead (surface/subsurface soil child residents and construction workers) as contaminants that required further action in the CMP. As part of the CMP, an HHRA for the constructible area was prepared for antimony, iron, and lead based on the RFI Report sampling results (see Table 2-3).

Residential Child Risks

The updated risk assessment process for the hypothetical future child resident involved calculating non-carcinogenic HQs for antimony and iron and evaluating risks from exposure to lead using USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model for lead in children (USEPA, 2001). The exposure point concentrations (EPCs) for antimony and iron were upper confidence limits (UCLs) calculated for surface soil in the constructible area according to the USEPA's ProUCL guidance (Singh et. al, 2004). As recommended by USEPA guidance for lead, the EPC for lead was the arithmetic average of surface soil data in the constructible area (USEPA, 1994).

Table 2-4 presents the exposure factors used in the risk calculations for the future child resident. Table 2-5 presents the calculation of non-carcinogenic HQs for exposure of the future child resident [Reasonable Maximum Exposure (RME)] to antimony and iron in surface soil in the constructible area. According to current USEPA dermal guidance, dermal risks are not calculated for antimony and iron in soil area (USEPA, 2004). The HQs for future child residents from exposure to antimony (HQ = 1) and iron (HQ = 0.9) in surface soil for the constructible area were less than the USEPA's goal of unity.

The average lead concentration for surface soil in the constructible area was 138 mg/kg, which is less than the USEPA screening level for lead-contaminated soil in a residential setting where children are frequently present (400 mg/kg). The results of the IEUBK Model evaluation using a surface soil concentration of 138 mg/kg indicate that the estimated geometric mean blood-lead level for a child resident is 1.6 µg/dL. This blood-lead level is less than the established level of concern (10 µg/dL). Approximately 0.38 percent of children are expected to experience blood-lead levels greater than 10 µg/dL. This estimate is less than the USEPA's goal of limiting exposure to lead so that no more than 5 percent of exposed children have estimated blood-lead levels greater than the established level of concern (i.e., 10 µg/dL). The results of the IEUBK Model analysis therefore indicate that the predicted blood-lead levels of children exposed to lead in soil in the constructible area of SWMU 5 are within acceptable levels.

Construction Worker Risks

The updated risk assessment process for the future construction worker involved calculating the HQ for antimony in combined surface/subsurface soil and evaluating risks from exposure to lead using the USEPA's Adult Lead Model (USEPA, 2003a). The EPC for antimony was the UCL calculated for combined surface soil/subsurface soil in the constructible area. The EPC for lead was the arithmetic average of surface/subsurface soil data in the constructible area.

Table 2-6 presents the exposure factors used to estimate risks for the construction worker, and Table 2-7 presents the calculation of the HQ for exposure of the future construction worker (RME) to antimony in surface/subsurface soil.

The HQ for the construction worker from exposure to antimony in surface/subsurface soil (HQ = 0.6) was less than USEPA's goal of unity.

The average lead concentration for surface/subsurface soil in the constructible area was 245 mg/kg, which is less than the USEPA's screening level for industrial exposures (800 mg/kg). The results of the Adult Lead Model evaluation using a soil concentration of 245 mg/kg indicate that the predicted blood-lead levels of workers (e.g., blood-level of a pregnant worker's fetuses) exposed to lead in soil at SWMU 5 are within acceptable levels.

Conclusions

The risks calculated for the future child resident for exposure to antimony, iron, and lead in the constructible area meet USEPA goals. The risks calculated for the future construction worker for the constructible area are also less than USEPA's benchmarks.

Therefore, no further action is required for soil remediation for the constructible area. The constructible area will not be carried forward in this CMP for purposes of addressing human health risk.

HHRA Update for Non-Constructible Area

This section presents the updated risk assessment for antimony, iron, and lead based on sampling results for the non-constructible area. The analytical data used in the risk assessment for the non-constructible area are presented in Table 2-8.

Residential Child Risks

The EPCs for antimony and iron were the maximum detected concentrations in surface soil for the non-constructible area because the surface soil dataset consists of less than 10 samples. As recommended by USEPA guidance for lead, the EPC for lead was the arithmetic average of surface soil data in the non-constructible area.

Table 2-9 presents the calculation of non-carcinogenic HQs for exposure of future child residents (RME) to antimony and iron in surface soil in the non-constructible area. According to current USEPA dermal guidance, dermal risks are not calculated for antimony and iron in soil. The HQs for future child residents from exposure to antimony (HQ = 10) and iron (HQ = 1.5) in surface soil in the non-constructible area exceeded USEPA's goal of unity.

The average lead concentration for surface soil in the non-constructible area was 3,754 mg/kg, which exceeds the USEPA screening level for lead-contaminated soil in a residential setting where children are frequently present (400 mg/kg). The results of the IEUBK Model evaluation using a surface soil

concentration of 3,754 mg/kg indicate that the estimated geometric mean blood-lead level for a child resident is 22.7 µg/dL. This blood-lead level is greater than the established level of concern (10 µg/dL). Approximately 96 percent of children are expected to experience blood-lead levels greater than 10 µg/dL. This estimate exceeds USEPA's goal of limiting exposure to lead so that no more than 5 percent of exposed children have an estimated blood-lead level greater than the established level of concern (i.e., 10 µg/dL). The results of the IEUBK Model analysis indicate that the predicted blood-lead levels of children exposed to lead in soil at SWMU 5 within the non-constructible area exceed USEPA benchmarks.

Construction Workers Risks

The updated risk assessment process for the future construction worker in the non-constructible area involved calculating the HQ for antimony in combined surface/subsurface soil and evaluating risks from exposure to lead using the USEPA's Adult Lead Model. The EPC for antimony was the UCL calculated for combined surface soil/subsurface soil in the non-constructible area. The EPC for lead was the arithmetic average of surface/subsurface soil data in the non-constructible area.

Table 2-9 presents the exposure factors used to estimate risks for the construction worker, and Table 2-10 presents the calculation of the HQ for exposure of the future construction worker (RME) to antimony in surface/subsurface soil in the non-constructible area. The HQ for the construction worker from exposure to antimony (HQ = 1.3) in surface/subsurface soil slightly exceeds USEPA's goal of unity.

The average lead concentration for surface/subsurface soil in the non-constructible area was 3,010 mg/kg, which is greater than the USEPA's screening level for industrial exposures (800 mg/kg). The results of the Adult Lead Model evaluation using a soil concentration of 3,010 mg/kg indicate that the predicted blood-lead levels of fetuses of workers exposed to lead in soil in the non-constructible area of SWMU 5 exceed the USEPA goal of 10 µg/dL and that the probability of exceeding 10 µg/dL is greater than the goal of 5 percent.

Conclusions

The risks calculated for the future child resident for exposure to antimony, iron, and lead in the non-constructible area exceed USEPA goals. The risks calculated for the future construction worker for the non-constructible area also exceed USEPA's benchmark.

Therefore, the non-constructible area will be carried forward in this CMP for purposes of addressing human health risk.

2.4.1.2 Groundwater

Risks from dioxins/furans, BEHP, arsenic, and manganese were based on hypothetical future residential use, no risk are indicated under current and future industrial land use. Because the risk to current receptors is acceptable for these Chemicals of Concern (COCs), the CM will be LUCs prohibiting withdraw of groundwater. In addition, the concentrations of dioxins in groundwater are less than the MCL (0.00000003 mg/L) (USEPA, 2006).

2.4.2 Ecological

Section 2.3 summarizes the RFI Ecological Risk Assessment. Ecological impacts on individual members of species in the immediate vicinity of the contamination were evaluated. No evaluations were conducted regarding the extent of contamination in relation to the greater contiguous landscape (i.e., impacts were for individual species rather than populations).

In this section, the results of the RFI Ecological Risk Assessment are re-evaluated to discuss impacts of contamination at SWMU 5 on ecological populations. The SWMU 5 contamination is small in areal extent when compared to the contiguous surrounding ecosystem. SWMU 5 was evaluated as a small-scale contaminant release resulting in small patches of potentially impacted habitat within a primarily intact habitat. Potential impacts on populations were then evaluated to determine whether significant risks existed. The following presents the re-evaluation of ecological risks to populations for these areas.

NSWC Crane

A biological characterization of NSWC Crane, including a listing of plants and animals found at the facility, was presented in the Installation Assessment (IA) (Army, 1978) and the IAS (NEESA, 1983), and is summarized in the Environmental Monitoring Reports (EMRs) (Halliburton NUS, 1992a and 1992b). A list of the species that may inhabit NSWC Crane and that are protected under the United States Endangered Species Act, Indiana Department of Natural Resources Heritage Data Center, or the United States Fish and Wildlife Service is summarized in the RCRA Facility Permit (USEPA, 1995). The following paragraphs briefly summarize the environmental setting at the installation.

Eighty percent of NSWC Crane's 63,463 acres are classified as Central Hardwoods Forest of the United States (NEESA, 1983). In addition, some agricultural fields are in various stages of succession.

Openings on dry upland sites contain almost pure stands of grasses with some clumps of woody plants such as persimmon, sassafras, and sumac. Wetter sites have river birch, willow, sycamore, and cottonwood. Hillside communities have mostly hickory, white and black oak, red and sugar maple, tulip poplar, ash, and beech (NEESA, 1983).

The great variety of habitats at NSWC Crane (i.e., many stages of forest succession, streams, ponds, Lake Greenwood, grassy open spaces) has lead to a high diversity of animal species (NEESA, 1983). Some of these species include (but are not limited to) mammals such as white-tailed deer, beaver, coyote, hawks, red fox, rabbits, raccoons, mice; birds such as ducks, geese, wild turkey, bobwhite quail, red-tailed hawks, and American robins; and various amphibians, reptiles, fish, and invertebrates.

The bird population includes a number of State or federal threatened, endangered, or species of special concern that use NSWC Crane as their home range. These species include the bald eagle, osprey, sharp-shinned hawk, red-shouldered hawk, broad-winged hawk, black and white warbler, hooded warbler, and the worm-eating warbler (B&RE, 1997). Also, the Indiana bat, a federal endangered species, is known to forage at NSWC Crane. During a mist net and radiotelemetry survey conducted for NSWC Crane, a male Indiana bat was captured along Furst Creek, which is approximately 1.5 miles west of SWMU 10. SWMU 10 is approximately 6.2 miles due east of SWMU 5. No Indiana bats were captured near SWMU 5. Because of the bat and its potential habitat, the cutting of trees is restricted to certain times during the year, and the cutting of shagbark hickory trees is prohibited.

SWMU 5

SWMU 5 consists of approximately 25 acres located in the alluvial valley of Culpepper Branch and is surrounded by hills and ridges. Of the 25 acres, approximately 16 acres are forested, 6.5 acres are grass covered, and 2.5 are light industrial (i.e., gravel parking areas). A gully to the north of the site is forested with mixed hardwoods and shrubs. The walls of the gully are eroded and have steep slopes. This area contains old waste drums and metallic debris, and has an average to good quality stand of mixed hardwoods. Canopy species encountered include maples (red, sugar, and boxelder), sycamore, oaks, hickories, black cherry, yellow poplar (tulip tree), and American elm, with black locust as the dominant species in the highly disturbed areas. Commonly encountered understory species included maples, white ash, bitternut hickory, flowering dogwood, multiflora rose, and poison ivy.

During a site visit by Tetra Tech NUS, Inc. (TtNUS) in October 2001, the water in the unnamed creek (e.g., drainageway north of SWMU 5) was observed to be 2 to 3 feet wide and less than 1 foot deep. The water flow was slow, and there were some stagnant pools. The sediment was silty with some sand. No

fish were observed in the unnamed creek, and the small size of the creek would limit the fish population to a few small fish, if fish are present at all.

Figure 2-2 is an aerial photograph of SWMU 5 and the surrounding area. As can be seen from the figure, the forested part of SWMU 5 comprises a very small percentage of the contiguous forested area. It is also apparent from Figure 2-1 (which is an enlargement of a portion of Figure 2-2), that the forested habitat at SWMU 5 appears to be similar to the habitat in the surrounding forested area. In fact, if the SWMU boundary line was removed from the figure, it would not be possible to determine the boundaries of the SWMU.

An animal survey was not conducted at SWMU 5, but spring peepers were vocally confirmed and wild turkey tracks were observed during one of the site visits. Based on the habitat, a variety of small mammals and birds would be expected to inhabit SWMU 5 and the surrounding area. Although roads west, north, and south of the SWMU 5 may limit the movement of some very small mammals, in general, mammals and birds are free to roam throughout the SWMU as well as in the adjacent forested areas immediately surrounding the SWMU. In fact, as seen in Figure 2-2, SWMU 5 comprises a small percentage (less than 5 percent) of the overall habitat for mammals and birds in this area of NSWC Crane.

Summary of Ecological Risk Assessment

Terrestrial Plants and Invertebrates

Many metals detected in surface soil samples were found at concentrations that exceeded plant and invertebrate benchmarks, so there is a potential risk to these receptors at the SWMU. Most of the metals retained as COPCs for risks to plants and invertebrates had their greatest detected concentrations in the northern area of the SWMU, specifically in sample 05SB060002. This sample was located in the forested area of SWMU 5 and contained metal shavings that contributed to the very high concentrations of metals in that sample (some of the shavings were likely analyzed along with the soil).

As shown in Figure 5-7 in the SWMU 5 RFI Report (the inorganic soil tag map), other soil samples collected in the forested area (05SB05002, 05SB07002, and 05SB08002) had much lower concentrations of metals. Various metal debris piles are located throughout the forested area (and the steep drop-off into the main gully) and include rusted drums, metal shavings, and other pieces of metal. Because of this debris, high concentrations of metals may be present in soil within these areas, but lower concentrations are expected at locations where metal debris are not present.

Although soil samples at several locations in the forested area had concentrations of metals greater than plant and invertebrate benchmarks, there is uncertainty as to whether plants and invertebrates are actually being impacted. Metals in freshly salt-spiked soils, which are typically used in toxicity tests to develop plant and invertebrate benchmarks, are typically much more toxic than equivalent metals concentrations in field soils (Allen, 2002). This is supported by observations made during several site visits, as documented in photographs (see Figure 1-9 in the RFI Report), showing that SWMU 5 is heavily vegetated where metal debris is present. Therefore, the metals at SWMU 5 do not appear to be significantly impacting the plant community in these areas. Also, it is unlikely that invertebrates are being impacted to any significant degree because if invertebrates were not present to break down plant material, aerate the soil, etc, the plant community would be impacted.

In summary, based on observations during site visits and the apparent similarity between the forested area at and surrounding SWMU 5 (as seen in Figure 2-2), it does not appear that local populations of plants/invertebrates and/or the plant/invertebrate community is being significantly impacted by metals in surface soils at SWMU 5. This is especially true because SWMU 5 comprises such a small portion of the available habitat in this area of NSWC Crane.

Risks to Insectivorous/Herbivorous Mammals and Birds

The 16 forested acres and 6.5 acres of grass at SWMU 5 are of sufficient size to support some small mammals and birds that have been identified at NSWC Crane and may be present at the site. These include organisms such as shrews and robins. The ecological risk assessment concluded that small mammals and birds may experience some reproductive effects from exposure to dioxins and metals in soil at SWMU 5, but there was significant uncertainty in the conclusion because the bioavailability of the chemicals in the soil is not known. This was especially true because metal shavings were present in the soil sample that had some of the greatest detected concentrations of metals at the site. Because the metal shavings will not be very bioavailable, calculated risks were likely overestimated. Also, the bioavailability of dioxins in the soil is not known, but it is likely to be low because a portion of the dioxins will be bound to the organic matter in the soil. However, for the conservative ecological risk assessment, it was assumed that 100 percent of the chemicals were bioavailable.

In the ecological risk assessment food-chain modeling, the potential risks for small mammals (i.e., shrew) were lower than the potential risks estimated for small birds (i.e., robin and, to a lesser extent, quail), based on the shrew food-chain modeling having much lower ecological effects. Although it is possible that there may be some reproductive impacts to some birds and small mammals at SWMU 5, a decrease

in reproduction of these species at SWMU 5 will not impact the populations and/or communities of these receptors in this area at NSWC Crane because SWMU 5 comprises such a small portion of the available habitat in this area.

Conclusions

As presented above, it is possible that some individual plants and/or invertebrates are being impacted at locations where metals concentrations in soil are elevated. However, as discussed in OSWER Directive 9285.7-28P, Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles for Superfund Sites, remedial actions generally should not be designed to protect organisms on an individual basis (with the exception of certain protected species) but to protect local populations and communities of biota (1999).

SWMU 5 comprises a very small percentage of the contiguous forested area (less than 5 percent) (see Figure 2-2). Based on observations during site visits and the apparent similarity between the forested area at and surrounding SWMU 5 (as seen in Figure 2-2), it does not appear that local populations of plants/invertebrates and/or the plant/invertebrate community is being significantly impacted by metals at SWMU 5. Also, even if there are subtle impacts to ecological receptors from chemicals in surface soil at the site, these impacts would be localized to the areas where chemical concentrations are elevated. Because the site comprises only a small portion of the overall habitat for ecological receptors in this area, any localized impacts to ecological receptors (including wildlife) at SWMU 5 will not impact the overall ecology in this area of NSWC Crane. Furthermore, approximately half of SWMU 5 may be developed in the future (see Figure 2-1), which would limit the exposure of ecological receptors to site chemicals in this area. For these reasons, potential risks to ecological receptors at SWMU 5 are not great enough to warrant basing any decisions in the CMP on risks to these receptors. Therefore, ecological receptors will not be carried forward in this CMP.

2.5 MEDIA CLEANUP STANDARDS

Based on the results of the risk assessments presented in Sections 2-1 through 2-3, unacceptable risks to current and future human receptors have been identified. The following identifies the constituents that present unacceptable risk to current and future human and ecological receptors for the constructible and non-constructible areas of SWMU 5:

Soils:

- Metals
  - Antimony and iron (current and future receptors) (non-constructible area)
  - Lead (future receptors) (non-constructible area)

Groundwater:

- Metals
  - Manganese (current and future receptors) (constructible and non-constructible areas)

2.5.1 Soil

MCSs developed for current receptor COCs in soil at SWMU 5 are shown in Table 2-11.

The human health soil MCSs for SWMU 5 were back calculated from the risk assessment included in the RFI for SWMUs 4, 5, 9, and 10 (TtNUS, 2005). Because risk assessment equations are linear in the concentration term, an acceptable remediation concentration for the site can be calculated using a ratio of the site concentration to the resulting risk estimate that was determined in the risk assessment utilizing a target cancer risk (TCR) or target hazard index (THI). Because the COCs for SWMU 5 (antimony, iron, and lead) are classified as non-carcinogenic, a THI of unity (1) is employed to determine the remediation concentration.

The soil MCSs were calculated by the following equation:

$$MCS = \frac{Cs \times THI}{Risk}$$

Where:

MCS	=	Media Cleanup Standard (mg/kg)
Cs	=	Soil concentration used in the SWMU 5 risk assessment (mg/kg)
THI	=	Target hazard index
Risk	=	Soil risk calculated in the SWMU 5 risk assessment

For example, the residential soil MCS for antimony based on child residential exposures was calculated as follows for an ILCR of 1E-05:

Cs = 301 mg/kg

THI = 1

Risk = 9.61

$$MCS = \frac{301 \times 1}{9.61}$$

MCS (antimony) = 31.3 mg/kg

Because toxicological data are currently not available for lead, the soil cleanup levels for lead cannot be calculated using this methodology. As an alternative, the residential MCS for lead (400 mg/kg) is derived from the Child Lead Model (IEUBK), and the industrial MCS for lead (800 mg/kg) is derived from the Technical Review Workgroup (TRW) Adult Lead Model.

Antimony

Surface soil MSCs of 31.3 and 140 mg/kg were established for cleanup to acceptable antimony risks associated with the future child residents and construction workers, respectively. Antimony concentrations at surface soil sample locations 05SB006 (301 mg/kg), 05SB005 (76.1 mg/kg), and 05SB002 (33.2 mg/kg) exceeded this cleanup level.

A subsurface soil MSC of 140 mg/kg was established for cleanup to acceptable antimony risks associated with construction workers. The antimony concentration at surface soil sample location 05SB006 (208 mg/kg) exceeded this cleanup level.

Iron

A surface soil MSC of 106,000 mg/kg was established for cleanup to allow for acceptable iron risk associated with future residents. Iron concentrations at surface soil sample locations 05SB006 (105,000 mg/kg) and 05SB007 (32,800 mg/kg) exceeded this cleanup level.

Lead

A surface soil MSC of 400 mg/kg was established for cleanup to allow for acceptable lead risk associated with future residents. Lead concentrations at surface soil sample locations 05SB0502 (450 mg/kg) and 05SB0506 (16,900 mg/kg) exceeded this cleanup level.

A surface and subsurface soil MSC of 800 mg/kg was established to allow for acceptable lead risk associated with construction workers. The lead surface soil concentration at SB0506 (16,900 mg/kg) exceeded this cleanup level. Unacceptable risk to construction workers from lead was determined at three subsurface soil locations [05SB002 (1,330 mg/kg), 05SB005 (2,550 mg/kg), and 05SB006 (2,860 mg/kg)] where concentrations exceeded this cleanup level.

2.5.2 Groundwater

MCSs have been developed for current receptors COCs for current receptors in groundwater at SWMU 5 and are shown in Table 2-11.

The human health groundwater MCS for SWMU 5 was back calculated from the risk assessment included in the RFI for SWMUs 4, 5, 9, and 10 according to the methodology used by USEPA Region 9 in the development of its PRGs. Because risk assessment equations are linear in the concentration term, an acceptable remediation concentration for the site can be calculated using a ratio of the site concentration to the resulting risk estimate that was determined in the risk assessment utilizing a TCR or THI. Because the COC for SWMU 5 (manganese) is classified as non-carcinogenic, a THI of unity (1) was employed to determine the remediation concentration.

The groundwater MCS was calculated by the following equation:

$$MCS = \frac{Cgw \times THI}{Risk}$$

Where:

MCS	=	Media cleanup standard (µg/L)
Cgw	=	Groundwater exposure point concentration used in the SWMU 5 risk assessment (µg/L)
THI	=	Target hazard index
Risk	=	Groundwater risk for manganese calculated in the SWMU 5 Risk assessment

For example, the residential groundwater MCS for manganese was calculated as follows:

Cgw	=	2,270 µg/L
THI	=	1
Risk	=	2.93 (ingestion + dermal HI)

$$MCS = \frac{2{,}270 \times 1}{2.93}$$

MCS (manganese) = 775 µg/L

Manganese

A groundwater MSC of 775 µg/L was established for cleanup to acceptable manganese risks associated with the future child residents. Manganese concentrations at monitoring wells 05-07 (855 µg/L), 05-06 (1,170 µg/L), 05-07 (855 µg/L), 05-08 (1,290 µg/L), and 05-15 (2,270 µg/L) exceeded this cleanup level.

A groundwater MSC of 14,000 µg/L was established for cleanup to acceptable manganese risks associated with construction workers. No manganese groundwater concentrations exceeded this cleanup level.

Dioxins/Furans

A groundwater MSC of 3E-04 µg/L (e.g., the MCL for dioxins) was established for cleanup to acceptable 2,3,7,8-TCDD risks associated with current receptors. No 2,3,7,8-TCDD groundwater concentrations exceeded this cleanup level.

TABLE 2-1

RFI REPORT SUMMARY OF RECEPTOR-SPECIFIC HUMAN RISK AND HAZARDS, ECOLOGICAL RISKS, AND RECOMMENDATIONS
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

Receptor Population	Environmental Media	Overall Carcinogenic Risk (Human)	Overall Hazard Index (Human)	Overall Risk (Ecological)	Critical Pathways and Chemicals of Concern	Recommendations
Future Construction Worker (Adult)	Soil and Groundwater	7.1E-06	3.7E+00	NA	Ingestion of soil (antimony)	• CMP to evaluate hot spot removal • Debris removal at toe of dump for aesthetic purposes
Future Maintenance Worker (Adult)	Surface Soil	1.9E-06	1.1E-01	NA	NA	NFA
Future Recreational User (Adult)	Surface Soil, Surface Water, and Sediment	5.5E-05	3.6E-01	NA	NA	NFA
Current/Future Trespasser (Adolescent)	Surface Soil, Surface Water, and Sediment	6.4E-06	2.3E-01	NA	NA	NFA
Future Resident (Adult)	Soil, Surface Water, Sediment, and Groundwater	5.7E-04	5.6E+00	NA	Ingestion of soil (antimony) and ingestion of groundwater (dioxins/furans and manganese)	• Proceed to CMP • Collect supplemental hydraulic conductivity data to support CMP
Future Resident (Child)	Soil, Surface Water, Sediment, and Groundwater	2.9E-04	2.7E+01	NA	Ingestion of soil and dermal contact with soil (antimony, and iron) and ingestion of groundwater (dioxins/furans and manganese)	• Proceed to CMP • Collect supplemental hydraulic conductivity data to support CMP

RFI - Resource Conservation and Recovery Act Facility Investigation.
NA - Not applicable.
NFA - No further action.
CMP - Corrective Measures Proposal.

TABLE 2-2

SUMMARY OF RFI REPORT ECOLOGICAL RISK CONCLUSIONS
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

Receptor Population	Environmental Media	Overall Risk	Critical Pathways and Chemicals of Concern	Recommendations
Terrestrial Plants and Invertebrates	Surface Soil	Unacceptable	Terrestrial plants and invertebrates contacting soils (antimony, barium, cadmium, chromium, copper, iron, lead, silver, tin, and zinc)	Proceed to CMS
Mammals and Birds	Surface Soil	Unacceptable	Insectivorous/herbivorous mammals and birds through the food chain (dioxins, cadmium, chromium, copper, lead, mercury, silver, and zinc)	Proceed to CMS
	Sediment and Surface Water	Acceptable	NA	NFA
Aquatic Organisms	Surface Water and Sediment	Acceptable	NA	NFA

NA - Not applicable.
NFA - No further action.
CMS - Corrective Measures Study.

TABLE 2-3

ANTIMONY, IRON, AND LEAD CONCENTRATIONS IN CONSTRUCTIBLE AREA
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

SAMPLE NUMBER	SAMPLE LOCATION	DEPTH RANGE (feet)	ANTIMONY (mg/kg)	IRON (mg/kg)	LEAD (mg/kg)
0 to 2 Feet Approximate Depth Range					
05SB010002	05SB01	0 - 2	5.8 J	20,400 J	82.7 J
05SB020002	05SB02	0 - 2	33.2 J	21,100 J	450. J
05SB030002	05SB03	0 - 2	13.3 J	16,700 J	204. J
05SB040002	05SB04	0 - 2	0.9 U	17,300 J	15.2 J
05/03-01-90 #1	05/03-01-90	0.5 - 1	1.5 U	21,600	16.
05/03-02-90 #1	05/03-02-90	0.5 - 1	1.5 U	18,600	35.4
05/03-03-90 #1	05/03-03-90	0.5 - 1	1.5 U	18,800	41.9
05/03-04-90 #1	05/03-04	0.5 - 1	1.5 U	19,200	49.8
05/03-05-90 #1	05/03-05	0.5 - 1	11.6	21,500	266.
05/03-05-90 #1 D	05/03-05	0.5 - 1	8.1	21,900	198.
05/03-06-90 #1	05/03-06	0.5 - 1	4.3	19,700	278.
05/03-07-90 #1	05/03-07	0.5 - 1	1.5 U	18,800	18.5
2 to 4 Feet Approximate Depth Range					
05SB040204	05SB04	2 - 4	0.84 U	12,700 J	8.2 J
05/03-04-90 #2	05/03-04	3.5 - 4	1.5 U	23,200	27.1
05/03-05-90 #2	05/03-05	2.5 - 3	12.2	91,400	1,150.
05/03-06-90 #2	05/03-06	3.5 - 4	6.11	24,800	620.
4 to 6 Feet Approximate Depth Range					
05SB020406	05SB02	4 - 6	96.1 J	31,600 J	1,330. J
05SB030507	05SB03	5 - 7	126. J	72,900 J	549. J
05/03-01-90 #2	05/03-01-90	5.5 - 6	1.5 U	18,500	8.4
05/03-02-90 #2	05/03-02-90	5.5 - 6	1.5 U	19,600	12.5
05/03-03-90 #2	05/03-03-90	5.5 - 6	1.5 U	18,900	11.6
6 to 10 Feet Approximate Depth Range					
05SB010810	05SB01	8 - 10	0.9 J	11,400 J	9. J

mg/kg - Milligrams per kilogram.

TABLE 2-4

VALUES OF DAILY INTAKE CALCULATIONS FOR EXPOSURE OF
FUTURE CHILD RESIDENTS TO SURFACE SOIL IN CONSTUCTIBLE AREA
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Entire Site
Receptor Population: Residents
Receptor Age: Child (0 - 6 years)

Exposure Route	COPC	Medium EPC Value (mg/kg)	Route EPC Value (mg/kg)	EPC Selected for Hazard Calculation	Intake (Non-Cancer) (mg/kg-day)	RfD (mg/kg-day)	Reference Concentration	HQ
Ingestion	Antimony	3.30E+01	3.30E+01	Medium	4.2E-04	4.00E-04	NA	1
	Iron	8.08E+04	8.08E+04	Medium	1.0E+00	1.10E+00	NA	0.9
Dermal	Antimony	3.30E+01	3.30E+01	Medium	NA	6.00E-05	NA	NA
	Iron	8.08E+04	8.08E+04	Medium	NA	1.10E+00	NA	NA

Dermal Absorption Fraction from Soil (ABS) (USEPA 2004):

Antimony - No ABS value provided

COPC - Chemical of Potential Concern.
EPC - Exposure point concentration.
RfD - Reference dose.
HQ - Hazard quotent.
ABS - Absorption.
NA - Not applicable.
USEPA - United States Environmental Protection Agency.

TABLE 2-5

CALCULATION OF NON-CANCER HAZARDS FROM EXPOSURE OF FUTURE CHILD RESIDENTS TO SURFACE SOIL
REASONABLE MAXIMUM EXPOSURE
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Entire Site
Receptor Population: Residents
Receptor Age: Child (0 - 6 years)

Exposure Route	Parameter Code	Parameter Definition	Unit	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Cs	Chemical Concentration in Soil	mg/kg	95% UCL	USEPA, 1993	95% UCL	USEPA, 1993	Ingestion CDI (mg/kg/day) =
	IR	Ingestion Rate of Soil	mg/day	200	USEPA, 1993	100	USEPA, 1993	Cs x IR x Fi x EF x ED x CF
	Fi	Fraction ingested	unitless	1.0	USEPA, 1993	1.0	USEPA, 1993	BW x AT
	EF	Exposure Frequency	days/year	350	USEPA, 1993	234	USEPA, 1993	USEPA, 1989.
	ED	Exposure Duration	years	6	USEPA, 1993	2	USEPA, 1993	
	CF	Conversion Factor	kg/mg	1.0E-06	USEPA, 1989	1.0E-06	USEPA, 1989	
	BW	Body Weight	kg	15	USEPA, 1993	15	USEPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA, 1989	25,550	USEPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2,190	USEPA, 1989	730	USEPA, 1989	
Dermal	Cs	Chemical Concentration in Soil	mg/kg	95% UCL	USEPA, 1993	95% UCL	USEPA, 1993	Dermal CDI (mg/kg/day) =
	CF	Conversion Factor	kg/mg	1.0E-06	USEPA, 1989	1.0E-06	USEPA, 1989	Cs x CF x SA x AF x ABS x EF x ED
	SA	Skin Surface Area	cm^2/day	2,000	USEPA, 1997	1,745	USEPA, 1997	BW x AT
	AF	Soil to Skin Adherence Factor	mg/cm^2	0.2	USEPA, 2004	0.04	USEPA, 2004	USEPA, 1989.
	ABS	Dermal Absorption Factor (Solid)	unitless	chemical specific	USEPA, 2004	chemical specific	USEPA, 2004	
	EF	Exposure Frequency	days/year	350	USEPA 1993	234	USEPA 1993	
	ED	Exposure Duration	years	6	USEPA, 1989	2	USEPA, 1989	
	BW	Body Weight	kg	15	USEPA, 1993	15	USEPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA, 1989	25,550	USEPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2,190	USEPA, 1989	730	USEPA, 1989	

1 Surface soil is defined as soil collected from depths of 0 to 2 feet below ground surface.

Daily Intake Calculations

Ingestion Intake = (IR x Fi x EF x ED x CF) / (BW x AT)
Dermal Intake = (CF x SA x AF x ABS x EF x ED) / (BW x AT)

Cancer Ingestion Intake - RME = 1.10E-06
Noncancer Ingestion Intake - RME = 1.28E-05

Cancer Ingestion Intake - CTE = 1.22E-07
Noncancer Ingestion Intake - CTE = 4.27E-06

Cancer Dermal Intake - RME = 2.19E-06
Noncancer Dermal Intake - RME = 2.56E-05

Cancer Dermal Intake - CTE = 8.52E-08
Noncancer Dermal Intake - CTE = 2.98E-06

CTE - Central Tendency Exposure.
CDI - Chronic Daily Intake.
kg - kilograms.
mg - milligrams.

RME - Reasonable Maximum Exposure.
UCL - Upper confidence limit.
USEPA - United States Environmental Protection Agency.

TABLE 2-6

CALCULATION OF NON-CANCER HAZARDS
FROM EXPOSURE OF CONSTRUCTION WORKERS TO SURFACE/SUBSURFACE SOIL IN CONSTRUCTIBLE AREA
REASONABLE MAXIMUM EXPOSURE
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

Scenario Timeframe: Future
Medium: Surface Soil/Subsurface Soil
Exposure Medium: Surface Soil/Subsurface Soil
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	COPC	Medium EPC Value (mg/kg)	Route EPC Value (mg/kg)	EPC Selected for Hazard Calculation	Intake (Non-Cancer) (mg/kg-day)	RfD (mg/kg-day)	Reference Concentration	HQ
Ingestion	Antimony	8.71E+01	8.71E+01	Medium	2.5E-04	4.00E-04	NA	6.1E-01
Dermal	Antimony	8.71E+01	8.71E+01	Medium	NA	6.00E-05	NA	NA

Dermal Absorption Fraction from Soil (ABS) (USEPA 2004):

Antimony - No ABS value provided

EPC - Exposure point concentration.
ABS - Absorption.
COPC - Chemical of Potential Concern.
HQ - Hazard quotient.
NA - Not applicable.
RfD - Reference dose.
USEPA - United States Environmental Protection Agency.

TABLE 2-7

VALUES OF DAILY INTAKE CALCULATIONS FOR EXPOSURE OF CONSTRUCTION WORKERS TO SURFACE / SUBSURFACE SOIL
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

Scenario Timeframe: Future
Medium: Surface Soil/Subsurface Soil
Exposure Medium: Surface Soil/Subsurface Soil
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Unit	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Cs	Chemical Concentration in Soil	mg/kg	95% UCL	USEPA, 1993	95% UCL	USEPA, 1993	Ingestion CDI (mg/kg/day) =
	IR	Ingestion Rate of Soil	mg/day	480	USEPA, 1991	240	1/2 RME value	Cs x IR x Fi x EF x ED x CF
	Fi	Fraction Ingested	unitless	1.0	Professional Judgement	1.0	Professional Judgement	BW x AT
	EF	Exposure Frequency	days/year	150	Professional Judgement	150	Professional Judgement	USEPA, 1989.
	ED	Exposure Duration	years	1	Professional Judgement	1	Professional Judgement	
	CF	Conversion Factor	kg/mg	1.0E-06	USEPA, 1989	1.0E-06	USEPA, 1989	
	BW	Body Weight	kg	70	USEPA, 1993	70	USEPA, 1989	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA, 1989	25,550	USEPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	USEPA, 1989	365	USEPA, 1989	
Dermal	Cs	Chemical Concentration in Soil	mg/kg	95% UCL	USEPA, 1989	95% UCL	USEPA, 1993	Dermal CDI (mg/kg/day) =
	CF	Conversion Factor	kg/mg	1.0E-06	USEPA, 1989	1.0E-06	USEPA, 1989	Cs x CF x SA x AF x ABS x EF x ED
	SA	Skin Surface Area	cm^2/day	5,800	USEPA ,1997	5,000	USEPA, 1997	BW x AT
	AF	Soil to Skin Adherence Factor	mg/cm^2	0.3	USEPA, 2004	0.1	USEPA, 2004	USEPA, 1989.
	ABS	Dermal Absorption Factor (Solid)	unitless	chemical specific	USEPA, 2004	chemical specific	USEPA, 2004	
	EF	Exposure Frequency	days/year	150	Professional Judgement	150	Professional Judgement	
	ED	Exposure Duration	years	1	Professional Judgement	1	Professional Judgement	
	BW	Body Weight	kg	70	USEPA, 1993	70	USEPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA, 1989	25,550	USEPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	USEPA, 1989	365	USEPA, 1989	

1 Surface / subsurface soil is defined as soil collected from depths of 0 to 10 foot below ground surface.

Daily Intake Calculations

Ingestion Intake = (IR x Fi x EF x ED x CF) / (BW x AT)
Dermal Intake = (CF x SA x AF x ABS x EF x ED) / (BW x AT)

Cancer Ingestion Intake - RME = 4.03E-08
Noncancer Ingestion Intake - RME = 2.82E-06

Cancer Ingestion Intake - CTE = 2.01E-08
Noncancer Ingestion Intake - CTE = 1.41E-06

Cancer Dermal Intake - RME = 1.46E-07
Noncancer Dermal Intake - RME = 1.02E-05

Cancer Dermal Intake - CTE = 4.19E-08
Noncancer Dermal Intake - CTE = 2.94E-06

CTE - Central Tendency Exposure.
CDI - Chronic Daily Intake.
RME - Reasonable Maximum Exposure.
UCL - Upper confidence limit.
USEPA - United States Environmental Protection Agency.

TABLE 2-8

ANTIMONY, IRON, AND LEAD CONCENTRATIONS IN NON-CONSTRUCTIBLE AREA
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

SAMPLE NUMBER	SAMPLE LOCATION	DEPTH RANGE (feet)	ANTIMONY (mg/kg)	IRON (mg/kg)	LEAD (mg/kg)
0 to 2 Feet Approximate Depth Range					
05SB050002	05SB05	0 - 2	76.1 J	17,400. J	342. J
05SB060002	05SB06	0 - 2	301. J	105,000. J	16,900. J
05SB070002	05SB07	0 - 2	9.6 J	32,800. J	196. J
05SB080002	05SB08	0 - 2	3.2 J	15,600. J	16.4 J
05/03-08-90 #1 (90)	05/03-08	0.5 - 1	34.3	127,000.	2,350.
05/03-09-90 #1 (90)	05/03-09	0.5 - 1	43.	133,000.	2,720.
2 to 4 Feet Approximate Depth Range					
05/03-08-90 #2 (90)	05/03-08	3 - 3.5	44.7	205,000.	2,010.
6 to 10 Feet Approximate Depth Range					
05SB050608	05SB05	6 - 8	6.5 J	29,900. J	2,550. J
05SB060608	05SB06	6 - 8	208. J	43,900. J	2,860. J
05SB070608	05SB07	6 - 8	11.5 J	35,200. J	151. J

mg/kg - miligram per kilogram.

TABLE 2-9

VALUES OF DAILY INTAKE CALCULATIONS FOR EXPOSURE OF
FUTURE CHILD RESIDENTS TO SURFACE SOIL IN NON-CONSTRUCTIBLE AREA
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Non-Constructible Area
Receptor Population: Residents
Receptor Age: Child (0 - 6 years)

Exposure Route	COPC	Medium EPC Value (mg/kg)	Route EPC Value (mg/kg)	EPC Selected for Hazard Calculation [1]	Intake (Non-Cancer) (mg/kg-day)	RfD (mg/kg-day)	Reference Concentration	HQ
Ingestion	Antimony	3.01E+02	3.01E+02	Medium	3.8E-03	4.00E-04	NA	10
	Iron	1.33E+05	1.33E+05	Medium	1.7E+00	1.10E+00	NA	1.5
Dermal	Antimony	3.01E+02	3.01E+02	Medium		6.00E-05	NA	
	Iron	1.33E+05	1.33E+05	Medium		1.10E+00	NA	

1 - Dermal Absorption Fraction from Soil (ABS) (USEPA, 2004): Antimony and iron - No ABS value provided.

ABS - Absorption factor from soil.
COPC - Chemical of Potential Concern.
EPC - Exposure point concentration.
HQ - Hazard quotent.
mg/kg - Milligram per kilogram.
mg/kg-day - Milligram per kilogram per day.
NA - Not applicable.
RfD - Reference dose.
USEPA - United States Environmental Protection Agency.

TABLE 2-10

REASONABLE MAXIMUM EXPOSURE
CALCULATION OF NON-CANCER HAZARDS
FROM EXPOSURE OF CONSTRUCTION WORKERS TO SURFACE/SUBSURFACE SOIL IN NON-CONSTRUCTIBLE AREA
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

Scenario Timeframe: Future
Medium: Surface Soil/Subsurface Soil
Exposure Medium: Surface Soil/Subsurface Soil
Exposure Point: Non-Constructible Area
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	COPC	Medium EPC Value (mg/kg)	Route EPC Value (mg/kg)	EPC Selected for Hazard Calculation [1]	Intake (Non-Cancer) (mg/kg-day)	RfD (mg/kg-day)	Reference Concentration	HQ
Ingestion	Antimony	1.78E+02	1.78E+02	Medium	5.0E-04	4.00E-04	NA	1.3E+00
Dermal	Antimony	1.78E+02	1.78E+02	Medium		6.00E-05	NA	

1 - Dermal Absorption Fraction from Soil (ABS) (USEPA, 2004): Antimony - No ABS value provided.

EPC - Exposure point concentration.
ABS - Absorption factor from soil.
COPC - Chemical of Potential Concern.
HQ - Hazard quotient.
kg - kilograms.
mg - milligrams.
NA - not applicable.
RfD - Reference dose.
USEPA - United States Environmental Protection Agency.

TABLE 2-11

HUMAN HEALTH MEDIA CLEANUP STANDARDS
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

COC	Media Cleanup Standards		
	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Groundwater (µg/L)
Construction Worker			
Antimony	140	140	NA
Iron	106,000	106,000	NA
Lead	800	800	NA
National Primary Drinking Water Regulations			
Dixon/furans[1]	NA	NA	0.00003

1 - Maximum Contaminant Level (MCL) from USEPA website:
http://www.epa.gov/safewater/mcl.html#sec. September 14, 2006.

µg/L - Micrograms per liter.
COC - Chemical of concern.
MCS - Media cleanup standard.
mg/kg - Milligrams per kilogram.
NA - Not an applicable medium for this COC.
USEPA - United States Environmental Protection Agency.

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CONTRACT NO. 4267

APPROVED BY ___ DATE ___

APPROVED BY ___ DATE ___

DRAWING NO. FIGURE 2-1

REV -

CONSTRUCTIBLE AND NON-CONSTRUCTIBLE AREAS
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

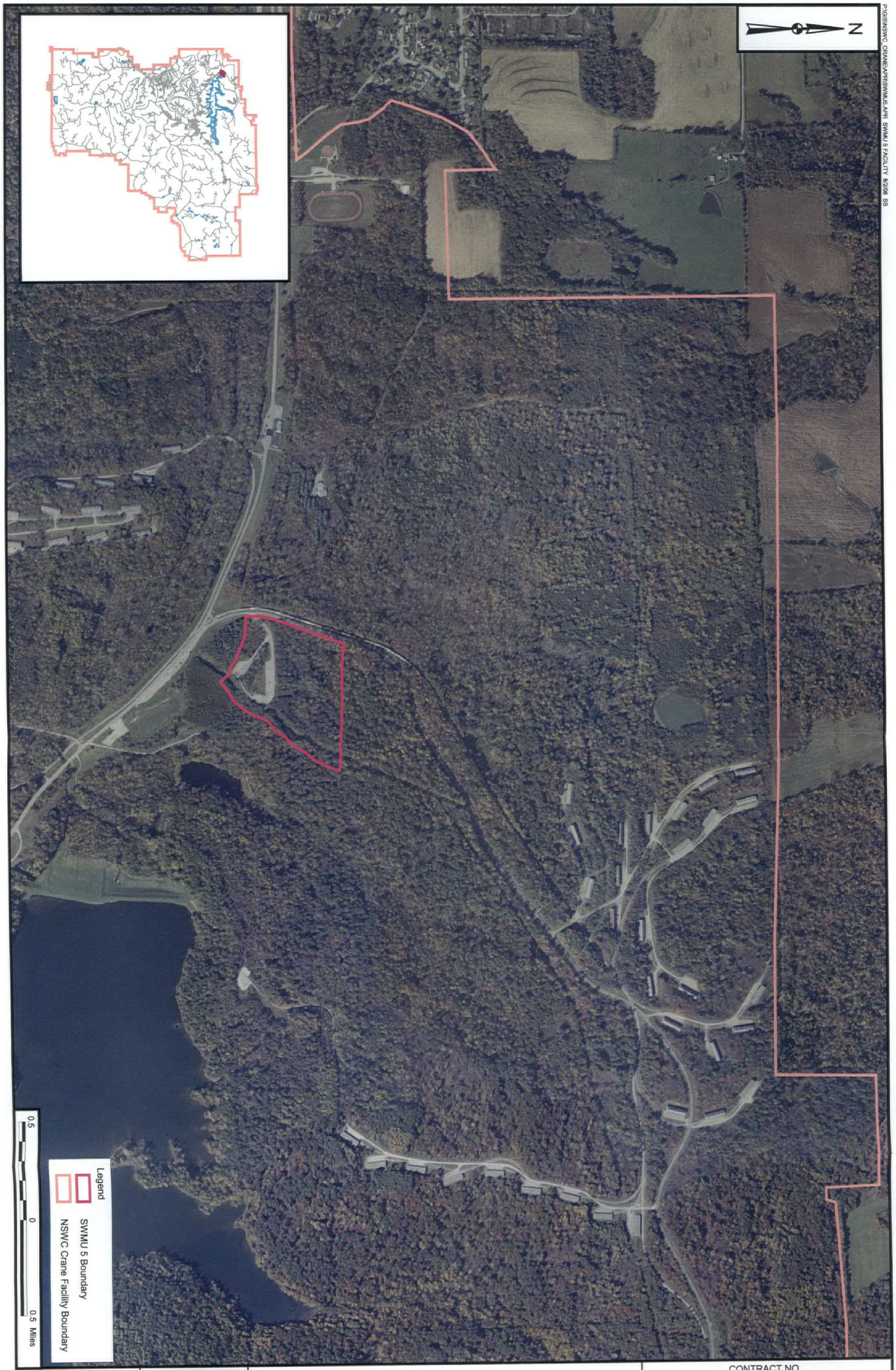
NAVFAC

DRAWN BY K. PEILA DATE 6/2/05

CHECKED BY V. PLACHY DATE 8/2/06

COST/SCHED-AREA

SCALE AS NOTED



P:\GIS\NSWC_CRANE\APRS\SWMU5.APR SWMU 5 FACILITY 8/2/06 SS

DRAWN BY K. PEILA	DATE 6/2/05	AERIAL PHOTOGRAPH (2003) SWMU 5 AND SURROUNDING AREAS CMP REPORT FOR SWMU 5 - OLD BURN PIT NSWC CRANE CRANE, INDIANA	CONTRACT NO. 4267
CHECKED BY V. PLACHY	DATE 8/2/06		APPROVED BY ___ DATE ___
COST/SCHED-AREA			APPROVED BY ___ DATE ___
SCALE AS NOTED	NAVFAC		DRAWING NO. FIGURE 2-2 REV –

3.0 DEVELOPMENT OF CORRECTIVE MEASURES RECOMMENDATIONS

Based on the current and future uses of SWMU 5 constructible and non-constructible areas that are described in Sections 1.0 and 2.0, the following CMs recommendations are made. Table 3-1 depicts the process used to arrive at these recommendations for SWMU 5.

As previously discussed, SWMU 5 is an inactive facility, and human receptors and pathways of exposure are limited to the existing land use scenario (military/industrial). A relatively flat area of SWMU 5 has a development potential (i.e., constructible area) (Figure 2-1). The constructible area future land use scenarios evaluated in this CMP are residential and construction worker. The use of the hilly/gully area of SWMU 5 (i.e., non-constructible area) will continue to be as an ecological habitat.

3.1 CORRECTIVE MEASURES

3.1.1 Soils

3.1.1.1 Constructible Area

No unacceptable soil risk has been identified for the constructible area of SWMU 5. Therefore, no CMs evaluation [e.g., no further action (NFA)] is required for soil contamination associated with the constructible area of SWMU 5.

3.1.1.2 Non-Constructible Area

The following two CMs will be considered for metals in soils in the non-constructible area:

- No Action, designated as Alternative S-1
- Limited Action, consisting of LUCs, and designated as Alternative S-2. The purpose of this alternative is to prevent human receptors exposure to soils.

3.1.2 Groundwater

It has been determined that the same CMs (No Action and Limited Action - LUCs) will be evaluated for groundwater in the constructible and non-constructible areas of SWMU 5. Two CMs to be considered for manganese in groundwater in the constructible and non-constructible areas are as follows:

- No Action, designated as Alternative GW-1.
- Limited Action, consisting of LUCs and designated as Alternative GW-2. The purpose of this alternative is to prevent use of groundwater.

TABLE 3-1

REMEDY EVALUATION PROCESS SUMMARY
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

INVESTIGATION PHASE				REMEDIAL ACTION EVALUATION PHASE		
Medium (Receptor)	**Document**	**Findings / Evaluations**	**Conclusion**	**Considerations**	**Evaluation Conclusions**	**Remedy**
Soils (Human Health):						
Metals (antimony and iron)	RFI Report – TtNUS	Excess risk from ingestion of antimony for future construction workers and future residents Excess risk from ingestion of iron for future child residents Excess risk from dermal contact with antimony and iron for future child residents	• Proceed to CMP • Further evaluate "hot spot" for removal based on risks for future construction workers • Excess risk from iron to future child residents based on the daily recommended allowances	• SWMU consists of constructible area and non-constructible area • Current and future land use of constructible area: military/industrial • Current and future land use of non-constructible area: ecological habitat • Conduct HHRA for current land use and current receptors	• No unacceptable risk from antimony, iron, and lead to future residents and construction workers was identified for the constructible area • Unacceptable risk from antimony, iron, and lead to future residents and construction workers was identified for the non-constructible area • NFA for antimony, iron, and lead is required for the constructible area • LUCs were the only remedial actions evaluated for the non-constructible area	• Constructible area: NFA • Non-constructible area recommended alternative: LUC to prevent exposure to soil
Groundwater: (Human Health):						
Dioxins/Furans	RFI Report – TtNUS	Elevated residential carcinogenic risk from ingestion of dioxins/furans in groundwater	Proceed to CMP	• Risks from dioxins/furans are based on hypothetical future residential use • Concentrations of dioxins/furans (as 2,3,7,8,-TCDD TEQs) in all samples were less than the MCL for 2,3,7,8,-TCDD (0.0003 µg/L) • Groundwater is not used under current and future (industrial) land uses	• NFA for dioxins/furans • Dioxin/furan concentrations in groundwater are less than the MCL • NFA and LUCs were the only remedial actions evaluated for manganese	• Recommended alternative: LUCs to prevent use of groundwater contaminated with manganese
Metals (manganese)		Elevated residential non-carcinogenic risk from ingestion of manganese in groundwater				
Soils (Ecological):						
Metals (antimony, barium, cadmium, chromium, copper, dioxins/furans, iron, lead, mercury, silver, tin, and zinc)	RFI Report – TtNUS	Unacceptable for terrestrial plans and invertebrates contacting soils (antimony, barium, cadmium, chromium, copper, iron, lead, silver, tin, and zinc)	Proceed to CMP	• Re-evaluate ecological risk in context of contiguous ecological system	• ERA conducted as part of CMP determined that there are no adverse ecological impacts when considering the contiguous ecological system	• NFA
Dioxins/Furans		Unacceptable for insectivorous/herbivorous mammals and birds through the food chain (dioxins/furans, cadmium, copper, lead, silver, and zinc)				

CMP - Corrective Measures Proposal.
ERA - Environmental Risk Assessment.
HHRA - Human Health Risk Assessment.
LUC - Land use control.
MCL - Maximum Contaminant Level.
NFA - No further action.
RCRA - Resource Conservation and Recovery Act.
RFI - RCRA Facility Investigation.
SWMU - Solid Waste Management Unit.
TCDD - Tetrachlorodibenzo-p-dioxin.
TEQ - Toxicity Equivalents.

RFI Report -TtNUS, 2005. Resource Conservation and Recovery Act Facility Investigation Report for SWMUs 4 (McComish Gorge), 5 (Old Burn Pit), 9 (Pesticide Control/R-150 Tank Area), and 10 (Rockeye), Naval Surface Warfare Center, Crane Division, Crane, Indiana, July.

4.0 CORRECTIVE MEASURES COMPARISON

This section evaluates the CMs presented in Section 3.0 and summarized in Table 3-1. Section 4.4 presents the conclusions from the CMP.

As previously discussed, the OBP is an inactive site contained entirely within NSWC Crane. NSWC Crane, including the OBP, is a military facility; therefore, only current OBP receptors (i.e., construction workers and trespassers) will be addressed in this CMP. LUCs will be implemented to ensure that the site remains military/industrial (e.g., no residential receptors).

The alternatives were evaluated using the following criteria set forth in the draft Statement of Work for a Corrective Measures Proposal developed by USEPA Region 5 (USEPA, 2005):

- Protection of human health and the environment
- Attainment of MCSs
- Control of release sources
- Compliance with applicable standards for waste management
- Other factors including:
  - Long-term reliability and effectiveness
  - Reduction in toxicity, mobility, or volume of wastes
  - Short-term effectiveness
  - Implementability
  - Cost

4.1 SOIL ALTERNATIVES

As previously discussed, there is no risk to current or future receptors associated with soils in the constructible area. Therefore, the soil alternatives will address the non-constructible area of SWMU 5.

4.1.1 Alternative S-1: No Action (Non-Constructible Area)

4.1.1.1 Protection of Human Health and the Environment

Alternative S-1 is considered primarily as a baseline for comparison to other CMs. This alternative would not be protective of human health because of lack of institutional controls. Alternative S-1 would not prevent exposure to metals (antimony, iron, and lead) contaminated soils that could result in

unacceptable human health risks in the non-constructible area. Alternative S-1 would not ensure that the land use remained military/industrial (i.e., would not prevent future use of the land for residential development), which could result in additional unacceptable human health risks.

4.1.1.2 Attainment of Media Cleanup Standards

Alternative S-1 would not attain the metals MCSs because it would leave soils in place in the area where unacceptable antimony, iron, and lead contamination results in risk to construction workers and the future residential receptors exists.

4.1.1.3 Source Control

Localized metals-contaminated soil has been identified in the non-constructible area (TtNUS, 2005). Alternative S-1 would not involve any source control measures.

4.1.1.4 Compliance with Waste Management Standards

There are no removal actions to be implemented for Alternative S-1 and therefore no waste would be generated.

4.1.1.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative S-1 would not be reliable and effective in the long term because no action would occur. The localized area of antimony, iron, and lead contamination would remain. The potential threat to human health would remain because there would be no controls to prevent future residential land use or construction activities in the non-constructible area, and there would be no monitoring to warn of potential contaminant migration.

Reduction in Toxicity, Mobility, and Volume

Alternative S-1 would not reduce contaminant toxicity, mobility, or volume.

Short-Term Effectiveness

Alternative S-1 would not involve any action and therefore would not pose any risks to on-site workers during remedy implementation, and no environmental impacts would be expected.

Implementability

Because no action would occur, Alternative S-1 would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Cost

There are no costs associated with No Action, Alternative S-1.

4.1.2 Alternative S-2: Limited Action - Land Use Control (Non-Constructible Area)

4.1.2.1 Protection of Human Health and the Environment

Alternative S-2 would be protective of human health and the environment. LUCs would protect human health by preventing exposure to contaminated soils in the non-constructible area as long as antimony, iron, and lead concentrations remain unacceptable.

4.1.2.2 Attainment of Media Cleanup Standards

Alternative S-2 would not attain the antimony, iron, or lead MCSs; however, LUCs would protect human health by preventing exposure of future residents and construction workers to metals-contaminated soils in the non-constructible area as long as concentrations of these metals remain unacceptable.

4.1.2.3 Source Control

Alternative S-2 does not provide for source control. Although localized metals-contaminated soil has been identified (TtNUS, 2005), the contaminated soil hot spot is located in the non-constructible area. It is anticipated that any remedial efforts in the non-construction area would adversely impact the ecological habitat, which currently does not show obvious adverse impacts from the contamination. Therefore, source control has not been considered as part of this CMP.

4.1.2.4 Compliance with Waste Management Standards

Alternative S-2 would not involve any removal of contaminated soils; therefore, residues would not be generated.

4.1.2.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative S-2 would be reliable and effective in the long term for protection of human health from antimony, iron, and lead contamination. LUCs would reliably and effectively prevent potential current and future exposure to metals-contaminated soils and ensure that land use remains military/industrial.

Reduction in Toxicity, Mobility, and Volume

Alternative S-2 would not reduce contaminant toxicity, mobility, or volume.

Short-Term Effectiveness

Alternative S-2 would involve administration of LUCs. Implementation of this alternative would not result in any short-term threat to the surrounding community or to ecological receptors.

Implementability

Alternative S-2 would be readily implementable. LUCs would be readily implementable because SWMU 5 is completely contained within NSWC Crane, and LUCs would be similar to those implemented at other environmental sites within NSWC Crane.

Alternative S-2 could be implemented within approximately 12 months.

Cost

The following costs are estimated for Alternative S-2: Limited Action - LUCs:

Capital Cost:	$ 3,000
30-Year Net Present Worth (NPW) of Operation and Maintenance (O&M) Costs:	$ 40,000
30-Year NPW:	$ 43,000

The above cost figures have been rounded to the nearest $1,000 to reflect the preliminary nature of these estimates. Detailed cost estimates are provided in Appendix A-1.

4.2 GROUNDWATER ALTERNATIVES

4.2.1 Alternative GW-1: No Action

4.2.1.1 Protection of Human Health and the Environment

Alternative GW-1 is considered primarily as a baseline for comparison to other CMs. This alternative would not be protective of human health because of lack of monitoring and institutional controls. Although there are no current users of groundwater at SWMU 5 and thus no unacceptable risks to human receptors, Alternative GW-1 would not prevent future use of the aquifer as a drinking water source, which could result in unacceptable human health risks.

Although there is no current evidence that migration of groundwater contaminants to surrounding surface water has resulted in unacceptable human health or ecological risks, continued migration of the manganese plume could potentially lead to such unacceptable risks and, in the absence of long-term monitoring (LTM), there would be no warning of this.

4.2.1.2 Attainment of Media Cleanup Standards

Alternative GW-1 would not attain the MCSs.

4.2.1.3 Source Control

Alternative GW-1 would not involve any source control because no action would be performed as part of this alternative and no sources of manganese contamination have been identified.

4.2.1.4 Compliance with Waste Management Standards

There are no actions to be implemented for Alternative GW-1 and therefore no waste would be generated.

4.2.1.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative GW-1 would not be reliable and effective in the long term because no action would occur. The potential threat to human health and the environment would remain because there would be no controls to prevent future groundwater use and no monitoring to warn of potential contaminant migration.

Reduction in Toxicity, Mobility, and Volume

Alternative GW-1 would not reduce contaminant toxicity, mobility, or volume.

Short-Term Effectiveness

Alternative GW-1 would involve no action and therefore would not pose any risks to on-site workers during remedy implementation, and no environmental impacts would be expected.

Implementability

Because no action would occur, Alternative GW-1 would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Cost

There are no costs associated with the No Action, Alternative GW-1.

4.2.2 Alternative GW-2: Limited Action - Land Use Controls

4.2.2.1 Protection of Human Health and the Environment

Alternative GW-2 would be protective of human health and the environment. LUCs would protect human health by preventing exposure to manganese-contaminated groundwater.

4.2.2.2 Attainment of MCSs

Alternative GW-2 would not attain the manganese MCSs but would prevent exposure to contaminated groundwater.

4.2.2.3 Source Control

Alternative GW-2 would not involve any source control because no sources of manganese contamination have been identified.

4.2.2.4 Compliance with Waste Management Standards

Alternative GW-2 would not involve any removal or ex-situ treatment of contaminated groundwater; therefore, no residues would be generated.

4.2.2.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative GW-2 would be reliable and effective in the long term because LUCs would prevent potential future exposure to contaminated groundwater.

Reduction in Toxicity, Mobility, and Volume

Alternative GW-2 would not reduce contaminant toxicity, mobility, or volume.

Short-Term Effectiveness

Alternative GW-2 would involve administration of LUCs. The short-term human health risks associated with these limited remedial activities would be minimal. Implementation of this alternative would not result in any short-term threat to the surrounding community or to ecological receptors.

Implementability

Alternative GW-2 would be readily implementable. LUCs would be readily implementable because SWMU 5 is completely contained within NSWC Crane, and they would be similar to those implemented at other environmental sites within NSWC Crane.

Alternative GW-2 could be implemented within approximately 12 months.

Cost

The following costs are estimated for Alternative GW-2: Limited Action - LUCs:

Capital Cost:	$ 3,000
30-Year NPW of O&M Costs:	$ 40,000
30-Year NPW:	$ 43,000

The above cost figures have been rounded to the nearest $1,000 to reflect the preliminary nature of these estimates. Detailed cost estimates are provided in Appendix A-2.

4.3 SWMU 5 CMP CONCLUSIONS

The following sections summarize conclusions of the CMP for SWMU 5. These conclusions are based on existing and planned future uses for the constructible and non-constructible areas of SWMU 5 (military/industrial).

4.3.1 Groundwater

The following conclusions are made for SWMU 5 groundwater:

- Screening and detailed evaluations of alternatives to address excess risk from ingestion of groundwater by site workers, construction workers, and trespassers at SWMU 5 are not necessary because none of the current receptors are exposed to groundwater, and all future exposure to groundwater can be prevented by implementing LUCs.

- Alternative GW-2: Limited Action - LUCs is the recommended alternative for manganese in groundwater. LUCs should be evaluated to assure that no withdraw of or contact with groundwater occurs, that the constructible and non-constructible areas are maintained, and that no changes occur in current military/industrial use of SWMU 5.

4.3.2 Soils

The following conclusions are made for SWMU 5 soils:

- Most of the contaminated soil and miscellaneous debris (e.g., old waste drums, metal shavings) within the non-constructible area cannot be removed without disturbing the existing habitat (e.g., cutting trees and shrubs). It is anticipated that any remedial efforts in the non-constructible area would adversely impact the ecological habitat, which currently does not show obvious adverse impacts from the contamination.

- Screening and detailed evaluations of alternatives to address excess risk from exposure to metals-contaminated soils for site workers, construction workers, and trespassers at SWMU 5 are not necessary because all exposure to soils can be prevented by LUCs.

- Alternative S-2: Limited Action - LUCs is the recommended alternative for metals in soils. LUCs should be evaluated to assure that the constructible area is available for military/industrial activities and non-constructible area is maintained as an ecological habitat only (i.e., no changes occur in current military/industrial and ecological uses at SWMU 5).

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APPENDIX A

ALTERNATIVE COST ESTIMATES

APPENDIX A-1

COST ESTIMATE

ALTERNATIVE S-2: LIMITED ACTION – LAND USE CONTROLS

NAVAL SURFACE WARFARE CENTER CRANE
Crane, Indiana
SWMU 5
Alternative S-2: Limited Action - Land Use Controls
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Material	Labor	Equipment	Labor	Subtotal
1 PROJECT PLANNING & INSTITUTION CONTROLS								
1.1 Prepare Site - Specific LUC	40	hr			$35.00		$1,400	$1,400
Subtotal							$1,400	$1,400
Local Area Adjustments							82.9%	
							$1,161	$1,161
Overhead on Labor Cost @ 30%							$348	$348
G & A on Labor Cost @ 10%							$116	$116
G & A on Material Cost @ 10%								$0
G & A on Subcontract Cost @ 10%								$0
Total Direct Cost							$1,625	$1,625
Indirects on Total Direct Cost @ 35%								$569
Profit on Total Direct Cost @ 10%								$162
Subtotal								$2,356
Health & Safety Monitoring @ 1%								$24
Total Field Cost								$2,380
Contingency on Total Field Costs @ 0%								$0
Engineering on Total Field Cost @ 10%								$238
TOTAL CAPITAL COST								**$2,618**

NAVAL S[illegible]ACE WARFARE CENTER CRANE
Crane, Indiana
SWMU 5
Alternative S-2: Limited Action - Land Use Controls
Operation and Maintenance Cost

	Item	Quantity	Unit	Unit Cost	Subtotal	Notes
1	System Maintenance		ls	$0	$131	5% of Installation Cost; replacement signs, etc.
2	Annual Report	1	ea	$1,000	$1,000	
				O & M per year	**$1,131**	

NAVAL SURFACE WARFARE CENTER CRANE
Crane, Indiana
SWMU 5
Alternative S-2: Limited Action - Land Use Controls
Annual Cost

Item	Item Cost Year 1	Item Cost Years 2 - 3	Item Cost Years 4 - 30	Item Cost Every 5 Years Through 30 Years	Notes
Annual Report	$1,000	$2,000	$1,000		Document sampling events and results, $1,000 per report.
Site Inspection	$500	$500	$500		To verify continued implementation of the LUC
Site Review				$1,000	Site review every 5 years for 30 years.
TOTALS	**$1,500**	**$2,500**	**$1,500**	**$1,000**	

NAVAL SURFACE WARFARE CENTER CRANE
Crane, Indiana
SWMU 5
Alternative S-2: Limited Action - Land Use Controls
Present Worth Analysis

Year	Capital Cost	Operation & Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$2,618			$2,618	1.000	$2,618
1		$1,131	$1,500	$2,631	0.935	$2,460
2		$1,131	$2,500	$3,631	0.873	$3,170
3		$1,131	$2,500	$3,631	0.816	$2,963
4		$1,131	$1,500	$2,631	0.763	$2,007
5		$1,131	$2,500	$3,631	0.713	$2,589
6		$1,131	$1,500	$2,631	0.666	$1,752
7		$1,131	$1,500	$2,631	0.623	$1,639
8		$1,131	$1,500	$2,631	0.582	$1,531
9		$1,131	$1,500	$2,631	0.544	$1,431
10		$1,131	$2,500	$3,631	0.508	$1,844
11		$1,131	$1,500	$2,631	0.475	$1,250
12		$1,131	$1,500	$2,631	0.444	$1,168
13		$1,131	$1,500	$2,631	0.415	$1,092
14		$1,131	$1,500	$2,631	0.388	$1,021
15		$1,131	$2,500	$3,631	0.362	$1,314
16		$1,131	$1,500	$2,631	0.339	$ 892
17		$1,131	$1,500	$2,631	0.317	$ 834
18		$1,131	$1,500	$2,631	0.296	$ 779
19		$1,131	$1,500	$2,631	0.277	$ 729
20		$1,131	$2,500	$3,631	0.258	$ 937
21		$1,131	$1,500	$2,631	0.242	$ 637
22		$1,131	$1,500	$2,631	0.226	$ 595
23		$1,131	$1,500	$2,631	0.211	$ 555
24		$1,131	$1,500	$2,631	0.197	$ 518
25		$1,131	$2,500	$3,631	0.184	$ 668
26		$1,131	$1,500	$2,631	0.172	$ 453
27		$1,131	$1,500	$2,631	0.161	$ 424
28		$1,131	$1,500	$2,631	0.150	$ 395
29		$1,131	$1,500	$2,631	0.141	$ 371
30		$1,131	$2,500	$3,631	0.131	$ 476
					TOTAL PRESENT WORTH	**$39,109**

APPENDIX A-2

COST ESTIMATE

ALTERNATIVE GW-2: LIMITED ACTION – LAND USE CONTROLS

NAVAL SURFACE WARFARE CENTER CRANE
Crane, Indiana
SWMU 5
Alternative GW-2-Exp: Limited Action - Land Use Controls
Capital Cost

Item	Quantity	Unit	Subcontract	Unit Cost Material	Labor	Equipment	Labor	Subtotal
1 PROJECT PLANNING & INSTITUTION CONTROLS								
1.1 Prepare Site - Specific LUC	40	hr			$35.00		$1,400	$1,400
Subtotal							$1,400	$1,400
Local Area Adjustments							82.9%	
							$1,161	$1,161
Overhead on Labor Cost @ 30%							$348	$348
G & A on Labor Cost @ 10%							$116	$116
G & A on Material Cost @ 10%								$0
G & A on Subcontract Cost @ 10%								$0
Total Direct Cost							$1,625	$1,625
Indirects on Total Direct Cost @ 35%								$569
Profit on Total Direct Cost @ 10%								$162
Subtotal								$2,356
Health & Safety Monitoring @ 1%								$24
Total Field Cost								$2,380
Contingency on Total Field Costs @ 0%								$0
Engineering on Total Field Cost @ 10%								$238
TOTAL CAPITAL COST								**$2,618**

	Item	Quantity	Unit	Unit Cost	Subtotal	Notes
1	Sys[illegible]aintenance		[illegible]s	$0	$131	5% of Installation Cost; replacement [illegible]s, etc.
2	Annual Report	1	ea	$1,000	$1,000	
				O & M per year	**$1,131**	

NAVAL SURFACE WARFARE CENTER CRANE
Crane, Indiana
SWMU 5
Alternative GW-2-Exp: Limited Action - Land Use Controls
Present Worth Analysis

Year	Capital Cost	Operation & Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$2,618			$2,618	1.000	$2,618
1		$1,131	$2,000	$3,131	0.935	$2,927
2		$1,131	$3,000	$4,131	0.873	$3,606
3		$1,131	$3,000	$4,131	0.816	$3,371
4		$1,131	$2,000	$3,131	0.763	$2,389
5		$1,131	$2,000	$3,131	0.713	$2,232
6		$1,131	$2,000	$3,131	0.666	$2,085
7		$1,131	$2,000	$3,131	0.623	$1,951
8		$1,131	$2,000	$3,131	0.582	$1,822
9		$1,131	$2,000	$3,131	0.544	$1,703
10		$1,131	$2,000	$3,131	0.508	$1,590
11		$1,131	$2,000	$3,131	0.475	$1,487
12		$1,131	$2,000	$3,131	0.444	$1,390
13		$1,131	$2,000	$3,131	0.415	$1,299
14		$1,131	$2,000	$3,131	0.388	$1,215
15		$1,131	$2,000	$3,131	0.362	$1,133
16		$1,131	$2,000	$3,131	0.339	$1,061
17		$1,131	$2,000	$3,131	0.317	$ 992
18		$1,131	$2,000	$3,131	0.296	$ 927
19		$1,131	$2,000	$3,131	0.277	$ 867
20		$1,131	$2,000	$3,131	0.258	$ 808
21		$1,131	$2,000	$3,131	0.242	$ 758
22		$1,131	$2,000	$3,131	0.226	$ 708
23		$1,131	$2,000	$3,131	0.211	$ 661
24		$1,131	$2,000	$3,131	0.197	$ 617
25		$1,131	$2,000	$3,131	0.184	$ 576
26		$1,131	$2,000	$3,131	0.172	$ 539
27		$1,131	$2,000	$3,131	0.161	$ 504
28		$1,131	$2,000	$3,131	0.150	$ 470
29		$1,131	$2,000	$3,131	0.141	$ 441
30		$1,131	$2,000	$3,131	0.131	$ 410
					TOTAL PRESENT WORTH	**$43,158**