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SITE INSPECTION REPORT FOR MUNITIONS RESPONSE PROGRAM RANGES VOLUME I OF II NSTC GREAT LAKES IL

9/1/2010

TETRA TECH

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Site Inspection Report (Volume I of II)

for

Munitions Response Program Ranges

Naval Station Great Lakes
Great Lakes, Illinois

Naval Facilities Engineering Command Midwest

Contract Number N62472-03-D-0057

Contract Task Order F274

September 2010

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SITE INSPECTION REPORT

MUNITION RESPONSE PROGRAM RANGES

NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Naval Facilities Engineering Command Midwest
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LIST OF ACRONYMS AND ABBREVIATIONS

AA	Anti-Aircraft
bgs	Below Ground Surface
BL&P	Blind Loaded and Plugged
bss	Below Sediment Surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
CSM	Conceptual Site Model
CTO	Contract Task Order
°	Degree
%D	Percent Difference or Percent Drift
DERP	Defense Environmental Restoration Program
DI	Dark Ignition
DMM	Discarded Military Munitions
DoD	Department of Defense
DPT	Direct Push Technology
DQI	Data Quality Indicator
DQO	Data Quality Objective
ECO SSL	Ecological Soil Screening Level
ELAP	Environmental Laboratory Accreditation Program
EPA	Environmental Protection Agency
EPC	Exposure Point Concentration
ESS	Explosive Safety Submission
ER-L	Effects-Range Low
ER-M	Effects-Range Median
F	Fahrenheit
FBL	Fixed Base Laboratory
FD	Field Duplicate
FOL	Field Operations Leader
FS	Feasibility Study
FY	Fiscal Year

GC/MS	Gas Chromatograph/Mass Spectrometer
GIS	Geographic Information System
GPS	Global Positioning System
HASP	Health and Safety Plan
HE	High Explosive
HEI	High Explosive Incendiary
HEIT-SD	High Explosive Incendiary Tracer – Self Destruct
HET	High Explosive Tracer
HET-SD	High Explosive Tracer – Self Destruct
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HSM	Health and Safety Manager
IDW	Investigation-Derived Waste
INRMP	Integrated Natural Resources Management Plan
IS	Internal Standard
ITRC	Interstate Technology and Regulatory Council
LANT	Mid-Atlantic
LC	Liquid Chromatography
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management Systems
LOEC	Lowest Observed Effects Concentration
MBE	Multibeam Echosounder
MC	Munitions Constituants
MDL	Method Detection Limit
MEC	Munitions and Explosives of Concern
mg/kg	Milligrams/Kilogram
mm	Millimeter
MPC	Measurement Performance Criteria
MPPEH	Material Potentially Presenting Explosive Hazard
MRP	Munitions Response Program
MRS	Munitions Response Site
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NA	Not Applicable
NAD83	North American Datum of 1983
NAVFAC	Naval Facilities Engineering Command

NAVSTA	Naval Station
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	No Further Action
NG	Nitroglycerin
NIST	National Institute of Standards and Technology
NOEC	No Observed Effects Concentration
NOSSA	Naval Ordnance Safety and Security Activity
NSGL	Naval Station Great Lakes
NTC	Navy Training Center
OSHA	Occupational Safety and Health Administration
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PAL	Project Action Limit
PEC	Probable Effects Concentration
PETN	Pentaerythritol Tetranitrate
PID	Photoionization Detector
PM	Project Manager
POC	Point of Contact
PPE	Personal Protective Equipment
ppm	Parts Per Million
PQLG	Project Quantitation Limit Goals
QA	Quality Assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QL	Quantitation Limit
QSM	Quality Systems Manual
RBSL	Risk-Based Screening Level
RCRA	Resource Conservation and Recovery Act
%R	Percent Recovery
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RF	Response Factor
RI	Remedial Investigation
RPD	Relative Percent Difference
RSD	Relative Standard Deviation

R-RSL	Residential – Regional Screening Level
RTK	Real Time Kinematic
RV	Recreational Vehicle
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SDG	Sample Delivery Group
SDZ	Safety Danger Zone
SI	Site Inspection
SIM	Selected Ion Monitoring
SOP	Standard Operating Procedure
SSC	Service School Command
SSL	Soil Screening Level
TACO	Tiered Approach to Corrective Action Objectives
TBD	To Be Determined
TCLP	Toxicity Characteristic Leaching Procedure
TEC	Threshold Effects Concentration
TEF	Toxicity Equivalency Factor
Tetra Tech	Tetra Tech NUS, Inc.
Tetryl	N-methyl-N-2,4,6-tetranitroaniline
TNT	Trinitrotoluene
TSA	Trap, Skeet, and Archery
UCL	Upper Confidence Limit
UFP	Uniform Federal Policy
USBL	Ultra Short Acoustic Baseline Positioning System
USEPA	United States Environmental Protection Agency
U.S.C	United States Code
UV	Ultraviolet
UXO	Unexploded Ordnance
WAMS	Water Area Munitions Study
WWII	World War II
XRF	X-ray Fluorescence Spectrometer

EXECUTIVE SUMMARY

Tetra Tech NUS, Inc. (Tetra Tech) has prepared this Site Inspection (SI) Report under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-03-D-0057, Contract Task Order (CTO) F274. This report has been prepared for a SI for Munitions Constituents (MC) under the Munitions Response Program (MRP) at four Munitions Response Sites (MRSs) located at Naval Station Great Lakes (NSGL), Great Lakes, Illinois. The MRP sites included in the scope of this SI are the former Trap, Skeet, and Archery (TSA) Ranges; the former Pistol Butts; the former Machine Gun Range; and the former Naval Training Center (NTC) Lakefront anti-aircraft (AA) Range (NTC Lakefront). Figure ES-1 presents a Site Location Map depicting the location of the four MRSs on the NSGL installation. The MRSs are described briefly below.

The U.S. Department of Navy (Navy) has conducted various testing and training activities involving military munitions at the MRSs. Because of these activities, Munitions Constituents (MC) and Munitions and Explosives of Concern (MEC)/material potentially presenting an explosive hazard (MPPEH) may be present at one or more of these locations. The term MC includes constituents associated with munitions such as metals and nitroglycerin (NG). The term MEC includes Discarded Military Munitions (DMM), Unexploded Ordnance (UXO), and MC in high enough concentrations to pose an explosive hazard. The Department of Defense (DoD) has established the MRP to address MC and MEC environmental concerns at closed ranges. The DoD is following the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) process for the investigation and remediation of these sites. The Navy is responsible for implementing the MRP at NSGL.

The four MRP SIs at NSGL were inspected to determine the nature of the potential hazards associated with MC and/or MEC linked to past on-site training activities. This SI Report documents the results of field activities and the current conceptual site models (CSMs) for each area of concern. Table ES-1 and ES-2 summarize the results of the MC and MEC SI investigations, respectively. This collected data was used to approximate site boundaries, collect broad site information, and assess the potential hazards posed by any MC and/or MEC/MPPEH remaining at a site in order to support the final site recommendations. The SI augmented the data collected in the Preliminary Assessment (PA) Reports and Water Area Munitions Study (WAMS) investigation phases prepared by Malcolm Pirnie in 2005 and 2008, respectively; and generated field data to determine if further response action or remedial investigation (RI) is appropriate. However, this MC SI investigation was not intended as a full-scale study of the nature and extent of MC or MEC/MPPEH hazards, but was intended to confirm the absence of significant MC and/or MEC/MPPEH.

The investigation samples were analyzed for MC potentially associated with historical training activities at each site using a combination of on-site field analyses for lead and off-site fixed-base laboratory (FBL) analyses for lead (to confirm the on-site lead results) and other constituents.

TSA Ranges

The former TSA Ranges site encompasses approximately 30.5 acres, including the land and water portions. The land portion consists of approximately 1.1 acres of Lake Michigan beachfront, which included the former firing arcs for the skeet and trap ranges and all associated structures. Fill material was added to the beachfront to extend the shoreline for the addition of the skeet range. The water portion of the TSA Ranges, where munitions were fired, includes the maximum extent of shotfall, which is approximately 29.4 acres. Munitions use was limited to small arms ammunition, primarily shotgun ammunition. The land and water portions are not suspected to contain MEC; therefore, no MEC investigation is planned for the TSA Range. The land portion has been redeveloped as a recreational vehicle (RV) park, leaving no evidence of the TSA Ranges. There are no records of previous sampling events. This SI focused on both the land and water portions of the TSA Ranges. For the land portion, surface soil samples were collected and analyzed on-site for lead using X-ray fluorescence (XRF) and off-site for polynulcear aromatic hydrocarbons (PAHs) and select metals (antimony, arsenic, and lead). For the water portion, sediment samples were collected and analyzed off-site for PAHs and select metals (antimony, arsenic, and lead). Figure ES-2 depicts the TSA Ranges and associated range features.

Pistol Butts

The former Pistol Butts site is located in a flat area of the NSGL Outer Harbor shoreline, south of the installation's former wastewater (sewage) treatment plant, and is approximately 4 acres in size. The site boundary on the west is an approximately 50-foot high bluff, and on the east is Lake Michigan. Currently, the northern end of a concrete retention pond and paved roadway southwest of the landing craft storage building (see Figure ES-3) cover the site. There is no evidence of the Pistol Butts remaining on the surface of NSGL. There are very limited records available on the history of this site, which only appears on one 1909 archival map provided in Appendix A of the UFP-SAP (Tetra Tech, 2010). The 1909 archival map indicates that the firing line was located immediately west of a former seawall that is located at the edge of Lake Michigan. Individual firing lines were not noted on the map; however, the firing lane lengths were estimated at approximately 40 yards. The former firing points and range floor are currently covered by a concrete retention pond, vegetation (grass strip), and a roadway. The location of the former pistol range bullet stop/butt (the natural bluff to the west of the site) appears to have been buried during

redevelopment. Therefore, subsurface soil sampling was conducted at the suspected bullet impact (former Pistol Butts) area to depths below the fill thickness. Because it is believed that only small arms training occurred at this site, MEC would not be expected to be present at a pistol range. Therefore, no MEC investigation occurred at the former Pistol Butts site. The SI focused on the buried bullet stop/butt area where subsurface soil samples were collected and analyzed on-site for lead using XRF and off-site at the FBL for select metals (antimony, arsenic, and lead).

Machine Gun Range

The former Machine Gun Range site is located immediately south of Building 13 (the Boat House) and the manmade boat channel entering in the harbor in the southern portion of the installation. The range was used for the training of naval personnel on small arms of .50-caliber or less. Based on the 1905, 1915, and 1918 archival maps, it appears that targets were located on the inner breakwater of the harbor and were fired upon from a 200- and 300-yard firing line on land; therefore, this range contains land-based firing locations and an impact area in Lake Michigan. A paved roadway and an area for landing craft storage now cover the majority of the site. The SI focused on the land portion of the site where surface soil samples were collected and analyzed off-site at the FBL for select metals (antimony, arsenic, and lead) and select propellants (nitroglycerine (NG). Additionally, the SI focused on the water portion or target area immediately in front of the breakwater where sediment samples were collected and analyzed off-site at the FBL for select metals (antimony, arsenic, and lead). Figure ES-4 depicts the Machine Gun Range site features. Because only small arms were used at this site, MEC would not be expected to be present at the Machine Gun Range. Therefore, no MEC investigation was conducted for this site.

NTC Lakefront

The former NTC Lakefront Site was a 3,728 acre AA range and target training area located on the eastern edge of the NSGL (3.3-acre portion of beachfront along Lake Michigan and the remaining 3,725 acres extending east over Lake Michigan). Potential MC issues are associated with the use of AA ammunition are tracers [20-millimeter (mm) high explosive (HE), high explosive incendiary (HEI), high explosive tracers (HET), and HET-dark ignition (DI) rounds, 40-mm blind loaded and plugged (BL&P), high explosive tracer – self destruct (HET-SD), and high explosive incendiary tracer – self destruct (HEIT-SD) rounds, 1.1-inch AA artillery, 3-inch 0.50-caliber artillery, and DI tracers]. The AA gun mounts were located on fill material along the shoreline and aimed at targets towed by plane with cables over Lake Michigan. Approximately 1,350 sailors per day were instructed on the 20- and 40-mm guns during AA training exercises and several million rounds were fired into Lake Michigan during the existence of the range. The NTC Lakefront Preliminary Assessment (PA) Report indicated that only AA ammunition was

used at the range. The expected dud rates of the types of AA ammunition used was five percent resulting in several hundred thousand rounds containing explosives, which may be present in Lake Michigan sediment.

The land portion of the site is currently paved and is bordered by an RV park, is used for the storage of fuel oil for the facility's power plant, and is not suspected for the presence of MC or MEC. Due to the paved roadway covering the location of the former gun mounts and high rates of erosion and deposition immediately in front of the gun mounts, MC sampling did not occur at the former firing line. However, the water portion of the site has a potential that MEC and associated MC is present within the sediment in Lake Michigan. The MC SI focused on the lake sediment in close proximity to potential MEC/MPPEH identified during the MEC SI, which focused on a nonintrusive geophysical investigation discussed in Volume II of the SI Report.

The performance of a multi-beam echosounder (MBE) survey to determine the bathymetry of the lake bottom and a marine gradiometer array (MGA) survey to identify magnetic anomalies, which may represent MEC/MPPEH, was conducted prior to the MC SI. These surveys identified bands of magnetic material located in the Lake Michigan sediment, which were used to identify MC sampling locations throughout the surface danger zone (SDZ).

The MC SI focused on the water portion of NTC Lakefront where sediment samples were collected and analyzed off-site for select explosives [octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), trinitrotoluene (TNT), N-methyl-N,2,4,6-tetranitroaniline (tetryl), and pentaerythriotol tetranitrate (PETN)] and select metals (antimony, arsenic, copper, iron, lead, magnesium, strontium, and zinc). Figure ES-5 depicts the NTC Lakefront site features.

CONCLUSIONS AND RECOMMENDATIONS

This section presents a summary of the results of the SI and recommendations for further actions. Table ES-1 presents a summary of the MC SI Investigation, and Table ES-2 presents a summary of the MEC SI Investigation.

CONCLUSIONS - TSA RANGES

- The environmental data collected during the SI sampling activities are sufficient to determine the presence or absence of MC associated with the former use of the ranges in the soil and sediment.

- The focused SI sampling activities for the TSA Ranges characterized the local site conditions in surface soils [0 to 0.5 feet below ground surface (bgs)] and sediment [0 to 0.5 feet below sediment surface (bss)].

- The SI identified concentrations of MC associated with small arms ammunition in surface soil and sediment.

- The SI identified MCs (lead and PAHs) at concentrations above project action limits (PALs) and their Illinois EPA background concentrations in a limited surface soil area collected from the TSA Ranges.

- The SI identified MCs (antimony and lead) at concentrations above ecological PALs and their Illinois EPA background concentrations in the sediment samples in a limited area collected from the TSA Ranges.

RECOMMENDATIONS - TSA RANGES

Soil

- Further actions are required at the site based on the SI identification of lead and PAH concentrations greater than respective PALs and the Illinois EPA background soil concentrations in surface soil within the project site at a limited area in the TSA Ranges.

Sediment

- Further action is recommended for sediment because sediment concentrations for lead and antimony exceed their respective ecological PALs for aquatic biota. However, the potentially impacted area associate with the sediment near the shore within the TSA Ranges is relatively small and impact from the lead and antimony concentrations appear to be insignificant. Further evaluation of ecological risks is warranted and recommended.

CONCLUSIONS – PISTOL BUTTS

- The environmental data collected during the SI sampling activities are sufficient to determine the presence, or absence, of MC associated with the former use of the range in the subsurface soils.

- All laboratory lead detections were less than the Human Health PAL (400 mg/kg).

- Antimony was not detected above the laboratory detection limit in any of the samples for the Pistol Butts site.

- The soil samples submitted for laboratory analyses exhibited concentrations of arsenic exceeding the Human Health PAL (0.39 mg/kg) but were below the Illinois EPA Tiered Approach to Corrective Action Objectives (TACO) soil background concentrations (13 mg/kg). Therefore, it has been determined that the concentrations of arsenic detected in the soil samples collected from the Pistol Butts site are not indicative of MC associated with the historical range activities conducted at the site.

RECOMMENDATIONS – PISTOL BUTTS

- NFA at the Pistol Butts site is recommended based on the SI sampling results.

CONCLUSIONS – MACHINE GUN RANGE

- The environmental data collected during the SI sampling activities are sufficient to determine the presence or absence of MC associated with the former use of the ranges in the soil and sediment.

- The focused SI sampling activities characterized the local site conditions and identified concentrations of MC associated with small arms ammunition in surface soil and sediment.

- MCs (arsenic and lead) were identified at concentrations above their respective PALs in the surface soil of the Machine Gun Range.

- None of the soil samples submitted for laboratory analyses exhibited lead concentrations exceeding the Human Health PAL (400 mg/kg), but there were exceedances of the ecological PAL (11 mg/kg).

- All of the arsenic soil samples submitted for FBL analyses exhibited arsenic concentrations exceeding the Human Health PAL (0.39 mg/kg)

- No lead sample concentration exceeded the TACO construction worker ingestion criteria (61 mg/kg).

- No arsenic sample concentration exceeded of the ecological PAL (18 mg/kg) or concentrations above the Illinois EPA soil background concentration (13 mg/kg).

- None of the soil samples exhibited concentrations above the respective PALs for antimony and NG.

- Ten sediment samples were collected from 10 discrete locations at depths of 0 to 0.5 feet bss within Lake Michigan.

- All 10 of the sediment samples submitted for FBL analyses exhibited lead concentrations exceeding the ecological PAL (35.8 mg/kg).

- Two of the sediment samples submitted for laboratory analyses exhibited arsenic concentrations exceeding the ecological PAL (9.79 mg/kg).

- Both lead and arsenic concentrations were statistically above site-specific upgradient/background sediment concentrations.

- None of the sediment samples had detected concentrations above the antimony Human Health PAL (0.39 mg/kg).

RECOMMENDATIONS – MACHINE GUN RANGE

Soil

- Further action is recommended for soil because concentrations for lead and arsenic exceed their respective ecological PALs for terrestrial biota. However, the potentially impacted area is relatively small, and impact to terrestrial ecological receptors appears to be insignificant. Further evaluation of ecological risk is warranted and recommended.

Sediment

- Further action is recommended for sediment because concentrations of lead and arsenic exceed their respective ecological PALs for aquatic biota. However, the potentially impacted area is relatively small and impact to aquatic biota appears to be insignificant. Further evaluation of ecological risk is warranted and recommended.

CONCLUSIONS – NTC LAKEFRONT

- Arsenic was the only metal that exhibited concentrations in excess of its ecological PAL in the sediment samples collected from NTC Lakefront.

- The levels of arsenic detected within the SDZ of the site were statistically below the arsenic concentrations detected in the upgradient (background) site-specific sediment samples.

- The arsenic observed within NTC Lakefront can be attributable to naturally occurring arsenic concentrations found within the lake.

- Explosive constituents (HMX and RDX) were detected in the sediment samples above the ecological screening criteria within NTC Lakefront. However, these detections were determined to be non-significant.

- No surface MEC was identified during the SI.

- Numerous anomalies, potentially MEC/MPPEH, were detected during the performance of the magnetic marine survey

RECOMMENDATIONS – NTC LAKEFRONT

Based on the results of the SI, further action is recommended for explosives and NFA is recommended for select metals for NTC Lakefront.

Further action will be necessary to ascertain whether magnetic anomalies identified during the underwater geophysical survey are MEC/MPPEH as part of an RI.

Additional geophysical investigation may be required to fully delineate the horizontal extent of magnetic anomalies north and south of the current range fan.

If anomalies are determined to be MEC/MPPEH, then biased MC samples should be collected at these locations for select metals and explosive analytes. In this event, an alternate explosive analytical method using mass spectral detectors should be used. The method should incorporate LC with a mass spectral detector due to its ability to determine the presence of low-level explosives constituents with a higher degree of certainty than the LC method with ultra violet (UV) detector.

TABLE ES-1

SUMMARY OF FINDINGS AND RECOMMENDATIONS
SITE INSPECTION REPORT - MC EVALUATION
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Site Name/Subareas	PAL Screening Exceedance	Contaminant(s) of Potential Concern	Background/Risk Screening Evaluation	Recommendation
TSA Ranges				
Surface Soil	YES	Lead, PAHs, Arsenic, Antimony	**Lead** - Average concentrations above TACO background level; **PAHs** - concentrations above TACO backround levels; **Arsenic** - concentrations below TACO backround levels; **Antimony** - concentrations below TACO backround levels	Proceed to RI for Lead and PAHs in soil.
Sediment	YES	Lead, Antimony	**Lead** - concentrations above ugradient/background levels, but ecological risk is insignificant; **Antimony** - concentrations below site-specific upgradient/background level;	Proceed to further action - ecological risk assessment of lead and antimony in sediment.
Pistol Butts				
Subsurface Soil	YES	Arsenic	**Arsenic** - concentrations below TACO backround level	NFA
Machine Gun Range				
Surface Soil	YES	Lead, Arsenic, Antimony	**Lead** - Only ecological PAL exceedances, average concentrations above TACO background level, but ecological risk appears insignificant; **Arsenic** - concentrations below TACO backround levels; **Antimony** - concentrations below TACO backround levels	Proceed to further action - ecological risk assessment of lead in soil
Sediment	YES	Lead, Arsenic	**Lead** - concentrations above ugradient/background levels, but ecological risk appears insignificant; **Arsenic** - concentrations above ugradient/background levels, but ecological risk appears insignificant;	Proceed to further action - ecological risk assessment of lead and arsenic in sediment.
NTC Lakefront				
Sediment	YES	Arsenic, Explosives (HMX, RDX)	**Arsenic** - concentrations below site-specific upgradient/background level; **HMX, RDX** - concentrations of explosive constituents are suspect due to laboratory QC/analytical method issues; therefore, resampling of the sediment for these parameters is recommended	Sampling of sediment for metals and explosive parameters during the MEC RI is recommended

TACO - Illinois EPA soil background concentration (Illionois EPA, Appendix A, Table G)
NFA = No further action
PALs = Project action limits
RI = Remedial Investigation

TABLE ES-2

MEC/MPPEH EVALUATION
NAVAL STATION GREAT LAKES
GREAT LAKES ILLINIOS

Site Name	Size (acres)	Date of Use/Use	RI MEC/MPPEH Results		MEC/MPPEH Recommendations
			Surface MEC/MPPEH	Subsurface MEC/MPPEH	
NTC Lakefront	3,728	1942 to 1945 – anti-aircraft artillery range and target training area	No surface MEC was identified during MEC SI. Numerous anomalies, potentially MEC/MPPEH, detected during performance of magnetic marine survey.	NA - No intrusive MEC investigation was performed during the MEC SI in accordance with the UFP-SAP	Proceed to RI MEC RI necessary to investigate magnetic anomalies in the shallow lake sediment to determine if MEC/MPPEH or non-munitions-related debris are present. Additional geophysical investigation may be required to delineate the horizontal extent of magnetic anomalies north and south of the current range fan.

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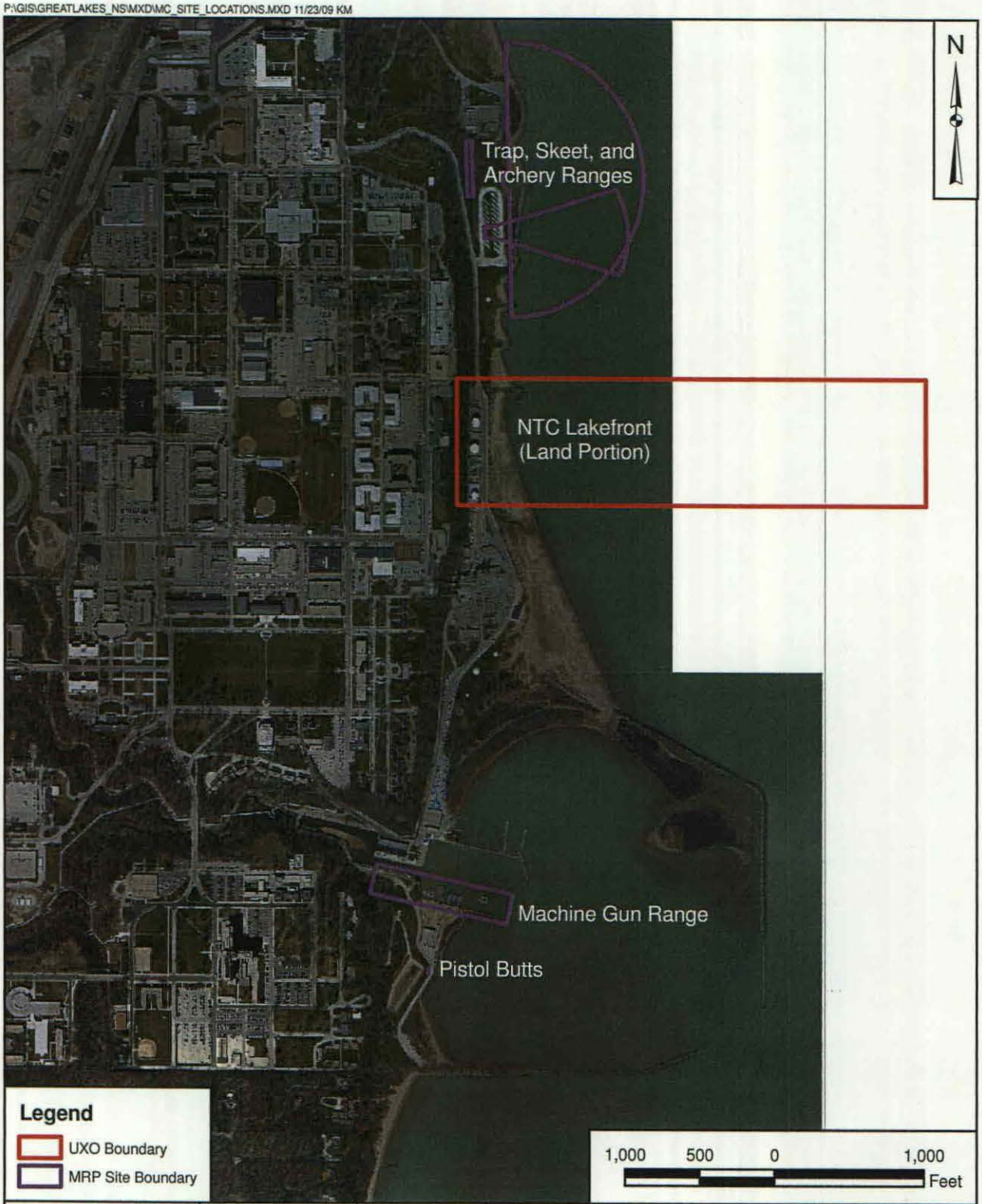

DRAWN BY K. MOORE	DATE 11/12/09
CHECKED BY E. LOVE	DATE 11/23/09
REVISED BY —	DATE —
SCALE AS NOTED	

NAVFAC

SITE LOCATION MAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER CTO F274	
OWNER NUMBER —	
APPROVED BY —	DATE —
FIGURE NO. FIGURE ES-1	REV 0

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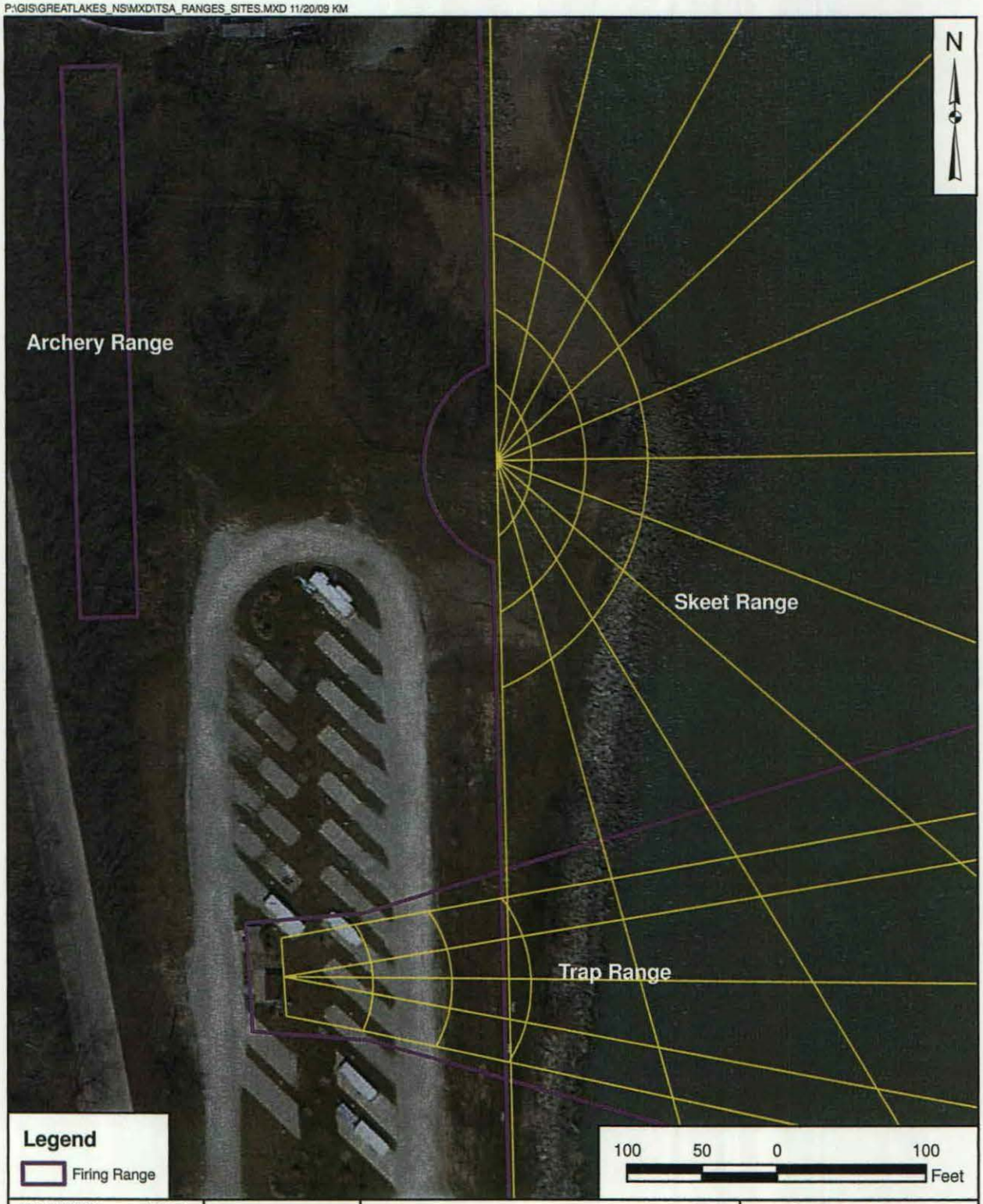

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CHECKED BY E. LOVE	DATE 11/20/09		OWNER NUMBER —
REVISED BY —	DATE —		APPROVED BY — DATE —
SCALE AS NOTED			FIGURE NO. FIGURE ES-2 / REV 0

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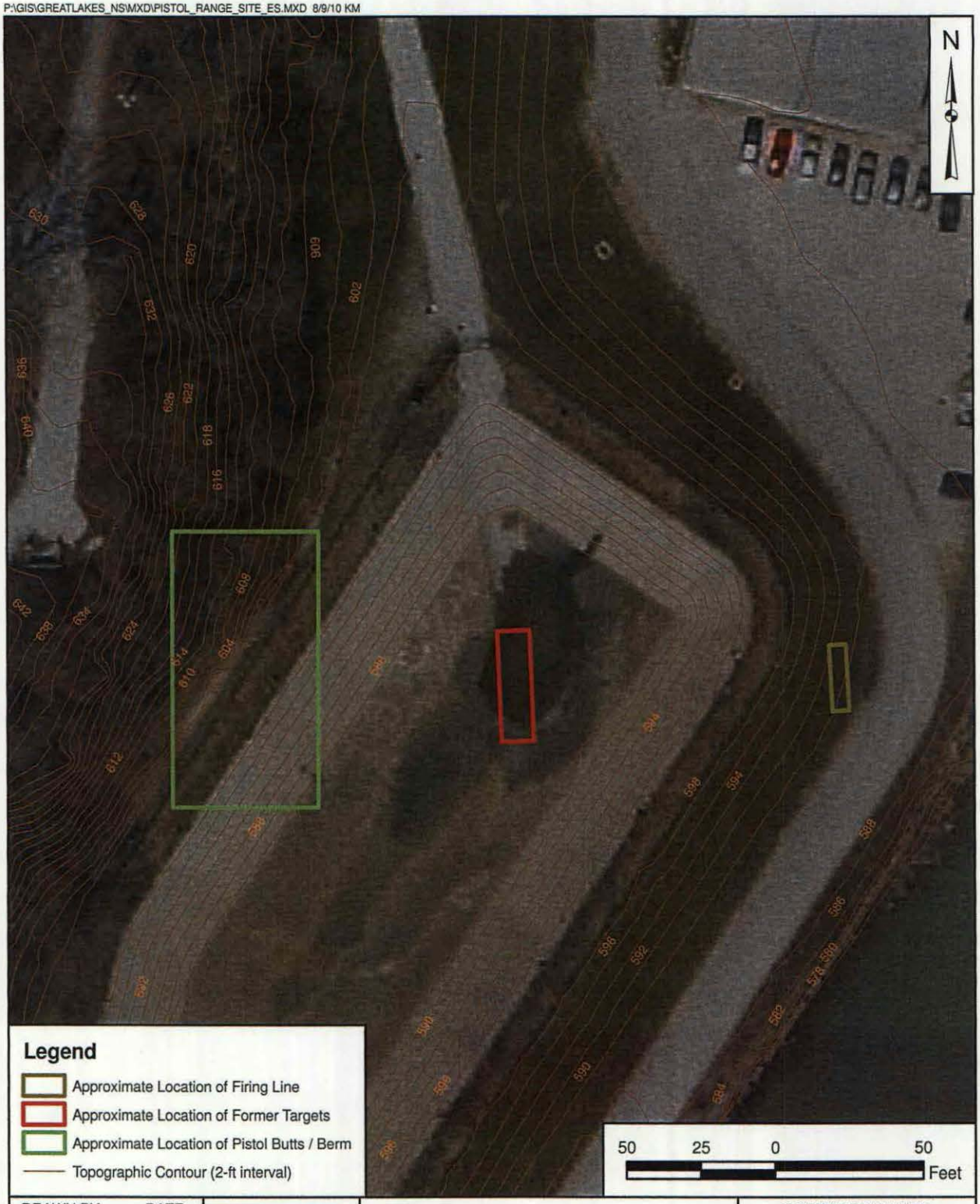

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REVISED BY —	DATE —		APPROVED BY — DATE —
SCALE AS NOTED		NAVFAC	FIGURE NO. FIGURE ES-3 REV 0

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CHECKED BY J. POULIOT	DATE 3/17/10		OWNER NUMBER —
REVISED BY —	DATE —		APPROVED BY — DATE —
SCALE AS NOTED			FIGURE NO. FIGURE ES-4 REV 0

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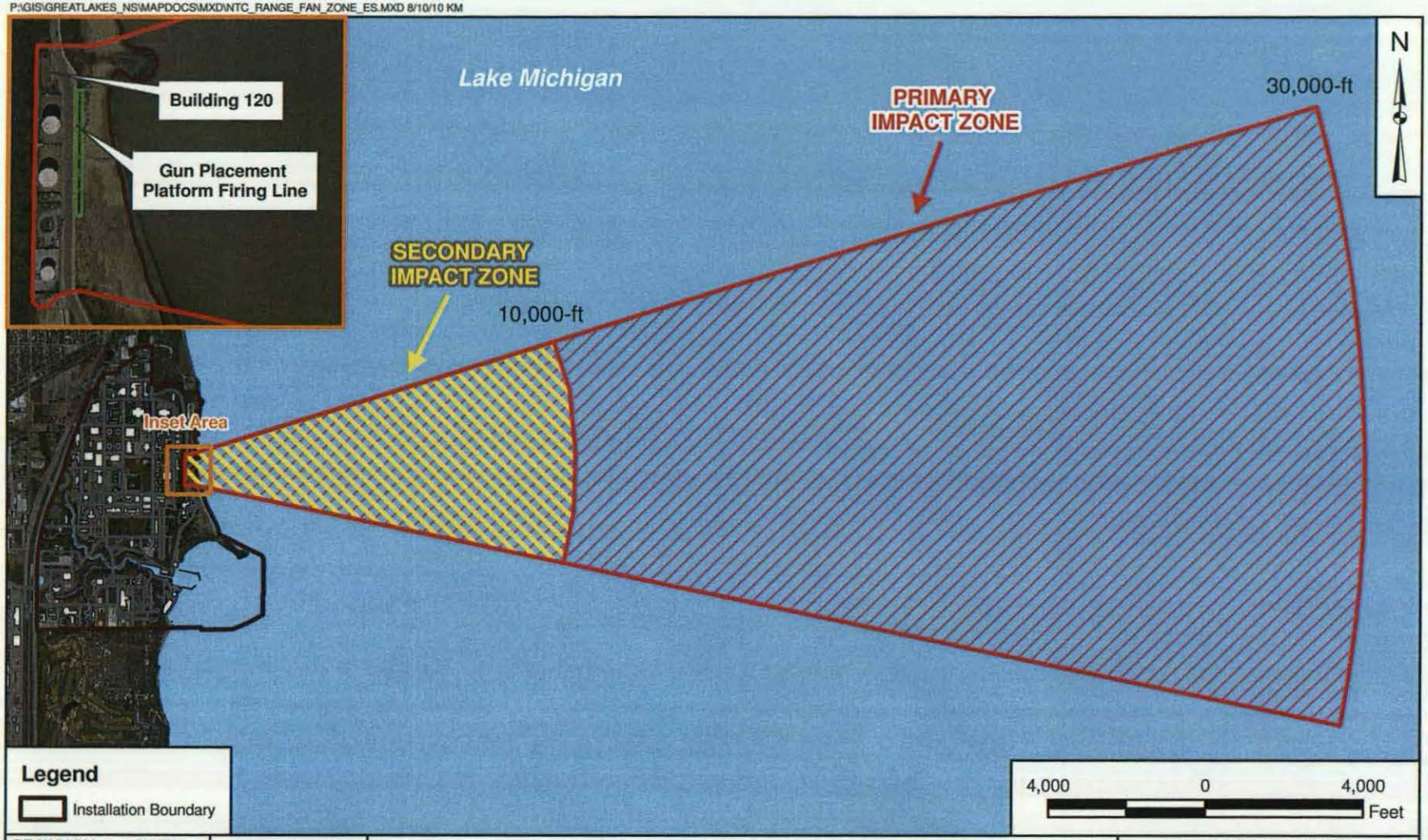

DRAWN BY T. WHEATON DATE 10/23/09	NAVFAC	CONTRACT NUMBER F274
CHECKED BY J. DUCAR DATE 8/10/10	NTC LAKEFRONT SURFACE DANGER ZONE (SDZ) NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	APPROVED BY ___ DATE ___
COST/SCHEDULE AREA		APPROVED BY ___ DATE ___
SCALE AS NOTED		FIGURE NO. FIGURE ES-5 / REV 0

1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

This report presents the results of the site inspection (SI) for four ranges at Naval Station Great Lakes (NSGL) in Great Lakes, Illinois (Figure 1-1). The SI included two investigations. The first was for munitions constituents (MC) at four ranges. The second was for munitions and explosives of concern (MEC), which consist of unexploded ordnance (UXO), discarded military munitions (DMM), and explosive munitions constituents in high enough concentrations to present an explosive hazard, at one range. The latter investigation was conducted using underwater geophysical methods to identify anomalies, which could be MEC or material potentially presenting an explosive hazard (MPPEH). The SI was performed by Tetra Tech, Inc. (Tetra Tech) for Naval Facilities Engineering Command (NAVFAC) Midwest under Contract Task Order (CTO) F274 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) IV Contract Number N62472-03-D-0057.

The Department of Defense (DoD) has established a separate program to address closed military ranges known as the Munitions Response Program (MRP). For MRP sites, the DoD follows the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) process. Malcolm Pirnie, Inc. conducted the initial phase of the CERCLA process by completing the Water Area Munitions Study (WAMS) (Malcolm Pirnie, 2005) for the Naval Training Center (NTC) Lakefront Site and the former Trap, Skeet, and Archery (TSA) Ranges and the Preliminary Assessment (PA) Report (2008). The PA Report was completed in February 2008 and identified the NTC Lakefront Site and TSA Ranges as munitions response sites (MRSs) requiring further investigation at the NSGL (Malcolm Pirnie, 2008). The Machine Gun Range and Pistol Butts were investigated as part of the SI; however, these sites were not included in the PA due to insufficient information available at the time the PA was completed (Malcolm Pirnie, 2008). The site-specific and technical information presented in the relevant WAMS and PA Report were collectively used to develop the SI field program for the NTC Lakefront Site and the TSA Ranges. The SI field program for the Pistol Butts and Machine Gun Range sites were developed by utilizing the available information and previous experience investigating similar ranges.

1.2 SCOPE OF WORK

This SI Report presents the results of the SI field program to determine the presence or absence of MC and MEC in accordance with the Uniform Federal Policy-Sampling and Analysis Plan (UFP-SAP) prepared for this project by Tetra Tech (2010).

Volume I of this document addresses MC activities and is designed to evaluate the presence or absence of potential MC at the four separate MRSs at NSGL (Figure 1-2). Volume II presents the results of the MEC investigation consisting of the bathymetric and geophysical investigations.
The following is a summary of the SI field work activities:

TSA Ranges

- Collection of discrete surface soil samples [0 to 0.5 feet below ground surface (bgs)].
- Collection of discrete sediment samples (0 to 0.5 feet bgs).
- Field analysis for lead utilizing an x-ray fluorescence (XRF) analyzer.
- Laboratory analysis for select metals and polycyclic aromatic hydrocarbons (PAHs).

Pistol Butts

- Collection of discrete subsurface soil samples (6 to 16 feet bgs).
- Field analysis for lead utilizing an XRF analyzer.
- Laboratory analysis for select metals.

Machine Gun Range

- Collection of discrete surface soil samples (0 to 0.5 feet bgs).
- Collection of discrete sediment samples (0 to 0.5 feet bgs).
- Laboratory analysis for select metals and nitroglycerin (NG).

NTC Lakefront (water portion)

- Underwater bathymetry and geophysical survey
- Collection of discrete sediment samples (0 to 0.5 feet bgs).
- Laboratory analysis for select metals and select explosives.

1.3 OBJECTIVES

The primary objective of this SI was to collect an appropriate amount of data to update the site-specific conceptual site models (CSMs), to ensure that a decision for each site could be made regarding whether a Remedial Investigation/Feasibility Study (RI/FS) is required, whether a site requires an immediate response, or whether the site qualifies for no further action (NFA).

The primary objectives of the SI were as follows:

- Determine the presence or absence of MC.
- Determine if any immediate hazards to human health existed
- Determine if anomalies are present in Lake Michigan sediment that may be indications of potential MEC or MPPEH.

1.4 REPORT ORGANIZATION

Volume I of the SI Report consists of eight sections:

- Section 1.0 – Introduction
- Section 2.0 – Background and Physical Setting
- Section 3.0 – General Methodology
- Section 4.0 – TSA Ranges SI
- Section 5.0 – Pistol Butts SI
- Section 6.0 – Machine Gun Range SI
- Section 7.0 – NTC Lakefront SI
- Section 8.0 – References

The appendices include the following:

- Appendix A – MC Field Forms
- Appendix B – Site Photographs
- Appendix C – Explosive Safety Submission (ESS) Determination
- Appendix D – Validated Analytical Results, Data Validation Reports, and Project Action Limit Background Table
- Appendix E – Data Usability Assessment (includes all background information)
- Appendix F – Correlation Statistical Evaluations XRF/Empirical Laboratories, LLC (Empirical)
- Appendix G – Statistical Evaluation of Background Objectives and Site Data

Volume II of the SI Report consists of the results of the MEC investigation consisting of the bathymetric and geophysical investigations.

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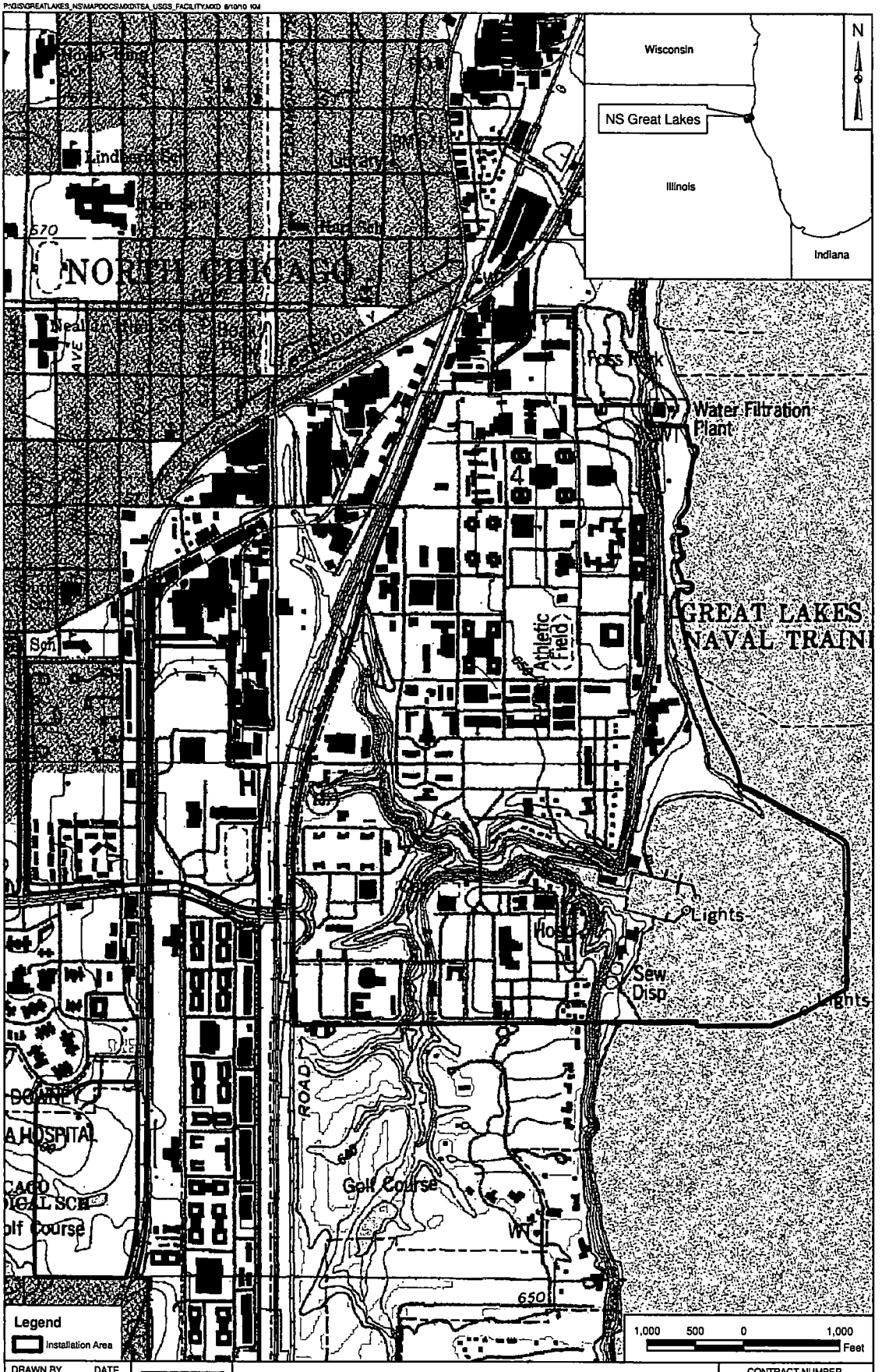

DRAWN BY K. MOORE	DATE 7/26/10	FACILITY LOCATION NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NUMBER CTO F274
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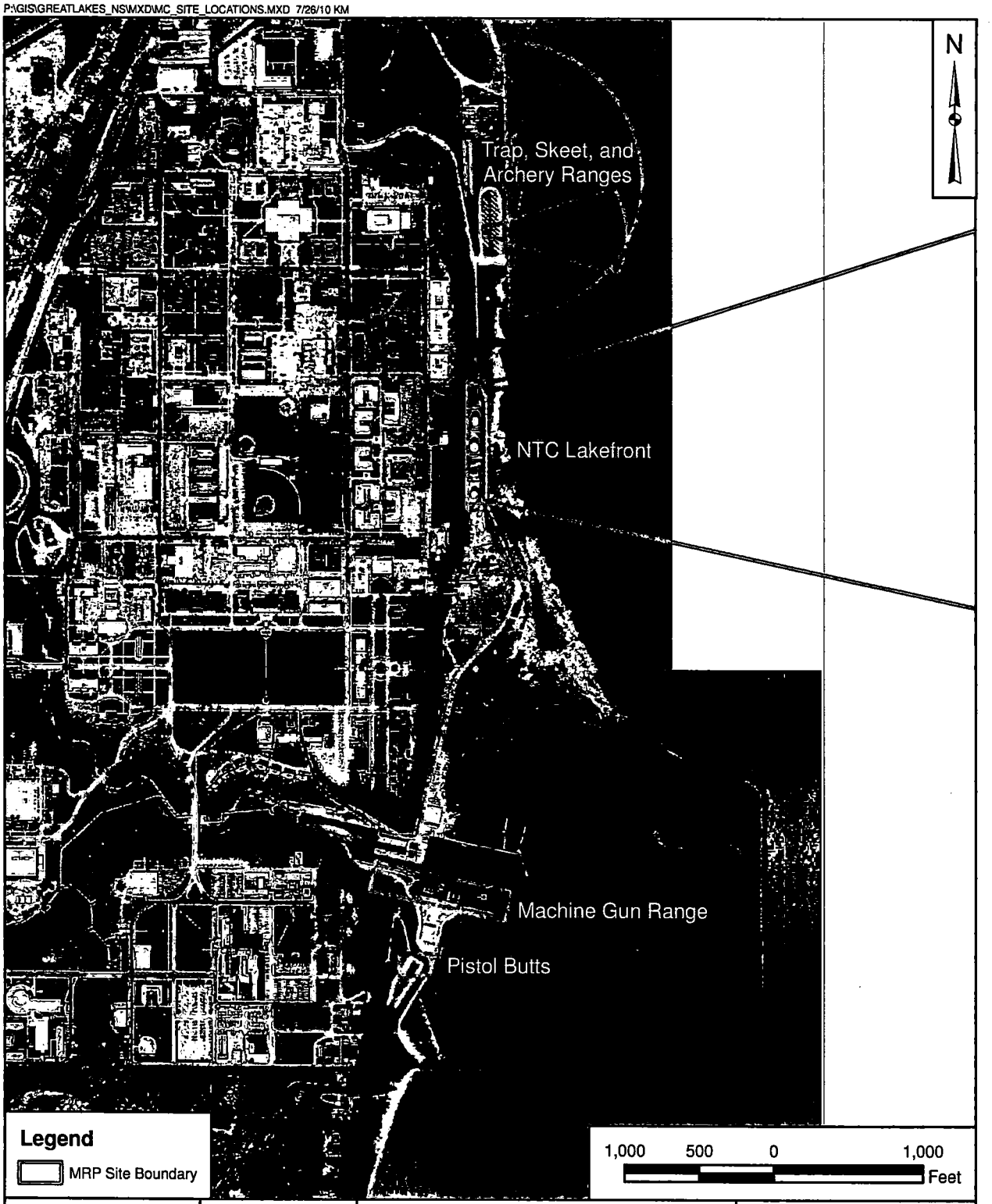

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2.0 FACILITY BACKGROUND AND PHYSICAL SETTING

2.1 GENERAL FACILITY BACKGROUND AND PHYSICAL SETTING

2.1.1 Regulatory Framework

The regulatory framework for managing Navy MRSs is guided by federal, state, and local laws, as well as DoD and Navy regulations and guidance, and provides the necessary information for Navy-decision makers. The key legislation, policy, and guidance directing the program include, but are not limited to the following:

- Navy MRP Guidance (2005) states that munitions response will be conducted "in accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan" (NCP).

- Management Guidance for the Defense Environmental Restoration Program (DERP) (2001). The history of the DERP dates back to the Superfund Amendments and Reauthorization Act (SARA) of 1986. The scope of the DERP is defined in 10 United States Code (U.S.C.) 2701(b), which states the following:

  "Goals of the program shall include the following: ... (1) The identification, investigation, research and development, and cleanup of contamination from hazardous substances, and pollutants and contaminants. (2) Correction of other environmental damage (such as detection and disposal of unexploded ordnance) which creates an imminent and substantial endangerment to the public health or welfare or to the environment..."

- Fiscal Year (FY) 02 National Defense Authorization Act (Sections 311-312) reinforced the DoD 2001 DERP Management Guidance by tasking the DoD to develop and maintain an inventory of defense sites that are known or suspected to contain MEC and MC. Section 311 requires the DoD to develop a protocol for prioritizing defense sites for response activities in consultation with states and tribes. Section 312 requires the DoD to create a separate program element to ensure that the DoD can identify and track munitions response funding. The 2001 Management Guidance for the DERP and 2002 National Defense Authorization Act, described here, established the MRP. The Navy baseline inventory of sites was completed in FY02 and was used to establish the sites/Areas of Concern (AOCs) where PAs were needed to further evaluate the potential for MEC and MC.

2.1.2 History

NSGL is the largest active duty DoD Naval training center in the United States. NSGL is home to enlisted men training and officer accession training. The installation is one of Illinois' largest employers with over 25,000 military and civilian personnel. The Great Lakes Naval Hospital trains 4,000 Navy Corpsmen annually and is the Navy Regional Processing Site for several hundred reservists.

NSGL provides support for the Navy through the intense training and specialized itinerary for enlisted men preparing for the fleet. Major commands at NSGL include Naval Station (NAVSTA), a shore activity reporting command; the Recruit Training Command, which trains sailors; and the Service School Command (SSC), which provides initial technical training. The SSC can also be broken down into combat systems schools, engineering systems schools, and a training department.

The four MC MRSs being investigated at NSGL include the TSA Ranges, Pistol Butts, Machine Gun Range, and NTC Lakefront.

2.1.3 Location and Setting

NSGL sits on approximately 1,628 acres in Great Lakes, Illinois, approximately 20 miles north of Chicago, in Lake County, Illinois. The installation is located along the western shores of Lake Michigan just east of US Route 41 and south of an adjacent town, North Chicago. The other population center in the vicinity is the town of Waukegan, approximately 8 miles north on US Route 41. NSGL is bound by Lake Michigan to the east and Skokie Highway (US Route 41) to the west. The Shore Acres Country Club is the southern border of NSGL. Figure 1-1 shows the general location of NSGL.

2.1.4 Current Land Use and Anticipated Future Land Use

Guarded entrance gates limit access to NSGL; however, access to the lakefront is not restricted once through the main installation gates. Thus, any Navy personnel or authorized visitor who has access through the main installation gates can access the four MRP sites without restriction. There are no specific restrictions associated with the ranges.

The TSA Range, Machine Gun Range, and near shore portions of the NTC Lakefront (water portion) range are monitored for approaching boats and vessels. However, access is not physically limited from the beach side of the installation off Lake Michigan. The current land use for each the range is discussed in Section 4.0 through Section 7.0. The future land use of each of the four ranges located within NSGL is anticipated to remain the same as the current land use, for the foreseeable future.

2.1.5 Munitions Related Training, Storage, and Usage

Based on information gathered during the completion of the PA Report by Malcolm Pirnie and development of the UFP-SAP, the history of the MRSs at NSGL included storage, training with, and use of many types of naval munitions, including anti-aircraft (AA) artillery munitions, small arms, and pyrotechnics. The TSA Ranges were used to prepare Navy personnel for the training program at the AA Training Center and originally included only a trap range. The skeet range and archery range were added to the site after World War II (WWII). The trap and skeet ranges fired over Lake Michigan. The ranges (with the exception of the archery range) utilized small caliber weapons (i.e., small arms) to train enlisted men in targeting moving objects. MEC was not expected to be present at the site. Archival data for ammunition orders from the 1940s and 1950s included the following munitions-related items that may have been used at the site:

- Shotguns, 12-gauge with slide repeating action and modified choke, 26-inch or 28-inch barrel.
- Shells, shotgun, 12-gauge, No. 7 ½ shot.
- Targets, clay pigeon

The Navy may have used the Pistol Butts during the early years of the Naval Station for small arms training; the PA did not discover records of other types of munitions use at the site. The usage dates of the site are unknown. The Pistol Butts appears on only one archival map dated 1909. Figure 2-1 presents a portion of that map showing the former Pistol butts.

The Machine Gun Range was used for training naval personnel on small arms of 0.50-caliber or less. The Machine Gun Range is not suspected to contain chemical warfare material filled munitions, electrically fuzed munitions, or depleted uranium associated munitions. The dates of operation and specific location of this course are unknown; however, an archival map (dated 1909) indicates that there were two firing lines associated with the range, one at 200-yards, and another at 300-yards (Figure 2-1). The 200-yard range was located on the western edge of the Inner Harbor, immediately west of the water's edge, and the 300-yard range was located across the Boat Basin, south of the western edge of the Boat House. The range was used by the Navy during the early years of the Naval Station. Based on the archival map, it appears that moving targets over the harbor were fired upon from land.

The NTC Lakefront was used to train enlisted men of the Armed Guard on AA artillery weapons from 1943 until October 15, 1945, the disestablishment date, as directed by the Secretary of the Navy. Twenty-five gun mounts were located on the beachfront. Targets were towed by aircraft over Lake Michigan. Approximately 1,350 sailors per day were instructed in AA training using 20- and 40-millimeter

(mm) guns and several million shells. The ammunition used included 20-mm, 40-mm, and 1.1-inch high explosive (HE), high explosive incendiary (HEI), high explosive tracers (HET) and/or HET-dark ignition (DI) rounds. The munitions fired contained explosives. Some of the munitions may not have functioned as designed and explosives may still be present in munitions deposited on Lake Michigan sediments. Based on the information obtained during the data collection process, no special consideration munitions are known or suspected to have been used at the site. Therefore, the NTC Lakefront Site is not suspected to contain chemical warfare material filled munitions, electrically fuzed munitions, or depleted uranium associated munitions (Malcolm Pirnie, 2005). Additional technical data regarding the munitions used at NTC Lakefront are included in Appendix A-3 of the UFP-SAP (Tetra Tech, 2010).

2.2 GENERAL FACILITY PHYSICAL/ENVIRONMENTAL CHARACTERISTICS

2.2.1 Climate

The climate at NSGL is influenced primarily by its proximity to Lake Michigan. The average temperature ranges from 20.3 degrees Fahrenheit (°F) in January to 71.5 °F in July, with an annual average of 47.3 °F. The annual average precipitation recorded is 34.1 inches, with monthly average peaks as high as 4.2 inches in October and as low as 1.4 inches in February. The mean seasonal snowfall is 37.9 inches. Because of the proximity to Lake Michigan, winter precipitation in the Chicago area is often in the form of wet snow.

Prevailing winds are from the northwest, but during the summer months, they become more southerly. The average annual wind speed is eight to 12 miles per hour; however, winds may reach 50 to 60 miles per hour or higher in severe thunderstorms, tornadoes, or general winter storms.

2.2.2 Topography

Lakeshore bluffs rise from 20 to 75 feet in height above Lake Michigan and continue this trend beyond the west coast of the lake. Perpendicular to the bluff are ravines that discharge surface runoff to Lake Michigan. The topography of NSGL is similar to the surrounding area with buildings constructed along the bluff ravines and beachfront (see Figure 1-1).

2.2.3 Regional Geology

The Wheaton Morainal Complex characterizes the geology of the area around NSGL. NSGL is listed as part of the Bluff-Ravine Complex of the Central Lowland Providence consisting of flat land cut by ravines and edged on the east with the bluff overlooking Lake Michigan. Pettibone Creek ravine runs

perpendicular to the shoreline of Lake Michigan, dividing NSGL. This land formation is the result of Pleistocene continental glacial deposits that released unconsolidated glacial drift along the bedrock. The glacial till is composed of varying proportions of clay, sand, silt, pebbles, and boulders and ranges from 40 to 200 feet in thickness because of the numerous glacial events that took place. The lakeshore presents the sandy phase of this formation. Underneath the glacial till are layers of dolomites, sand, stones, and shale from sea deposits. The bedrock is Precambrian granite that is relatively horizontal.

2.2.4 Soil and Vegetation

The soil predominately found in NSGL is located on top of morainic ridges. Silt deposits overlay a calcareous glacial till of a silty, sandy, clay soil, which has moderate to poor draining capacity. Soil of the first five feet in depth is relatively uniform in grain size distribution, liquid limit, and plasticity. The shoreline at NSGL has eroded over the centuries; however, fill material was placed to extend the shoreline in the early 1940s. The lakefront area, composed of fill material, includes soil and other various materials, such as concrete and consolidated material, serving as a foundation for the sandy beach and adjacent structures on-site, including Ziegemeier Street. The majority of the land acquired by NSGL was cleared for buildings to accommodate housing and classroom needs; however, some native woodland remains. Terrestrial vegetation in the undeveloped sections of NSGL consists predominately of woodland species. The individual stand compositions are the result of a combination of natural seeding, forest management, and planting. The majority of trees in the area are oak, maple, hickory, and other hardwoods. Native shrubbery consists of blackberry, black oak, blueberry, huckleberry, maple, osier, sassafras, and willow. Beach-grass, Kentucky bluegrass, Canada bluegrass, creeping red fescue, sheep fescue, tall fescue, and clover are all turf vegetation found in this location.

2.2.5 Hydrology

Lake County has a surplus of water available from the surface waters of Lake Michigan. Communities near Lake Michigan, including Great Lakes, utilize this source for potable water rather than groundwater aquifers. NSGL consumes lake water due to proximity. NSGL has two drainage basins: Skokie Ditch and Pettibone Creek ravine and water from these sources is not potable. There are two storm water discharges to Skokie Ditch: a storm sewer discharge from Forrestal Village (a residential area of the base) and a storm sewer located underneath the Willow Glen Golf Course that discharges to the headwaters of Skokie Ditch. Pettibone Creek receives runoff from the main area of the installation and this water discharges into Lake Michigan from the inner harbor location of the installation.

2.2.6 Regional Hydrogeology

Groundwater in the Lake County area consists of four aquifers: the Glacial Drift Aquifer, the Silurian Dolomite formation, the Cambrian-Ordovician Aquifer, and the Mount Simon Sandstone. The Glacial Drift and Silurian Dolomite are shallow aquifers reaching depths of 150 to 500 feet. The shallow aquifer located along the shoreline at the installation has a depth to groundwater between 2 and 5 feet bgs due to the proximity of the lake. This water is not potable and is not utilized at NSGL or the surrounding area. The remaining aquifer system is known as the deep aquifer system, with depths ranging from 900 to 1,900 feet bgs. The shallow aquifer system recharges from local rainfall infiltration, while the deep aquifer system receives sources from areas of central Wisconsin.

2.3 REGIONAL ECOLOGY SUMMARY

2.3.1 Endangered/Threatened Species

Natural resources at NSGL include Lake Michigan and the associated potable water and fish derived from the lake. The Navy's Integrated Natural Resources Management Plan (INRMP) for NSGL has no species of mammals, amphibians, fish, reptiles, or invertebrates documented at NSGL listed on state threatened or endangered species lists. Although undocumented during the surveys, threatened and/or endangered species may be present at the installation (INRMP, NTC Great Lakes, 2001). According to the PAs the protected species that are known to, or have the potential to, inhabit NSGL (as presented in the 2001 INRMP for NTC Great Lakes) include the following;

- State Listed Fauna Species
  - Black-crowned night heron (*Nycticorax nycticorax*) – E
  - Brown creeper (*Certhia americana*) – T
  - Cerulean warbler (*Dendriica cerulea*) – SWL
  - American bittern (*Botaurus lentiginosus*), common tern (*Sterna hirundo*) – E
  - Forester's tern (*Sterna forsteri*) – E
  - Peregrine falcon (*Falco peregrinus*) – E
  - Pied-billed grebe (*Podilymbus podiceps*) – T
- State Listed Flora Species
  - Forked aster (Aster furcatus) – T
  - Green yellow sedge (Carex viridula) – E
  - Marram grass (Ammophila breviligulata) – E
  - Sea rocket (Cakile edentula) – T
  - Seaside spurge (Chanaesyce polygonifolia) – E

- Federal Listed Species
  - Pitcher's thistle (*Cirsium pitcheri*) – T

T = Threatened species
E = Endangered species
SWL = State Watch List species

2.3.2 Wetlands

According to the US Fish and Wildlife Service National Wetlands Inventory and a visual inspection of each site, there are no wetlands associated with the MRSs.

2.3.3 Historical and Cultural Resources

The National Register of Historic Places added NSGL to the register in 1986. This includes 1,932 acres of land, 43 buildings, 14 structures, and six objects of architectural/engineering significance. A Phase I Cultural Resource Investigation that outlines the properties examined is provided in the PA (Malcolm Pirnie, 2008). No structures placed on the National Register are located at the TSA Ranges, Pistol Butts, Machine Gun Range, or NTC Lakefront.

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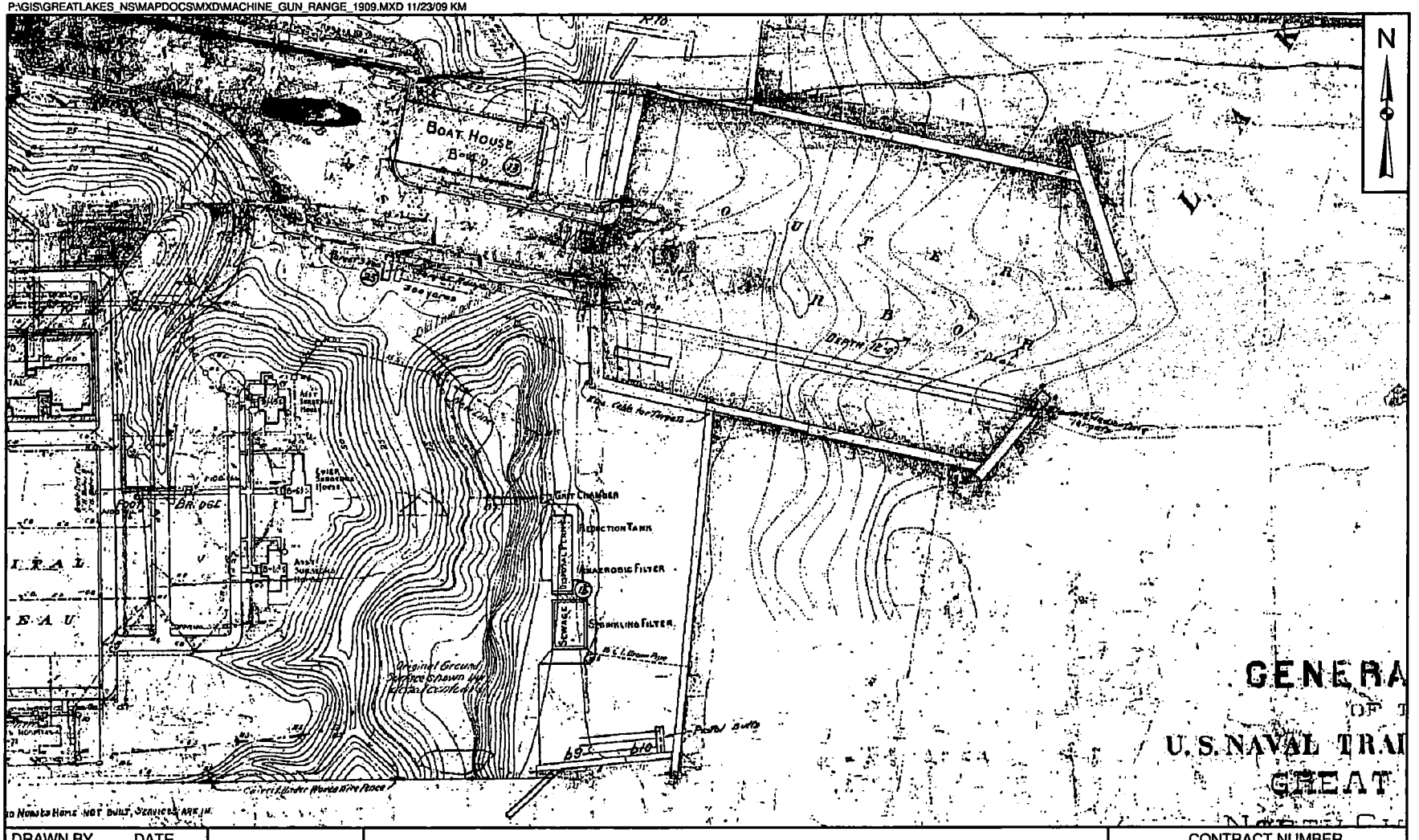

DRAWN BY K. MOORE	DATE 11/23/09	1909 ARCHIVAL BASE MAP PISTOL BUTTS AND MACHINE GUN RANGE NAVAL STATION GREAT LAKES	CONTRACT NUMBER F274
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COST/SCHEDULE AREA			APPROVED BY — DATE —
SCALE AS NOTED	NAVFAC		FIGURE NO. FIGURE 2-1 REV 0

3.0 GENERAL METHODOLOGY

3.1 SITE INSPECTION APPROACH

This section describes the sampling design, methods, and documentation utilized during the SI field activities performed April 20 through May 22, 2010, at the four MRP Ranges at NSGL. The MC field effort included surface soil sample collection using hand augers, soil borings and subsurface soil samples using direct push technology (DPT), and sediment sampling using dredges.

All field activities were performed in accordance with the UFP-SAP (Tetra Tech, 2010). Deviations from the SAP resulting from unanticipated site conditions are described within the site-specific sections of this report (Sections 4.0 through 7.0). A summary of the comprehensive quality assurance/quality control (QA/QC) and investigation-derived waste (IDW) sampling and analyses for the MC field effort is provided in Table 3-1.

MRS-specific designs and decisions are discussed in Sections 4.0 through 7.0. The Standard Operating Procedures (SOPs) that governed the MC field work are included in Appendix A of the approved UFP-SAP (Tetra Tech, 2010). Sample log sheets, field documentation, site photographs, and other supporting documentation associated with the MC SIs are provided in Appendices A through E and are referenced throughout this report.

3.1.1 Site Preparation Activities and Mobilization Activities

All preliminary activities, such as subcontractor procurement and coordination, authorizations, site access, and clearance of utilities, were completed in accordance with the UFP-SAP. Following approval of the UFP-SAP, Tetra Tech personnel mobilized to NSGL on April 20, 2010. Mobilization activities included the receipt of field equipment directly from vendors. Each piece of equipment was checked upon receipt to verify that it was provided in proper working condition. Daily tailgate safety meetings were held each morning by the Field Operations Leader (FOL) to briefly address the day's planned activities.

MC SI field forms and field notes can be found in Appendix A. Photographic documentation of site activities is located in Appendix B. The field team members reviewed the approved UFP-SAP, associated appendices, and Health and Safety Plan (HASP) prior to the start of project activities. In addition, the FOL held a field team orientation meeting to ensure that personnel were familiar with the scope of field activities. All four ranges are located within controlled areas at NSGL, accessible only through an access gate after check-in at security and receipt of a pass for both personnel and vehicles entering the facility.

Access to the land portion of the NTC Lakefront site is not restricted once through the main installation gates. However, there is no means in place along the beach side of the installation, from Lake Michigan, to limit access to the entire east side of the installation, and Lake Michigan has no access controls other than marker buoys indicating Base property. Base security supervises the lakeside perimeter.

Upon completion of all SI activities work areas were thoroughly cleaned, trash was bagged and disposed in the trash dumpster outside the field office, the FOL shipped the equipment back to the third party vendor, and the field crew demobilized from the site.

3.1.1.1 Utility Clearance

Prior to all field activities, Tetra Tech personnel and the drilling subcontractor Environmental Field Services, Inc. contacted the Illinois One Call System (Joint Utility Locating Information for Excavators - JULIE) to begin the utility clearance process. A separate utility clearance ticket was processed for each of the individual sites (i.e., TSA Range, Pistols Butts, and the Machine Gun Range) (Appendix C). A utility clearance was not required for the NTC Lakefront site, because the investigation area was located within Lake Michigan. Upon mobilization for the initial MC field event, the FOL also met with a representative of the Base public works office to discuss utility clearance in the Pistol Butts Range.

3.1.1.2 Subcontracting

Preliminary activities included subcontractor mobilization and coordination. The project necessitated the use of two subcontractors, one to provide drilling services, and one to provide analytical laboratory services. Environmental Field Services, Inc. performed the drilling and Empirical performed the analytical services.

3.1.1.3 Vegetation Management

Vegetation clearance was not required at any of the MRP sites.

3.1.1.4 Permitting

Permits were not required for the SI field investigation activities.

3.1.1.5 Request for Explosives Safety Submission Determination and Naval Ordnance Safety and Security Activity Concurrence Notification

MEC was not expected to be present at the TSA Ranges, Pistol Butts or Machine Gun Ranges sites based on historical use. However, as a safety precaution an ESS Determination Request was submitted to Naval Ordnance Safety and Security Activity (NOSSA). The ESS Determination Request was submitted via email on January 14, 2010. The ESS Determination Request was received on January 29, 2010, and is included in Appendix C. No ESS was required.

In addition, an ESS Determination Request was submitted to NOSSA for the NTC Lakefront site. The ESS was submitted via email on January 19, 2010. The ESS Determination was received on January 29, 2010, and is also included in Appendix C. No ESS was required.

3.2 MUNITIONS CONSTITUENTS SITE INSPECTION METHODS

3.2.1 Field Investigation Methods

3.2.1.1 Unexploded Ordnance Avoidance Activities

During collection of the NTC Lakefront Site sediment samples a UXO Technician was present to determine whether any metallic debris collected as part of the sediment grab sample could be identified as suspect MEC or MPPEH.

3.2.1.2 Hand Auger

During the field event, several soil samples were collected with hand augers in accordance with SOP-05 (Appendix B of UFP-SAP). Hand augers were used to collect surface soil samples at the TSA Ranges and the Machine Gun Range.

The hand auger system consisted of a stainless steel bucket bit (i.e., cylinders 6.5-inches long and 2.75-inches in diameter), a 4-foot extension rod, and a cross handle. A properly decontaminated bucket bit was attached to a clean extension rod, and then to the cross handle. The area to be sampled was cleared of any surface debris (i.e., leaves, twigs). The hand auger was turned into the ground to a depth of 0.5-feet bgs. The auger was then removed and the sample material was placed into a Ziploc® bag. The sample identification (ID), date, time, and depth were marked on the bag with an indelible marker. Required information was provided on the Soil Sample Log Sheet and the chain-of-custody form. Excess soil core material was returned to the hole and tamped. All soil sampling equipment was decontaminated between sample locations in accordance with SOP-11 of the UFP-SAP (Tetra Tech, 2010).

Sample analyses are summarized in site-specific sections of this report.

3.2.1.3 Direct Push Technology

A track-mounted DPT GeoProbe® 6610DT drill rig was used to collect subsurface soil samples at the Pistol Butts site. Subsurface soil samples were collected with the use of DPT Macro-core® sampling techniques for chemical and lithologic analysis.

Subsurface soil samples were collected at 4-foot intervals to a depth of 16 feet bgs. The soil was logged for the entire length of the boring in accordance with the UFP-SAP (Tetra Tech, 2010). Upon advancement to the desired depth, the boring was abandoned by placing bentonite from the bottom of the boring to the ground surface in accordance with federal and local regulations. Boring logs are provided in Appendix A. Sample analyses for the Pistol Butts are summarized in Section 5.0 of this report.

3.2.1.4 Petite Ponar Dredge and Modified Van Veen Dredge

Lake Michigan sediment samples for the TSA Ranges, Machine Gun Range, and the NTC Lakefront Range were collected from 0 to 0.5-foot below sediment surface (bss). Samples from the TSA Range were collected in shallow water (less than 6 feet) and samples in the Machine Gun Range, collected west of the target area (Inner Harbor wall), were collected using a petite Ponar clam-shell dredge deployed from a Zodiac™ inflatable raft with an outboard motor in accordance with SOP-06 (Sediment Sampling) and SOP-08 (Large Body Water Sediment Sampling).

Sediment samples were proposed in the UFP-SAP (Worksheet #9) to be collected from 0 – 0.5 foot and 0.5 – 1 foot bss at each sampling location for the Machine Gun Range. However, due to accessibility issues near the breakwater area, the large research vessel could not be utilized to collect the sediment samples. The smaller, inflatable Zodiac™ boat was used for sampling. The boat was not stable or large enough to use the sampling equipment (e.g., vibracore sampler) required to penetrate to the 0.5 – 1 foot bss interval. Therefore, only the 0 – 0.5 foot bss sample was collected with the use of the dredge sampler.

Sediment samples for the TSA Ranges collected in water greater than 6 feet deep, the NTC Lakefront Site, and the samples collected upgradient of these sites in Lake Michigan were collected from 0 to 0.5-foot bss using a pneumatic modified Van Veen clam-shell dredge deployed from a 34-foot welded aluminum survey vessel with an 8.5-foot beam and a draft of 3.5 feet, in accordance with SOP-06 (Sediment Sampling) and SOP-08 (Large Body Water Sediment Sampling).
The Sediment Sample Log Sheets are included in Appendix A.

3.2.2 Field Sampling Operations

The sampling strategy employed a design to target those areas most likely to be contaminated based on the CSMs presented in the UFP-SAP, in addition to nearby areas, to help to bound any contamination. The data collected under this conservative strategy were expected to represent concentrations greater than those to which human or ecological receptors would actually be exposed. The strategy was to ensure that a potential unacceptable human health or ecological risk was not overlooked.

3.2.2.1 Surface Soil Sampling

Surface soil samples were collected for the TSA Ranges and Machine Gun Range. At the TSA Ranges, soil samples were placed in a Ziploc® bag marked with the sample location, ID, depth, date, and time. The samples were thoroughly mixed within the bag. The sample was then split and one-half was sieved to remove gravel and range debris then screened for lead using XRF analysis. The remaining portion of the sample was placed into a 4-ounce glass jar and placed on ice until samples were shipped to the fixed-base laboratory (FBL) for PAH analysis.

Surface soil samples at the Machine Gun Range were placed in a Ziploc® bag marked with the sample location, ID, depth, date, and time. The samples were thoroughly mixed within the bag. The homogenized samples were transferred to the appropriate sample containers and placed on ice until the samples were shipped to the laboratory for select metals and NG analysis. Unused portions of a collected sample were containerized as IDW.

Soil sample log sheets are provided in Appendix A. Surface sample analyses are summarized in Sections 4.0 and 6.0 of this report.

3.2.2.2 Subsurface Soil Sampling

Subsurface soil samples were collected via DPT in 4-foot intervals from 0- to 16-feet bgs for chemical and lithologic analysis at the Pistol Butts. A photoionization detector (PID) was used to screen the soil collected approximately every foot from each boring. Beginning at 6 feet bgs, 2-foot intervals were collected, homogenized, sieved to remove gravel and vegetation, dried, and then screened for lead using XRF analysis. A subset of these samples was selected for FBL analysis for select metals in accordance with the UFP-SAP (Tetra Tech, 2010). The samples were then transferred to the appropriate sample containers and placed on ice until they were shipped to the laboratory for select metals analysis. Unused portions of a collected sample were containerized as IDW.

Soil sample log sheets are provided in Appendix A. Subsurface sample analyses are summarized in Section 5.0 of this report.

3.2.2.3 X-Ray Fluorescence Analysis

On-site field XRF analysis for lead in soil was conducted at the TSA Ranges and Pistol Butts ranges. Analysis was performed according to SOP-10 (Field Portable X-Ray Fluorescence Analysis of Soil and Sediment Using the INNOV-X Alpha Series Instrument) of the UFP-SAP (Tetra Tech, 2010). All soil samples collected from the TSA Ranges and Pistol Butts underwent XRF field screening. During sample collection activities, all soil material was visually inspected for the presence of bullets, bullet fragments, lead shot, and clay target fragments. Any observance of these materials was noted on the sample bag and subsequently on the respective soil sample log. The soil material was again visually inspected in the field laboratory during processing for XRF analysis.

Sample processing prior to field XRF analysis consisted of thoroughly homogenizing each soil sample within a large Ziploc® bag, removing rocks and other debris via a coarse sieve, placing a portion of that sample in a small aluminum pan, drying the sample in an electronic convection oven, and then manually processing the dried sample material to eliminate clods and produce a fine uniform particle size. Due to the relatively dry sandy soil conditions at most sample locations, average drying time for each sample was approximately 10 to 20 minutes. Each sample was then transferred to a smaller thin-walled Ziploc® bag from which three separate XRF measurements were made, one from each end and one from the center of the sample bag. The average lead concentration of the three readings was used as the final XRF lead concentration for the sample.

Prior to analyzing samples, the XRF was standardized in accordance with manufacturer instructions, and three known lead standards from the National Institute of Standards and Technology (NIST) were analyzed to verify the accuracy of the instrument and to assess the stability and consistency of the results.

After the initial screening with the XRF, 20 samples each from the TSA Ranges and the Pistol Butts were selected based on the screening criteria of 100 milligrams per kilograms (mg/kg) for analysis of lead and other select metals at the FBL. The objective was to send samples having an XRF lead concentration between 250 and 550 parts per million (ppm) to the FBL.

A general discussion of the correlation analyses is presented in Section 3.3, and a more detailed site-specific correlation analysis for each of the two MC sites is discussed in their respective site-specific sections (Sections 4.0 and 5.0), with supporting documentation included in Appendix F.

3.2.2.4 Sediment Sampling

Sediment samples in Lake Michigan were collected for the TSA Ranges, Machine Gun Range, and NTC Lakefront with the use of dredge samplers. In addition, upgradient sediment samples were collected for the TSA Ranges and NTC Lakefront. Ten discrete sediment samples were collected; three north of the TSA Ranges and seven north of the NTC Lakefront. Sediment samples were collected from 0 to 0.5-foot bss using either a petite Ponar dredge or a pneumatic modified Van Veen dredge in accordance with SOP-06 (Sediment Sampling) and SOP-08 (Large Body Water Sediment Sampling) in the UFP-SAP.

Samples were inspected for MEC/MPPEH, measured, photographed, logged, and placed into a stainless steel bowl and gently mixed. The samples were then transferred into the appropriate sample containers and placed on ice until they were shipped to the laboratory for select metals, PAH and/or select explosives analysis. Unused portions of a collected sample were returned to the water near the location of the sample.

The Sediment Sample Log Sheets are included in Appendix A. Sediment sample analyses are summarized in Sections 4.0, 6.0, and 7.0 of this report.

3.2.2.5 Quality Assurance/Quality Control Samples

QA/QC samples were generated and collected during sampling activities to monitor both field and laboratory procedures, in accordance with the approved UFP-SAP. QA/QC samples included field duplicates, equipment rinsate blanks, and temperature blanks. The duplicate sample analysis and the locations where they were collected are summarized in the site-specific sections of this report. The following types of QA/QC samples were collected during the SI:

Field Duplicates consisted of a single sample split into two portions. Field duplicates were collected at the rate of one per 10 during this field investigation to assess the overall precision of the sampling and analysis program.

Equipment Rinsate Blanks were obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through or over sample collection equipment after

decontamination and before use. Equipment rinsate blanks were analyzed for the same chemical constituents as the associated environmental samples at a rate of one per analyte per sampling method.

Temperature Blanks were used to determine if samples were adequately cooled during shipment. Temperature blanks consisted of analyte-free water supplied by Empirical. One temperature blank was submitted to the laboratory in each cooler, and the temperature was checked upon receipt at the laboratory.

A summary of all QA/QC samples collected during the investigation is provided Table 3-1. Sample log sheets were generated for each QA/QC sample and are provided in Appendix A.

3.2.3 Field Sample Documentation

The sample numbering scheme and sample labeling was in accordance with SOP-01, as detailed in the UFP-SAP (Tetra Tech, 2010). Sample documentation consisted of the completion of sample log sheets, chain-of-custody forms, field logbooks, and health and safety documentation. The sample log sheets contain information such as sample location and sample ID number, container requirements and analyses performed, and sample type, time, and date. Any unusual circumstances encountered during sample collection were noted on the form. Chain-of-custody forms (Appendix A) were used to track each sample from collection in the field to receipt and analysis at the laboratory.

3.2.4 Sample Handling, Packaging, and Shipping

Sample containers, preservation, packaging, and shipping were in accordance with the UFP-SAP. All sample containers shipped to the laboratory were sealed in plastic Ziploc® bags. The sample containers were then placed in a cooler lined with a large plastic garbage bag and covered with ice. A temperature blank was placed in each cooler prior to shipment. The plastic garbage bag was sealed with tape, and the chain-of-custody form was sealed in a Ziploc® bag and taped to the inside of the cooler lid. A signed and dated custody seal was applied to each end of the cooler and then covered with strapping tape to provide a tamper-evident seal. A Federal Express® airbill was applied to the shipping cooler. Tetra Tech maintained custody of the samples until they were relinquished to Federal Express®. The Federal Express® tracking number (airbill number) was recorded on each chain-of-custody form, and the sender's copy of the airbill was maintained for shipment tracking, if needed. All samples were shipped to the laboratory for overnight delivery and were received within sample holding times.

Laboratory sample custody procedures (receipt of samples, archiving, and disposal) were in accordance with Empirical SOPs, with the exception of three upgradient samples collected north of the TSA Range (NTC-SD-UPG001-0006 through NTC-SD-UPG003-0006). These three samples were not properly logged in by Empirical upon arrival at the FBL and were not analyzed for PAHs during the correct holding time. The samples were analyzed outside of holding time and the results are presented in this report for qualitative information only and will not be used for decision-making purposed.

3.2.5 Global Positioning System

Prior to mobilization for the field effort, all Geographic Information System (GIS) grade sample coordinates were uploaded into a hand-held global positioning system (GPS) unit capable of sub-meter accuracy (i.e., Trimble GeoHX). The GPS was then used in the field to locate the sampling points. The GPS coordinate system was set up so that all data points were collected in North American Datum of 1983 (NAD83) Illinois State Plane coordinates in US survey feet.

Upon location with the GPS, the sample locations were marked with a brightly colored pin flag with the sample ID written on each flag. Once all samples at a site were collected, a field team member returned to each individual sample location and updated the GPS coordinates by collecting actual sample location coordinates. GPS coordinates were collected at each location for a minimum of one minute during periods when satellite reception was optimal (i.e., greater than six available satellites).

3.2.6 Decontamination Procedures

Small reusable (non-dedicated) sampling equipment (e.g., hand auger, stainless steel bowl and spoon) was decontaminated prior to beginning sampling and between sample locations, in accordance with the UFP-SAP (SOP-11), using potable and deionized water with Liquinox® detergent.

At the conclusion of SI field activities, the FOL completed a final decontamination of all equipment, which was then shipped back to the appropriate vendor(s).

3.2.7 Investigation-Derived Waste

All decontamination and purge water was collected and containerized for off-site disposal during the field investigation. The IDW was handled in accordance with the UFP-SAP (Tetra Tech, 2010). Approximately 20 gallons of purge and decontamination water was generated during the field investigation. Approximately 25 gallons of IDW soil was generated during the investigation. The IDW drums were temporarily stored near the Pistol Butts Range west of the Naval Reserve Building prior to being

transported by NSGL to the base drum storage area. The drums were placed on 4-mm plastic sheeting, which was taped to provide secondary containment of the IDW. Flagging, wooden stakes, and labels were used to identify the IDW stored in two 55-gallon drums.

Table 3-1 provides a summary of the IDW analysis and sample identification.

IDW sample log sheets and IDW disposal documentation is provided in Appendix A.

3.2.8 Record Keeping

SI records included field forms, chain-of-custody forms, and field log books. Information recorded daily included field activities, weather conditions, identity, arrival, and departure times of personnel, management issues, etc.

3.3 ANALYTICAL METHODOLOGY

3.3.1 Analytical Methods

Chemical analysis for select metals (arsenic, antimony, copper, iron, lead, magnesium, strontium, and zinc), PAHs, select propellants (NG), select explosives (trinitrotoluene [TNT], hexahydro-1,3,5-trinitro-1,3,5-triazine [RDX], octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine [HMX], pentaerythritol tetranitrate [PETN], and n-methyl-N-2,4,6-tetranitroaniline [tetryl]), and Toxicity Characteristic Leaching Procedure (TCLP) was performed by Empirical. This subcontracted laboratory was DoD Environmental Laboratory Approval Program (ELAP) approved.

3.3.2 Data Usability General Methodology

Data review processes were used to determine whether analytical laboratory data were of acceptable technical quality for use in decision-making. The review began with data validation, which is a comparison of data quality indicators (DQIs) to prescribed acceptance criteria. The DQIs used are measures to assess the bias and precision of the analytical calibrations and sample analyses. The output of this review was a set of alphabetic flags such as "U," "J," "R," or combinations thereof that may have been assigned to individual results based on the validation effort. These flags were used to infer the general quality of the data. Also evaluated were the measures of data completeness, sensitivity, comparability, and representativeness. Validated analytical results are provided in Appendix D and the MC data usability report is provided in Appendix E.

3.3.3 Data Validation Process

Full data validation was completed for the data. Assignment of data qualification flags conformed to United States Environmental Protection Agency (USEPA) Contract Laboratory Program National Functional Guidelines for Organic Data Review (June 2008), USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Validation (October 2004) and Region III Modifications to the National Functional Guidelines for Organic and Inorganic Data Review (1995). Data validation specifications require that various data qualifiers be assigned when a deficiency is detected or when a result is less than its detection limit. If no qualifier is assigned to a result that has been validated, the data user is assured that no technical deficiencies were identified during validation. The qualification flags used are defined as follows:

"U" – Indicates that the chemical was not detected at the numerical detection limit (sample-specific detection limit) noted. Non-detected results from the laboratory are reported in this manner.

"UJ" – Indicates that the chemical was not detected; however, the detection limit (sample-specific detection limit) is considered to be estimated based on problems encountered during laboratory analysis. The associated numerical detection limit is regarded as inaccurate or imprecise.

"UL" - Indicates that the chemical was not detected; the quantitation limit is probably higher.

"J" – Indicates that the chemical was detected; however, the associated numerical result is not a precise representation of the concentration that is actually present in the sample. The laboratory reported concentration is considered to be an estimate of the true concentration.

"K"– Indicates that the chemical was detected; however, the reported value may be biased high. Actual value is expected to be lower.

"L" - Indicates that the chemical was detected; however, the reported value may be biased low. Actual value is expected to be higher.

"B" – Indicates that the chemical is not detected substantially above the level reported in the laboratory or field blanks.

"UR" – Indicates that the chemical may or may not be present. The non-detected analytical result reported by the laboratory is considered unreliable and unusable. The "UR" qualifier is applied in

cases of gross technical deficiencies (e.g., holding time missed by two times the specified time limit, severe calibration non-compliance, and extremely low QC recoveries).

"R" – Indicates that the chemical may or may not be present. The analytical result reported by the laboratory is considered unreliable and unusable. The "R" qualifier is applied in cases of gross technical deficiencies (i.e., holding times missed by a factor of two times the specified time limit, severe calibration noncompliances, and extremely low QC recoveries).

The preceding data qualifiers may be categorized as indicative of major or minor problems. Major problems are defined as issues that result in the rejection of data and qualification with "UR" or "R" qualifiers. These data are considered invalid and are not used for decision-making purposes unless they are used in a qualitative way and their use is justified and documented. Minor problems are defined as issues resulting in the estimation of data and qualification with "U", "J", "K", "L", "UL", and "UJ" qualifiers. Estimated analytical results are considered suitable for decision-making purposes unless the data use requirements are very stringent and the qualifier indicates a deficiency that is incompatible with the intended data use. A "U" qualifier does not necessarily indicate that a data deficiency exists because all non-detect values are flagged with the "U" qualifier regardless of whether a quality deficiency has been detected.

3.3.4 Data Validation Outputs

After data were validated, a list of non-conformities requiring data qualifier flags was developed to alert the data user to inaccurate or imprecise data. The reviewer then prepared a technical memorandum presenting qualification of the data, if necessary, and the rationale for making such qualifications. These data validation packages are included in the project file. The net result was a data package that had been carefully reviewed for its adherence to prescribed technical requirements. Pertinent quality estimates are summarized in a quantitative manner in the following section.

3.3.5 Data Quality Review

DQIs are parameters monitored to help establish the quality of data generated during an investigation. Some of the DQIs are generated from analysis of field samples (e.g., field duplicates) and some are generated from the analysis of laboratory samples (e.g., laboratory duplicates). Individually, field and laboratory DQIs provide measures of the performance of the respective investigative operations (field or laboratory). During data validation, individual QC results were evaluated. If individual QC results were

acceptable, no validation flag was assigned to an analytical result; otherwise, a flag indicating the type of QC deficiency was assigned to the result.

Completeness

Completeness is a measure of the number of valid samples or measurements that are available relative to the number of samples or measurements that were intended to be generated. For this project, completeness was measured on two bases: samples collected and laboratory measurements.

Samples collected was a measure of the usable samples collected compared to those intended to be collected.

Laboratory measurement was a measure of the amount of usable, valid laboratory measurements per matrix obtained for each target analyte.

Usable, valid samples (or results) were those judged, after data assessment, to represent the sampling populations and to have not been disqualified for use through data validation or additional data review. Completeness was determined using the following equation:

$$\%C = \frac{V}{T} \times 100$$

where %C = percent completeness
V = number of samples (or results) determined to be valid
T = total number of planned samples (or results)

Sensitivity

Sensitivity is a measure of the lowest concentration of an analyte in a particular sample matrix that can be detected. A sensitivity analysis was conducted by comparing project action limits (PALs) to the reported non-detect values. This comparison was conducted to determine whether the achieved sensitivity is sufficient to satisfy the PALs listed on Worksheet #15 of the SAP (or subsequent updates),

Accuracy

Accuracy requirements for field measurements are typically ensured through control over sample collection and handling and through routine instrument calibration. Field accuracies were monitored

using blanks to detect cross-contamination and by monitoring adherence to procedures that prevent sample contamination or degradation. Equipment rinsate blanks were collected during the SI to assess cross-contamination via sample collection equipment. The blank was obtained under representative field conditions by collecting the rinse water generated from running analyte-free water through the sample collection equipment after decontamination and before use. The rinsate blank was analyzed for the same chemical constituents as the associated environmental samples.

Accuracy in the laboratory was measured through the comparison of a spiked sample or laboratory control sample/laboratory control sample duplicate (LCS/LCSD) result to a known or calculated value and was expressed as a %R. Accuracy was also assessed by monitoring the analytical recovery of select surrogate compounds added to samples that are analyzed by organic chromatographic methods. LCSs were used to assess the accuracy of laboratory operations with minimal sample matrix effects. Matrix spike/matrix spike duplicate (MS/MSD) and surrogate compound analyses measure the combined accuracy effects of the sample matrix, sample preparation, and sample measurement. LCS and MS analyses were performed at a frequency of one per 20 associated samples of like matrix. Laboratory accuracy was assessed by comparing calculated %R values to accuracy control limits specified by the laboratory using the appropriate SW-846 Method.

%R is calculated using the following equation:

$$\%R = \frac{Ss - So}{S} \times 100$$

where %R = percent recovery
Ss = result of spiked sample
So = result of non-spiked sample
S = concentration of spiked amount.

Precision

Precision is a measure of the degree to which two or more measurements agree and describes the reproducibility of measurements of the same parameter for samples analyzed under similar conditions. Precision for chemical parameters is expressed as a relative percent difference (RPD), which is defined as the ratio of the difference to the mean for the two values being evaluated. RPDs, typically expressed as percentages, are used to evaluate both field and laboratory duplicate precision and are calculated as follows:

$$RPD = \frac{|V1 - V2|}{(V1 + V2)/2} \times 100$$

where RPD = relative percent difference
V1, V2 = two results obtained by analyzing duplicate samples

The precision estimates obtained from duplicate field samples encompass the combined uncertainty associated with sample collection, homogenization, splitting, handling, laboratory and field storage (as applicable), preparation for analysis, and analysis. In contrast, precision estimates obtained from analyzing duplicate laboratory samples incorporate only homogenization, subsampling, preparation for analysis, laboratory storage (if applicable), and analysis uncertainties.

Comparability

Comparability is defined as the confidence with which one data set can be compared to another (e.g., among sampling points and among sampling events). Comparability was achieved by using standardized sampling and analysis methods and standardized data reporting formats. Comparability of field data was insured by following the UFP-SAP (Tetra Tech, 2010). Comparability of laboratory measurements was achieved primarily through the use and documentation of standard sampling and analytical methods. Results were reported in units that ensured comparability with previous data and with current state and federal standards and guidelines. Comparability of laboratory measurements was assessed primarily using QC samples and through adherence to the laboratory's QA plans.

Representativeness

Representativeness is an expression of the degree to which data accurately and precisely depict the actual characteristics of a population or environmental condition existing at the site. The UFP-SAP (Tetra Tech, 2010), use of standardized sampling, sample handling, sample analysis, and data reporting procedures were designed so that the final data would accurately represent actual site conditions. It is believed that all reported data are adequately representative of site conditions.

3.4 CORRELATION BETWEEN X-RAY FLUORESCENCE AND FIXED BASE LABORATORY

From soil samples that were analyzed in the field using XRF and at Empirical, a regression analysis was conducted to evaluate the correlation between the laboratory lead results and XRF lead results. To evaluate the regression analysis, the Pearson Correlation and R-squared value were calculated. The

Pearson Correlation is a measure of the strength of the linear relationship between two or more variables with a range of -1 to +1. The value of -1 represents a perfect negative correlation (i.e., as one variable decreases the other increases proportionally); whereas, a value of +1 represents a perfect positive correlation (i.e., as one variable increases the other increases proportionally). A value of 0 represents a lack of correlation.

The correlation analysis results for the two sites are presented in Sections 4.0 and 5.0, with supporting documentation included in Appendix F.

3.5 DATA USABILITY ASSESSMENT

Adherence to laboratory QC measures and field measurement requirements was evaluated partially in the data validation process described in Section 3.4. Biases and imprecision identified during that process as well as data comparability, sensitivity, representativeness, and completeness were evaluated further to determine whether the data were of sufficient type, quantity, and quality to support the decision-making required by the UFP-SAP (Tetra Tech, 2010).

The data usability process was completed in accordance with Worksheet #37 of the UFP-SAP (Tetra Tech, 2010).

3.6 DATA COMPARISON TO PROJECT ACTION LIMITS

Screening criteria PALs were evaluated and chosen based on the rationale presented in this report. The tables presented in Appendix D show the PALs, rationale, PAL references, the screening criteria that were evaluated and used for comparison to chemical concentrations to determine if and where exceedances occurred, and the minimum and maximum MDLs achieved by the FBL. If an analyte concentration in any sample within the study area exceeded the PAL, the project team evaluated whether further investigation was warranted at a given site. Any future actions would be documented in a future UFP-SAP. Detailed discussions regarding site-specific PAL evaluations are presented in the site-specific sections of this report.

This investigation required field measurements and FBL chemical analyses data that were used to determine whether further investigation is necessary. If individual MC analytes (inorganics, PAHs, NG, or select explosives) are detected in any sample at concentrations that exceed PALs then the Project Team may recommend proceeding to an RI for the site. If MC concentrations in the samples do not exceed PALs in all samples, then NFA for MCs may be recommended for that particular site.

Detailed discussions regarding site-specific PAL evaluations for the four sites are presented in Sections 4.0 through 7.0 of this report.

BaP Equivalents

The USEPA has identified seven PAHs as potentially carcinogenic, these include: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)-pyrene. Of these PAHs, benzo(a)pyrene has been subjected to the most toxicological study and the USEPA has used the toxicological data to establish quantitative toxicological parameters (cancer slope factors and inhalation unit risks) for benzo(a)pyrene. All seven of these PAHs have a similar chemical structure and similar chemical properties. For example, these PAHs have relatively low solubility in water, have low potential to volatilize into the air and have a propensity for adsorbing to soil rather than dissolving in water once they are in the environment. Laboratory studies suggest that these chemicals act similarly from the perspective of carcinogenicity and that the carcinogenic potency of the individual PAHs can be evaluated with reference to the carcinogenic potency of benzo(a)pyrene. Therefore, the USEPA has developed a toxicity equivalency factor (TEF) for each potentially carcinogenic PAH that can be used to convert the concentration of that PAH to an equivalent concentration of benzo(a)pyrene. Since benzo(a)pyrene is often abbreviated BaP, this process is known as determining the BaP equivalent concentration.

The TEFs for the seven potentially carcinogenic PAHs are given in the table below:

PAH	TEF
Benzo(a)pyrene	1.0
Benz(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenz(a,h)anthracene	1.0
Indeno(1,2,3-c,d)pyrene	0.1

The BaP equivalent concentration was calculated for each sample using the following four step process:

First, for any potentially carcinogenic PAH that was not detected, half the reporting limit was used as the concentration for that PAH. Second, the concentration of each potentially carcinogenic PAH was multiplied by its TEF to give its BaP equivalent concentration. Third, the BaP equivalent concentrations

for all potentially carcinogenic PAHs were summed to give the total BaP equivalent concentration. Fourth, if no potentially carcinogenic PAHs were detected in a sample, the reporting limit for benzo(a)pyrene was used as the total BaP equivalent concentration.

For those sites where PAHs are of concern (i.e., trap and skeet ranges), the site-specific detection tables present the concentrations of potentially carcinogenic PAHs in each discrete surface soil and sediment sample submitted for analysis of PAHs. These tables also provide the resulting total BaP equivalent concentration for each sample. The total BaP equivalent concentrations are compared to risk-based screening levels (RBSLs) for BaP for direct contact exposures to soil (i.e., incidental ingestion, dermal contact, and inhalation of constituents emitted from soil to the air) as well as ecological screening levels for BaP concentrations in sediments.

Illinois EPA TACO Background Screening

A 95 percent Upper Confidence Limit (UCL) is the upper bound of the associated confidence interval on the mean. Exposure assessment and cleanup decisions in support of USEPA projects are often made based upon the mean concentrations of the contaminants of potential concern. A 95 percent UCL of the unknown population arithmetic mean is often used to estimate the exposure point concentration (EPC) term (USEPA 1992; USEPA 2002). Therefore, it is important to compute a reliable, conservative, and stable 95 percent UCL of the population mean using the available data. There are several methods for calculating 95 percent UCLs depending on the data distribution that can be used to model the sample data and the amount of censoring that is present (percent of non-detected concentrations). Pro UCL version 4.05 was used to calculate the appropriate UCLs. Then the UCL was compared to the Illinois EPA Tiered Approach to Corrective Action Objectives (TACO) criteria. If the UCL was less than the TACO criteria it was determined that the chemical was within background, if the UCL was greater than the TACO criteria then it was determined that the chemical was greater than background.

For sediment samples where upgradient samples were taken, a comparison of the site concentrations to the upgradient concentrations was conducted using the Wilcoxon Rank Sum Test. The null hypothesis was that the median site concentrations are greater than the median upgradient site concentration plus one upgradient standard deviation. The alternative hypothesis was that the median site concentration is less than the median upgradient concentration plus one upgradient standard deviation. A five percent significance level was used to determine if the site concentrations are within the upgradient concentrations.

TABLE 3-1

SUMMARY OF QA/QC SAMPLES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Sample Number	Date Collected	Medium	Analyses
QA/QC			
EB042210-1	4/22/10	Rinsate/Equipment Blank - DPT drill rod/cutting shoe	Select Metals[1]
EB042310-1	4/23/10	Rinsate/Equipment Blank – hand auger	Select Metals[1], PAHs, Nitroglycerin
RB052110-1	5/21/10	Rinsate/Equipment Blank - Modified Van Veen Dredge	Select Explosives[2], Select Metals[1], PAHs
Trip Blank # 7795	4/23/10	Trip Blank	VOCs
IDW			
IDW001	4/23/10, 5/20/2010[3]	IDW – Waste Characterization	TCLP VOCs, TCLP SVOCs, TCLP Metals, TCLP Herbicides/Pesticides, PCBs, Phenols, Reactive Cyanide/Sulfide, Total Solids, Paint Filter Test, Density, Flashpoint, and pH.
IDW002	4/23/10	IDW – Waste Characterization	

1 Select metals include antimony, arsenic, and lead.
2 Select explosives include HMX, RDX, PETN, TNT, and tetryl.
3 Sample was re-collected for VOCs due to bottle breakage during transport to the laboratory.

IDW – Investigation-derived waste
QA/QC – Quality assurance/quality control
SVOC – Semivolatile organic compound
TCLP – Toxicity Characteristic Leachate Procedure
VOC – Volatile organic compound

4.0 TSA RANGES

4.1 SITE BACKGROUND

The former TSA Ranges (including the land and water portions) encompasses approximately 30.5 acres. The land portion of the TSA Ranges is a small area (approximately 1.1 acre), located east of the bluff on the beachfront of Lake Michigan. The site consisted of a trap range, a skeet range, and an archery range. Only the skeet and trap ranges are the subject of this SI. Fill material was placed at the site to extend the shoreline for the addition of the skeet range to the installation. Structures associated with the skeet and trap ranges and firing lines were located on the land. The shotfall zone, which is defined as the maximum extent that lead shot would travel extends into Lake Michigan. This encompasses an area of approximately 29.4 acres [consisting of overlapping areas for the skeet range (29 acres) and the trap range (6.6 acres)] located over Lake Michigan, as shown on Figure 4-1. The site originally consisted of only the trap range (constructed in the early 1940's), which was used in conjunction with the NTC Lakefront for Navy personnel to first experience targeting a moving object before handling the large caliber AA guns. The use of the trap range in conjunction with the AA training center ended with the closing of the NTC Lakefront site in October 1945; however, the trap range was likely used recreationally afterward, as it was common practice to allow enthusiasts to enjoy these ranges to offset costs for maintenance. Based on the construction drawings for the site, the skeet and archery ranges were added to the site in 1968 and were likely used for recreational purposes and for military practice sessions. Munitions use was limited to small arms ammunitions, primarily shotgun ammunition.

The equipment storage building and trap/skeet houses that were originally located at the site were demolished, and the ranges were decommissioned. Construction of a recreational vehicle (RV) park in July 2000 (RV sites, 10 tent sites, and one group camping site) within the TSA Ranges removed all visible signs of the ranges and associated structure, such as the trap house. No prior site investigations have been conducted at the NSGL TSA Ranges.

Figure 4-1 depicts the TSA Ranges and associated range features.

4.1.1 Historical Munitions Usage Information

Archival data for ammunition orders from the 1940s and 1950s included the following munitions-related items that may have been used at the site:

- Shotguns, 12-gauge with slide repeating action and modified choke, 26-inch or 28-inch barrel.
- Shells, shotgun, 12-gauge, No. 7 ½ shot.
- Targets, clay pigeon.

During the 2008 visual survey of the site by Malcolm Pirnie, no physical evidence of the skeet range firing arc and trap range firing points/stations was visible due to the construction of the RV park. Additionally, no evidence of broken clay targets was observed during the site walk. However, during the SI sampling activities, broken clay targets and shotgun shell wadding were observed in the surface soils of the erosional surface near the shoreline of the Trap Range. The TSA Ranges was dedicated to the use of small arms; therefore, MEC is not expected to be present at the site. In addition, based on the information obtained during the data collection process, no special consideration munitions are known or suspected to have been used at the site. Therefore, the TSA Ranges is not suspected to contain chemical warfare material filled munitions, electrically fuzed munitions, or depleted uranium associated munitions.

4.1.2 Munitions Constituents

For shotgun ammunition and clay targets, the primary MC of concern include lead from shot and PAHs from pitch tar used in the manufacturing of clay pigeons to help bind the clay particles. Other associated MC less likely to be of concern may include antimony and arsenic (which may be present in lead). Lead accounts for more that 95 percent of the weight of the projectile (ITRC, 2003). Antimony is added to bullets as a hardening agent in quantities ranging from 0.1 to 2 percent. Arsenic is naturally present in lead at trace levels (0.001 to 0.06 percent). Antimony and arsenic, if present, would be spatially correlated with the lead because they are associated with lead in the bullets. The USEPA screening value commonly used to indicate the presence of potentially unacceptable levels of antimony in soil and sediment is 31 mg/kg; the screening value for arsenic is 0.39 mg/kg and is within the typical soil background concentrations according to TACO of 13 mg/kg. Using the relative concentrations of these metals in projectiles, lead would have to be present in soil or sediment at a concentration greater than 600 mg/kg for arsenic or antimony from bullets to be present at potentially unacceptable levels for effects on human health. Therefore, lead, which is easier to measure in some prospects, is a useful indicator of potentially unacceptable concentrations of any of these five metals in soil or sediment. These MC components are not consumed when the munitions items function as they are designed. Therefore, these MC may exist at the TSA Ranges.

4.2 SITE FIELDWORK

4.2.1 Site Field Activities

The SI field program for the TSA Ranges included collection of surface soil samples (0 to 0.5 foot bgs) on the land portion of the site, and sediment samples (0 to 0.5 feet below sediment surface [bss]) from the area of the site within Lake Michigan to identify contaminants of potential concern (COPCs) (e.g., select metals and PAHs) that may exist as a result of past operations at the ranges. Soil and sediment sample log sheets are included in Appendix A. Photographs associated with the sampling activities at the TSA Ranges are presented in Appendix B.

Surface Soil Sampling

Table 4-1 lists the soil samples that were collected at the TSA Ranges. All surface soil samples were analyzed in the field utilizing XRF with a subset of those samples selected for submittal to the FBL for select metals analysis (lead, antimony, and arsenic). All sediment samples were submitted to the FBL for PAH and metals analysis. A correlation study comparing XRF and the FBL analytical data was completed after the field efforts to establish laboratory equivalent lead concentrations based on the field measurements, and to use as a correlation analysis between XRF and the FBL lead concentrations. This correlation is discussed in Section 4.5.

Soil sample locations were selected based on a bias toward areas that were believed to be most likely contaminated by past operations at the site. Figures 4-2 and 4-3 present the surface soil sample locations for the Trap Range and Skeet Range areas of the TSA Ranges, respectively. Prior to initiating sample collection, all terrestrial sample locations were marked by brightly colored pin flags bearing the sample location ID number. Sample locations identified in the approved UFP-SAP were located using a Trimble GeoHX sub-meter GPS unit. Upon collection of all the samples at the ranges, the GPS was used to update the sample coordinates using the horizontal datum: NAD 83 Illinois State Plane Coordinate System east.

Sediment Sampling

Table 4-1 includes the sediment samples that were collected at the TSA Ranges. As part of the SI sediment sampling event for the TSA Ranges, 18 sediment samples were collected from within Lake Michigan. Figures 4-2 and 4-3 present the sediment sample locations for the Trap Range and Skeet Range sites, respectively.

4.2.2 Work Plan Deviations

The only deviation from the UFP-SAP (Tetra Tech, 2010) for the TSA Ranges SI was that of the proposed 60 soil samples to be field analyzed by XRF, only 57 samples were able to be collected and analyzed due to three sample being composed of only coarse sand and gravel from the small beach area near the surf zone. Therefore, there was no soil associated with samples NTC-SD-TSA-054 through NTC-SD-TSA-056 and they were not analyzed by XRF for the site.

4.2.3 Field Data Collection

Surface Soil

Fifty-seven discrete surface soil samples were collected from 57 sample locations during the SI at the TSA Ranges in accordance with SOP-05 of the UFP-SAP. Sample locations were selected based on a spatial grid pattern to cover the land portion of the site immediately in front of the former firing arch and firing point for the trap and skeet ranges. A 0 to 0.5-foot bgs sample was collected at each sample location with the use of a hand auger. All samples underwent field XRF analysis for lead in accordance with SOP 10 of the UFP-SAP, and 20 samples were subsequently chosen for select metals (antimony, arsenic, and lead) analyses at the FBL by Method SW-846 6010B. In addition, the same 20 samples were submitted for PAH analyses by Method SW-846 8270C SIM. All samples chosen for metals laboratory analysis were selected from samples having an XRF lead concentrations greater than 100 parts per million (ppm).

All samples for metals analyses were placed in large Ziploc® bags and thoroughly homogenized prior to processing a portion for XRF analysis. For samples selected for laboratory analysis, a portion of the sample was placed in the appropriate sample jar and shipped to the FBL for select metals analyses.

Sediment

Sediment samples were collected in accordance with SOP-06 and SOP-08 of the UFP-SAP. A total of 18 sediment samples were collected from Lake Michigan for the TSA Ranges. Seven near shore shallow water (less than 6 feet) sediment samples, and six deep water (greater than 6 feet) sediment samples were collected for the Skeet Range area. Five deep water sediment samples were collected for the Trap Range area. The shallow water sediment samples were collected using a petite Ponar dredge from a Zodiac™ inflatable boat. The deep water sediment samples were collected using a modified pneumatic Van Veen dredge from a survey vessel.

All sediment samples were submitted to the FBL for laboratory analyses of select metals (antimony, arsenic, and lead) by Method SW-846 6010B and PAHs by SW-846 8270C SIM.

Table 4-1 provides a summary of the samples collected and their respective analysis at the TSA Ranges. Figures 4-2 and 4-3 show the soil sampling and sediment sampling locations for the Trap Range area and Skeet Range area, respectively. Soil and sediment sample log sheets are included in Appendix A of this document.

Upgradient Sampling Locations

Three discrete sediment samples (SD-UPG001 through SD-UPG003) were collected at sample locations upgradient (north) of the surface danger zone (SDZ) of the TSA Ranges and seven discrete samples (LAK-UPG004 through LAK-UPG010) were collected upgradient (north) of the SDZ of the NTC Lakefront using the modified pneumatic Van Veen sampling method. All 10 sediment samples were submitted to the laboratory analysis for select metals (antimony, arsenic, copper, iron, lead, magnesium, strontium, and zinc) by method SW-8946 6010B and three samples for PAHs analyses by Method 8270C. Figure 4-4 shows the upgradient sediment sampling locations for the TSA Ranges.

4.3 SITE INSPECTION DATA COLLECTION RESULTS

4.3.1 MC Sampling Results

Soil and sediment samples collected at the TSA Ranges were compared to respective PALs as listed in Worksheet #15 of the UFP-SAP (Tetra Tech, 2010). The chemical reference limits and background evaluation table and the complete validated FBL data tables are presented in Appendix D.

Table 4-2 summarizes the XRF lead results for the surface soil samples collected at the TSA Ranges. The lead PAL for the FBL analyses is 400 mg/kg, and was based on the Illinois EPA residential Tier 1 soil remediation objectives. The project field screening level for the field XRF analyses was 100 mg/kg, which was selected as a conservative measure and is one-quarter of the Illinois EPA residential Tier 1 soil remediation objective.

Tables 4-3 and 4-4 present the metals (antimony, arsenic, and lead) and PAH detections in the soil and sediment samples at the TSA Ranges, respectively. The data comparison to PALs is discussed in Section 4.6. Figures 4-5 and 4-6 present the select metals (antimony, arsenic, and lead) detections in the soil samples at the Trap Range and Skeet Ranges areas of the TSA Ranges, respectively. Figures 4-7

and 4-8 present the PAH detections in the soil samples at the Trap Range and Skeet Ranges, respectively. Figure 4-9 presents the select metals (antimony, arsenic, and lead) exceedances in the sediment samples at the TSA Ranges.

4.4 DATA PRESENTATION/DATA USABILITY

4.4.1 Data Quality Review of Samples at the TSA Ranges

This section contains a description of the data review processes used to determine whether analytical laboratory data collected during the sampling field effort for the TSA Ranges were of acceptable quality for use in decision-making. The review began with data validation, which is a comparison of DQIs against the prescribed acceptance criteria. The DQIs are measures used to assess the completeness, sensitivity, accuracy, precision, comparability, and representativeness of the sample collection and sample analysis process. The output of this review was a set of alphabetic flags such as "U," "J", "R," or combinations thereof, assigned to individual results based on the validation effort. These flags were used to infer the general quality of the data and if data quality meets the data quality objectives (DQOs) of the project. The DQOs presented in the approved UFP-SAP (Tetra Tech, 2010) were maintained through the course of the sampling event. Worksheets #15 and #19 of the UFP-SAP present the analytical methods and compounds analyzed.

4.4.1.1 Data Validation Process

All of the FBL sample results were validated according to several specifications. Assignment of data qualification flags conformed to rules established in USEPA National Functional Guidelines for Organic Data Validation (October 1999), USEPA National Functional Guidelines for Inorganic Data Validation (October 2004), and Department of Defense (DoD) document entitled Quality Systems Manual (QSM) for Environmental Laboratories (January 2006 and April 2009) to the greatest extent practicable for non-contract laboratory program data.

Several samples analyzed for various parameters were qualified due to numerous issues. Appendix D contains the data validation reports, which outline the specific qualification reasons for each sample according to the parameter.

4.4.1.2 Data Quality Review

Some of the DQIs are generated from the analysis of field samples (e.g., field duplicates) while others are from the analysis of FBL samples (e.g., laboratory duplicates). Individually, field and FBL DQIs provide

measures of the performance of the respective investigative operations (field or laboratory). If individual QC results were unacceptable, there was an assignment of a validation flag indicating the type of QC deficiency impacting the result. Supporting documentation regarding the data presentation and usability for the TSA Ranges is presented in Appendix E.

4.4.1.3 Completeness

The field XRF field screening of surface soil was 95 percent complete. The surface soil and sediment FBL sample collection and FBL analytical completeness for the TSA Ranges were 100 percent.

4.4.1.4 Sensitivity

The Project Quantitation Limit Goals (PQLGs) for each analyte were listed in Worksheet #15 of the UFP-SAP (Tetra Tech, 2010). Analytical sensitivity for the TSA Ranges data was satisfactory to meet the DQOs presented in the UFP-SAP.

4.4.1.5 Field and Laboratory Accuracy

There were no QC deficiencies noted for field or FBL precision for the TSA Ranges.

4.4.1.6 Field and Laboratory Precision

The PAH compounds 2-methylnapthalene, acenaphthene, anthracene, benzo(a)pyrene, benzo(k)fluoranthene, chrysene, naphthalene, and phenanthrene were qualified due to field duplicate imprecision for the field duplicate pair of sample TSA-053 because of noncompliant relative percent differences (RPDs) ranging from 53 to at most 200 percent. Fluoranthene was qualified due to field duplicate imprecision for the field duplicate pair of sample TSA-059 because of a noncompliant RPD of 72 percent. Benzo(a)pyrene was qualified due to field duplicate imprecision for the field duplicate pair of sample TSA-074 because of a noncompliant RPD of at least 200 percent.

No data was qualified due to laboratory duplicate imprecision.

4.4.1.7 Comparability

Comparability is defined as the confidence with which one data set can be compared with another (e.g., among sampling points and among sampling events). Comparability was achieved by using standardized sampling and analysis methods, as well as standardized data reporting formats.

Comparability of laboratory measurements was achieved primarily through the use and documentation of standard sampling and analytical methods. Results were reported in units that ensured comparability with current state and federal standards and guidelines. Comparability of laboratory measurements was assessed primarily through the use of QC samples and through adherence to the quality assurance (QA) plan. The data comparability for the TSA Ranges was deemed acceptable.

4.4.1.8 Representativeness

The UFP-SAP (Tetra Tech, 2010) and the use of standardized sampling, sample handling, sample analysis, and data reporting procedures were designed so that the final data would be accurate representations of actual site conditions. Based upon the field logs indicating the conditions during sample collection and FBL audits, all reported data are adequately representative of site conditions of the TSA Ranges.

4.5 LEAD CORRELATION BETWEEN FIELD XRF ANALYSIS AND FBL

All soil samples collected from the TSA Ranges were analyzed with XRF, with the exception of three samples, which had no soil remaining after removing the coarse sand and gravel. At the Trap Range, six of the 20 surface soil samples analyzed in the field with XRF had average lead concentrations exceeding the field screening level of 100 mg/kg, with concentrations ranging from 115 to 146 mg/kg (Table 4-2). These six samples were sent to the FBL for lead analysis. The highest concentrations of lead in the Trap Range were located in the area closest to the shoreline. No lead shot was observed in the samples; however, fragments of clay pigeon and shotgun shell wadding were visually observed during the SI field activities in this area of the site. Fragments of clay pigeon and shotgun shell wadding were removed from the soil sample prior to conducting the XRF lead analysis.

At the Skeet Range, 14 of the 37 soil samples analyzed in the field with XRF had average lead concentrations exceeding the field screening level of 100 mg/kg, with concentrations ranging from 24 to 468 mg/kg (Table 4-2). The highest concentrations of lead were located in the area closest to the firing line of the range.

From the samples that were analyzed in the field using XRF and at the FBL, a regression analysis was conducted to evaluate the correlation between the FBL lead results and XRF lead results. To evaluate the regression analysis, the Pearson Correlation and the R-squared value were calculated. The Pearson Correlation is a measure of the strength of the linear relationship between two or more variables with a range of -1 to +1. The value of -1 represents a perfect negative correlation (as one variable decreases

the other increases proportionally); whereas, a value of +1 represents a perfect positive correlation (as one variable increases the other increases proportionally). A value of 0 represents a lack of correlation.

The correlation between the XRF and FBL concentrations is -0.017 and the corresponding R^2 value is 3E-4. The correlation indicates a weak linear relationship. Therefore, the correlation between the XRF and FBL is not acceptable as outlined by the UFP-SAP. FBL concentrations cannot be predicted from XRF concentrations for the TSA Range. The regression analysis is presented in Appendix F.

4.6 DATA COMPARISON TO PROJECT ACTION LIMITS

4.6.1 Identification of Chemicals Exceeding Project Action Limits

Twenty of the 57 surface soil samples collected from the TSA Ranges were submitted to the FBL for select metals (arsenic, antimony, and lead) and PAH analysis. Six surface soil samples were selected from the Trap Range area of the TSA Ranges (TSA-015 through TSA-018, TSA-059, and TSA-060), and 14 soil samples were selected from the Skeet Range area of the TSA Ranges (TSA-020, TSA-021, TSA-023, TSA-028, TSA-030, TSA-031, TSA-038, TSA-039, TSA-041, TSA-044, TSA-050 through TSA-053). Additionally, six sediment samples from the Trap Range area (TSA-061 through TSA-066), and 12 sediment samples from the Skeet Range area (TSA-067 through TSA-078), were submitted to the FBL for select metals and PAH analysis.

The laboratory concentrations for the surface soil samples were compared to both the human health-derived PAL and the ecological-derived PAL for screening purposes to determine if further investigation is necessary. In addition, the Illinois EPA Tiered Approach to Corrective Action Objectives (TACO) area soil background concentrations for each metal and PAH were listed in the table for comparison purposes. All of the soil samples collected from the TSA Ranges were surface samples (0 to 0.5 feet bgs).

The laboratory concentrations for the sediment samples were compared to the ecological PAL for screening purposes to determine if further investigation is necessary. In addition, the data was compared to the site-specific background sediment sample concentrations for select metals and PAHs for evaluation purposes. All of the sediment samples collected from the TSA Ranges were collected 0 to 0.5 feet below the sediment surface (bss) of the lake.

Tables 4-3 and 4-4 summarize the laboratory analytical detection results as compared to the PALs for the TSA Ranges' surface soil and sediments samples, respectively. If a parameter exceeded its respective PAL in any sample, the parameter was highlighted (human health) or bolded (ecological). The parameter

was highlighted and bolded if the concentration exceeded both the human health and the ecological screening criteria for the soil data.

Three discrete sediment samples (SD-UPG001 through SD-UPG003) were collected at sample locations upgradient (north) of the SDZ of the TSA Ranges. All three sediment samples were submitted to the laboratory for select metals (antimony, arsenic, copper, iron, lead, magnesium, strontium, and zinc) and PAHs analyses. Concentrations of select metals and PAHs in the upgradient sediment samples were compared to the sediment samples collected within the TSA Range area for evaluation purposes. Table 4-4 summarizes the laboratory analytical detection results for the upgradient samples.

4.6.1.1 Select Metals and PAHs in Soil – Trap Range

Select Metals and PAHs – Laboratory Analyses

All six XRF soil samples that exceeded the field lead screening level (100 mg/kg) for the Trap Range area were subsequently submitted to the FBL for select metals and PAH analysis. Below is a discussion of the select metals and PAH laboratory results for these samples.

Lead

Lead laboratory analytical soil sample concentrations ranged from 127 to 193 mg/kg. None of the surface soil samples submitted for laboratory analyses exhibited lead concentrations exceeding the human health PAL of 400 mg/kg (Figure 4-5 and Table 4-3). However, all six samples exhibited exceedances of the ecological PAL of 11 mg/kg for lead. In addition, all six samples showed concentrations, which exceeded the Illinois EPA soil background concentration for lead of 36 mg/kg.

Antimony

Antimony laboratory analytical concentrations ranged from 0.641 to 1.07 mg/kg. None of the surface soil samples submitted for laboratory analyses exhibited antimony concentrations exceeding the human health PAL of 31 mg/kg (Figure 4-5 and Table 4-3). However, all six samples exhibited exceedances of the ecological PAL of 0.27 mg/kg. In addition, all six samples showed concentrations less than the Illinois EPA background concentration for antimony of 4 mg/kg. A statistical comparison of the exposure point concentration, represented by the 95 percent upper confidence limit of the mean, to the Illinois EPA background soil concentrations for antimony indicates that the concentrations of antimony detected in the soil samples collected from the Trap Range area are within the range of naturally occurring antimony concentrations in the area of the site (Appendix G).

Arsenic

Arsenic laboratory analytical concentrations ranged from 8.51 to 10.7 mg/kg. All six of the surface soil samples submitted for laboratory analyses exhibited arsenic concentrations exceeding the residential human health PAL of 0.39 mg/kg (Figure 4-5 and Table 4-3). Additional screening of the arsenic concentrations against the TACO construction worker ingestion criteria of 61 mg/kg indicated no exceedances. However all detected concentrations exceed the USEPA industrial screening level of 1.6 mg/kg.

None of the six samples exhibited exceedances of the ecological PAL of 18 mg/kg. In addition, all six samples showed concentrations less than the Illinois EPA background concentration for arsenic of 13 mg/kg. A statistical comparison of the exposure point concentration, represented by the 95 percent upper confidence limit of the mean, to the Illinois EPA background soil concentrations for arsenic indicates that the concentrations of arsenic detected in the soil samples collected from the Trap Range area are within the range of naturally occurring antimony concentrations in the area of the site (Appendix G).

PAHs

Table 4-3 summarizes the analytical results and any exceedance as compared to the screening PALs for PAHs. In Table 4-3, if a parameter exceeded the PAL at any sampling point, the parameter was highlighted (human health PAL exceedance), bolded (ecological PAL exceedance), or highlighted and bolded if both PALs are exceeded.

Six surface soil samples were sent to the FBL for PAH analysis. Nine PAHs were detected in the surface soil samples collected from the Trap Range area of the TSA Ranges at concentrations in excess of a PAL screening criteria (either human health, ecological, or both). The PAHs detected in at least one of the samples include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)anthracene, and pyrene. Five of the six samples exhibited concentrations of several PAHs in excess of a PAL. The only sample which did not have concentrations of individual PAHs at elevated concentrations was TSA-060, located in the northern portion of the Trap Range area.

In addition, the benzo(a)pyrene (BaP) equivalent concentration exceeded the human health PAL in all six of the surface soil samples, ranging from 121 to 20,279 µg/kg. A description on how the BaP equivalent

concentration was derived is presented in Section 3.6. Table 4-3 presents the calculated BaP equivalent concentrations. The BaP equivalent residential human health PAL is 90 µg/kg. The ecological PAL is 1,100 µg/kg for individual high molecular weight PAHs, and 29,000 µg/kg for individual low molecular weight PAHs.

The PAHs are believed to be associated with the fragments of the clay pigeons used as targets on the trap range. A pitch tar containing PAHs was used in the manufacture of the clay pigeons to help bind the clay particles. Any observance of clay target remnants was noted in the sample log sheets (Appendix A). Appendix D includes the full analytical results for the PAHs analyzed.

4.6.1.2 Select Metals and PAHs in Sediment – Trap Range

Below is a discussion of the select metals and PAHs detected in the sediment samples collected from the TSA Ranges – Trap Range area submitted to the FBL for analyses:

Lead

Lead laboratory analytical sediment sample concentrations ranged from 16.6 to 23.5 mg/kg for the Trap Range area. None of the sediment samples submitted for laboratory analyses exhibited lead concentrations exceeding the ecological PAL of 35.8 mg/kg (Table 4-4).

Antimony

All six of the sediment samples collected from the Trap Range area exhibited antimony concentrations below the laboratory detection limit, which is less than the ecological PAL of 2 mg/kg (Table 4-4).

Arsenic

Arsenic laboratory analytical sediment sample concentrations ranged from 2.6 to 3.03 mg/kg in the Trap Range area. None of the sediment samples submitted for laboratory analyses exhibited arsenic concentrations exceeding the ecological PAL of 9.79 mg/kg (Table 4-4).

PAHs

None of the sediment samples collected for the Trap Range area exhibited concentrations of any PAHs above its respective ecological PAL (Table 4-4).

4.6.1.3 Select Metals and PAHs in Soil – Skeet Range

Select Metals – Laboratory Analyses

All 14 XRF samples that exceeded the field lead screening level for the Skeet Range area were subsequently submitted to the FBL for select metals and PAH analysis. Below is a discussion of the select metals and PAH laboratory results for these samples.

Lead

Lead laboratory analytical concentrations ranged from 152 to 1,460 mg/kg. Five of the surface soil samples submitted for laboratory analyses exhibited lead concentrations exceeding the human health PAL of 400 mg/kg (Figure 4-6 and Table 4-3). Two samples (TSA-23 and TSA-30) exceed the TACO construction worker screening value of 700 mg/kg (Appendix D, Table D-1). However, all 14 samples exhibited exceedances of the ecological PAL of 11 mg/kg for lead, and exceeded the Illinois EPA background concentration for lead of 36 mg/kg.

Antimony

Antimony laboratory analytical concentrations ranged from 0.734 to 3.68 mg/kg. None of the surface soil samples submitted for laboratory analyses exhibited antimony concentrations exceeding the human health PAL of 31 mg/kg (Figure 4-6 and Table 4-3). However, all 14 samples exhibited exceedances of the ecological PAL of 0.27 mg/kg. In addition, all 14 samples showed concentrations less than the Illinois EPA background concentration for antimony of 4 mg/kg. A statistical comparison of the exposure point concentration, represented by the 95 percent upper confidence limit of the mean, to the Illinois EPA background soil concentrations for antimony indicates that the concentrations of antimony detected in the soil samples collected from the Skeet Range area are within the range of naturally occurring antimony concentrations in the area of the site (Appendix G).

Arsenic

Arsenic laboratory analytical concentrations ranged from 5.58 to 19.6 mg/kg. All 14 of the surface soil samples submitted for laboratory analyses exhibited arsenic concentrations exceeding the human health PAL of 0.39 mg/kg (Figure 4-6 and Table 4-3). No surface soil samples exceed the TACO construction worker ingestion criteria of 61 mg/kg. However all detected concentrations exceed the USEPA industrial screening level of 1.6 mg/kg.

Only one sample (TSA-041) exhibited exceedances of the ecological PAL of 18 mg/kg. The same sample was the only one which showed a concentration above the Illinois EPA background concentration for arsenic of 13 mg/kg. However, a statistical comparison of the exposure point concentration, represented by the 95 percent upper confidence limit of the mean, to the Illinois EPA background soil concentrations for arsenic indicates that the concentrations of arsenic detected in the soil samples collected from the Skeet Range area are within the range of naturally occurring antimony concentrations in the area of the site (Appendix G).

PAHs

Table 4-3 summarizes the analytical results and any exceedance of the PALs for PAHs. In Table 4-3, if a parameter exceeded the PAL at any sampling point, the parameter was highlighted (human health PAL exceedance), bolded (ecological PAL exceedance), or highlighted and bolded if both PALs are exceeded.

Fourteen surface soil samples collected from the Skeet Range area were sent to the FBL for PAH analysis. Only benzo(a)pyrene, was detected in 12 of the 14 surface soil samples at concentrations in exceedance of the TACO PAL screening criteria of 90 µg/kg (human health only). The concentrations of benzo(a)pyrene also exceeded the TACO construction worker screening criteria of 17 µg/kg and the USEPA industrial criteria of 0.21 µg/kg. The only samples, which did not have concentrations of PAHs at elevated concentrations, were TSA-031 and TSA-044.

In addition, the BaP equivalent concentration exceeded the PAL in 12 of the surface soil samples. A description on how the BaP equivalent concentration was derived is presented in Section 3.6. Table 4-3 presents the calculated BaP equivalent concentrations. The BaP equivalent human health PAL is 90 µg/kg. The ecological PAL is 1,100 µg/kg for individual high molecular weight PAHs and 29,000 micrograms per kilogram (µg/kg) for individual low molecular weight PAHs.

The PAHs appear to be associated with the fragments of the clay pigeons used as targets on the trap range. A pitch tar containing PAHs was used in the manufacture of the clay pigeons to help bind the clay particles. Any observance of clay target remnants was noted in the sample log sheets. Appendix D includes the full analytical results for the PAHs analyzed.

4.6.1.4 Select Metals and PAHs in Sediment – Skeet Range

Below is a discussion of the select metals and PAHs detected in the sediment samples collected from the Skeet Range area submitted to the FBL for analyses:

Lead

Lead laboratory analytical concentrations for the sediment samples collected from the Skeet Range area ranged from 15.7 to 204 mg/kg (Figure 4-9 and Table 4-4). Five of the sediment samples submitted for laboratory analyses exhibited lead concentrations exceeding the ecological PAL of 35.8 mg/kg for lead. In addition, a statistical comparison of the TSA Ranges sediment data to the upgradient/background sediment sample concentrations for lead indicates that the concentrations of lead detected in the sediment samples collected from the Skeet Range area are above the upgradient/background concentrations for lead (Appendix G).

The ecological screening level is based on the threshold effects concentration (TEC) from MacDonald et al. (2000), which is the concentration below which effects to sediment invertebrates are not expected. The probable effects concentration (PEC) from MacDonald et al. (2000) for lead is 128 mg/kg, which is the concentration above which effects to sediment invertebrates are likely to be observed. Only one location (TSA-078) had a lead concentration that exceeded the PEC. This location was well bounded by samples with lead concentrations either just slightly greater than or less than the screening level (see Figure 4-9). The locations with lead concentrations between the TEC and the PEC, which represents an area of uncertainty with regards to toxic effects to sediment invertebrates, are bounded to a small area along the shoreline. Therefore, although it is possible that lead is impacting sediment invertebrates, any impacts are limited to a small area.

Antimony

Antimony laboratory analytical sediment sample concentrations ranged from below the laboratory detection limit to 2.4 mg/kg. Only one of the sediment samples submitted for laboratory analyses exhibited antimony concentrations exceeding the ecological PAL of 2 mg/kg (Figure 4-6 and Table 4-3). Sample TSA-073 had a concentration of 2.4 mg/kg. In addition, a statistical comparison of the TSA Ranges sediment data to the upgradient/background sediment sample concentrations for antimony indicates that the concentrations of antimony detected in the sediment samples collected from the Skeet Range area are above the upgradient/background concentrations for antimony (Appendix G).

It should be noted, the ecological PAL is based on the Effects-Range Low (ER-L) from Long and Morgan (1991). The ER-L is similar to the TEC and is a concentration below which adverse effects would be rarely observed. Long and Morgan (1991) developed an Effects-Range median (ER-M) which are concentrations above which effects would frequently occur. The ER-M for antimony is 25 mg/kg. Therefore, antimony at one location slightly exceeded the ER-L, but was much lower than the ER-M. The sample location where the ER-L was exceeded is bounded in all directions by other samples with much lower concentrations or where antimony was not detected (see Table 4-4 and Figure 4-9).

Arsenic

None of the sediment samples submitted for laboratory analyses exhibited arsenic concentrations exceeding the ecological PAL of 9.79 mg/kg (Table 4-4).

PAHs

None of the sediment samples collected for the Skeet Range area exhibited concentrations of any PAHs above its respective ecological PAL.

4.7 UPDATED CSM

Table 4-5 contains the tabular CSM, which outlines the current understanding of the TSA Ranges. Figure 4-11 provides a graphical representation of the current understanding of the TSA Ranges. The figures identify the exposure pathways where site receptors could be exposed to in contact with, or be impacted by, MC. Based on the analytical information obtained during the SI, MC does exist at the TSA Ranges.

4.8 CONCLUSIONS

The initial environmental data collected during the SI sampling activities are sufficient to determine the presence of MC (lead and PAHs) associated with the former use of the ranges in the surface soils, and to provide preliminary horizontal (north to south) delineation of impacted surface soils. The extent of MC to the west and vertically in the subsurface soil has not been determined for the site. Identification of clay pigeon fragments and shotgun shell wadding in surface soils and along the erosional face of the former Trap Range indicates that a continuing source of PAHs may be present in the soil. Grading of the site for use as an RV park may have covered soil that contains MC located closer to the former firing line.

The focused SI sampling activities characterized the local site conditions in surface soils (0 to 0.5 feet bgs) and sediment (0 to 0.5 feet bss) and identified concentrations of MC associated with small arms ammunition in surface soil and sediment. MCs (lead and PAHs) were identified at concentrations above PALs in the surface soil of the TSA Ranges. MC in soil may bioaccumulate in plants or animals and then be consumed by animals foraging on the former ranges. Predation of prey and/or consumption of vegetation on the range may result in bioaccumulation of MC. Complete exposure pathways are identified for biota that may be exposed to MC through the food chain. In addition, potential human receptors (i.e., Navy personnel, visitors, and construction workers) may be exposed to MC through direct contact (ingestion, inhalation of particulates) with the impacted soils or less likely, consumption of biota.

MCs (antimony and lead) in the sediment samples collected from the TSA Ranges exhibited concentrations above both ecological PALs and the site-specific upgradient/background sediment sample data. Complete exposure pathways are identified for aquatic biota that may be exposed to MC through direct contact with the sediment and via the food chain. In addition, to a lesser extent, potential human receptors (i.e., fisherman) may come in contact with MC through consumption of aquatic biota.

4.9 RECOMMENDATIONS

The purpose of the SI phase of this project is to identify possible contaminant releases that require further investigation or pose a threat to human health and/or the environment.

SOIL

The SI identified a limited area in the TSA Ranges with lead, and PAH concentrations greater than respective PALs and the Illinois EPA background soil concentrations in surface soil within the project site. Based on the SI findings, further actions are required.

Additional focused sampling (horizontally and vertically) is recommended at the TSA Ranges to further characterize and quantify the contaminated range soil areas and identify discrete areas where removal actions could address the MC-contaminated soils that pose a threat to human health or the environment.

SEDIMENT

The SI identified a limited area of sediment near shore within the TSA Ranges with lead and antimony concentrations greater than their respective ecological PALs and the site-specific upgradient/background sediment sample data. However, lead concentrations only exceeded the PEC in one well bounded

location, surrounded by sample locations with concentrations below or nominally above the screening criteria and arsenic concentrations slightly exceeded the ER-L in one well bounded sample location surrounded by locations with concentrations well below the screening criteria or not detected at all. Therefore, the potentially impacted area is relatively small and impact to aquatic biota appears to be insignificant; therefore, further evaluation of ecological risks is warranted, and recommended.

TABLE 4-1

SUMMARY OF SAMPLES COLLECTED
NTC LAKEFRONT RANGE (WATER PORTION)
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS
1 of 2

Location	Sample ID	Date Collected	Medium	Depth (inches)	Analysis [1]
Surface Soil Samples					
TSA001	NTC-SS-TSA001-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA002	NTC-SS-TSA002-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA003	NTC-SS-TSA003-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA004	NTC-SS-TSA004-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA005	NTC-SS-TSA005-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA006	NTC-SS-TSA006-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA007	NTC-SS-TSA007-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA008	NTC-SS-TSA008-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA009	NTC-SS-TSA009-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA010	NTC-SS-TSA010-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA011	NTC-SS-TSA011-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA012	NTC-SS-TSA012-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA013	NTC-SS-TSA013-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA014	NTC-SS-TSA014-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA015	NTC-SS-TSA015-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA016	NTC-SS-TSA016-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA017	NTC-SS-TSA017-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA018	NTC-SS-TSA018-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA019	NTC-SS-TSA019-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA020	NTC-SS-TSA020-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA021	NTC-SS-TSA021-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA022	NTC-SS-TSA022-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA023	NTC-SS-TSA023-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA024	NTC-SS-TSA024-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA025	NTC-SS-TSA025-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA026	NTC-SS-TSA026-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA027	NTC-SS-TSA027-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA028	NTC-SS-TSA028-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA029	NTC-SS-TSA029-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA030	NTC-SS-TSA030-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA031	NTC-SS-TSA031-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA032	NTC-SS-TSA032-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA033	NTC-SS-TSA033-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA034	NTC-SS-TSA034-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA035	NTC-SS-TSA035-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA036	NTC-SS-TSA036-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA037	NTC-SS-TSA037-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA038	NTC-SS-TSA038-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA039	NTC-SS-TSA039-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA040	NTC-SS-TSA040-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA041	NTC-SS-TSA041-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA042	NTC-SS-TSA042-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA043	NTC-SS-TSA043-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA044	NTC-SS-TSA044-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA045	NTC-SS-TSA045-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA046	NTC-SS-TSA046-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA047	NTC-SS-TSA047-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA048	NTC-SS-TSA048-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA049	NTC-SS-TSA049-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA050	NTC-SS-TSA050-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA051	NTC-SS-TSA051-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA052	NTC-SS-TSA052-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA053	NTC-SS-TSA053-0006	4/21/2010	Soil	0 - 6	XRF, Select Metals and PAHs
TSA057	NTC-SS-TSA057-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA058	NTC-SS-TSA058-0006	4/21/2010	Soil	0 - 6	XRF Analysis only
TSA059	NTC-SS-TSA059-0006	4/21/2010	Sediment	0 - 6	XRF, Select Metals and PAHs
TSA060	NTC-SS-TSA060-0006	4/21/2010	Sediment	0 - 6	XRF, Select Metals and PAHs

TABLE 4-1

SUMMARY OF SAMPLES COLLECTED
NTC LAKEFRONT RANGE (WATER PORTION)
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS
2 of 2

Sediment Samples					
TSA061	NTC-SD-TSA061-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs
TSA062	NTC-SD-TSA062-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs
TSA063	NTC-SD-TSA063-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs
TSA064	NTC-SD-TSA064-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs
TSA065	NTC-SD-TSA065-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs
TSA066	NTC-SD-TSA066-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs
TSA067	NTC-SD-TSA067-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs
TSA068	NTC-SD-TSA068-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs
TSA069	NTC-SD-TSA069-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs
TSA070	NTC-SD-TSA070-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs
TSA071	NTC-SD-TSA071-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs
TSA072	NTC-SD-TSA072-0006	5/23/2010	Sediment	0 - 6	Select Metals and PAHs
TSA073	NTC-SD-TSA073-0006	5/23/2010	Sediment	0 - 6	Select Metals and PAHs
TSA074	NTC-SD-TSA074-0006	5/23/2010	Sediment	0 - 6	Select Metals and PAHs
TSA075	NTC-SD-TSA075-0006	5/23/2010	Sediment	0 - 6	Select Metals and PAHs
TSA076	NTC-SD-TSA076-0006	5/23/2010	Sediment	0 - 6	Select Metals and PAHs
TSA077	NTC-SD-TSA077-0006	5/23/2010	Sediment	0 - 6	Select Metals and PAHs
TSA078	NTC-SD-TSA078-0006	5/23/2010	Sediment	0 - 6	Select Metals and PAHs
Upgradient Sediment Samples					
UPG001	NTC-SD-UPG001-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs
UPG002	NTC-SD-UGP002-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs
UPG003	NTC-SD-UPG003-0006	5/19/2010	Sediment	0 - 6	Select Metals and PAHs

1 Select metals for TSA Ranges soil and sediment include antimony, arsenic, and lead.
Select metals for upgradient sediment samples include antimony, arsenic, copper, iron, magnesium, lead,

TABLE 4-2

XRF LEAD RESULTS
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

SAMPLE ID	SAMPLE COLLECTION DATE	XRF ANALYSIS DATE	1st (ppm)	2nd (ppm)	3rd (ppm)	DETECTION LIMIT (ppm)	AUTO GENERATED AVERAGE (ppm)	COMMENTS / ITEMS REMOVED FROM SAMPLE
NTC-SS-TSA001	4/21/2010	4/22/2010	23	24	26	10	24.33	
NTC-SS-TSA002	4/21/2010	4/22/2010	17	11	16	10	14.67	
NTC-SS-TSA003	4/21/2010	4/22/2010	34	43	48	10	41.67	limestone gravel
NTC-SS-TSA004	4/21/2010	4/22/2010	23	27	31	10	27.00	limetsone gravel
NTC-SS-TSA005	4/21/2010	4/22/2010	26	32	29	10	29.00	limestone gravel
NTC-SS-TSA006	4/21/2010	4/22/2010	--	16	19	10	17.50	
NTC-SS-TSA007	4/21/2010	4/22/2010	18	16	17	10	17.00	
NTC-SS-TSA008	4/21/2010	4/22/2010	16	17	10	10	14.33	
NTC-SS-TSA009	4/21/2010	4/22/2010	17	19	17	10	17.67	
NTC-SS-TSA010	4/21/2010	4/22/2010	19	17	11	10	15.67	
NTC-SS-TSA011	4/21/2010	4/22/2010	54	25	24	10	34.33	
NTC-SS-TSA012	4/21/2010	4/22/2010	28	23	19	10	23.33	
NTC-SS-TSA013	4/21/2010	4/22/2010	18	24	19	10	20.33	
NTC-SS-TSA014	4/21/2010	4/22/2010	10	19	18	10	15.67	
NTC-SS-TSA015	4/21/2010	4/22/2010	**104**	**109**	**141**	10	118.00	clay pigeon fragments, shotgunshell wadding
NTC-SS-TSA016	4/21/2010	4/22/2010	**112**	**112**	**123**	10	115.67	clay pigeon fragments, shotgunshell wadding
NTC-SS-TSA017	4/21/2010	4/22/2010	**111**	**133**	**118**	10	120.67	clay pigeon fragments, shotgunshell wadding
NTC-SS-TSA018	4/21/2010	4/22/2010	**130**	**114**	**114**	10	119.33	clay pigeon fragments, shotgunshell wadding
NTC-SS-TSA019	4/21/2010	4/22/2010	ND	59	10	10	24.67	clay pigeon fragments, shotgunshell wadding
NTC-SS-TSA020	4/21/2010	4/22/2010	**124**	**116**	96	10	112.00	
NTC-SS-TSA021	4/21/2010	4/22/2010	93	90	127	10	103.33	
NTC-SS-TSA022	4/21/2010	4/22/2010	39	35	47	10	40.33	
NTC-SS-TSA023	4/21/2010	4/22/2010	**471**	**481**	**393**	10	448.33	
NTC-SS-TSA024	4/21/2010	4/22/2010	63	66	67	10	65.33	
NTC-SS-TSA025	4/21/2010	4/22/2010	51	54	74	10	59.67	
NTC-SS-TSA026	4/21/2010	4/22/2010	55	53	64	10	57.33	
NTC-SS-TSA027	4/21/2010	4/22/2010	37	60	39	10	45.33	
NTC-SS-TSA028	4/21/2010	4/22/2010	72	203	73	10	116.00	
NTC-SS-TSA029	4/21/2010	4/22/2010	41	50	45	10	45.33	
NTC-SS-TSA030	4/21/2010	4/22/2010	**595**	**335**	**475**	10	468.33	
NTC-SS-TSA031	4/21/2010	4/22/2010	**127**	**174**	**188**	10	163.00	
NTC-SS-TSA032	4/21/2010	4/22/2010	80	76	87	10	81.00	
NTC-SS-TSA033	4/21/2010	4/22/2010	47	32	49	10	42.67	
NTC-SS-TSA034	4/21/2010	4/22/2010	47	54	48	10	49.67	

TABLE 4-2

XRF LEAD RESULTS
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

SAMPLE ID	SAMPLE COLLECTION DATE	XRF ANALYSIS DATE	1st (ppm)	2nd (ppm)	3rd (ppm)	DETECTION LIMIT (ppm)	AUTO GENERATED AVERAGE (ppm)	COMMENTS / ITEMS REMOVED FROM SAMPLE
NTC-SS-TSA035	4/21/2010	4/22/2010	44	47	46	10	45.67	
NTC-SS-TSA036	4/21/2010	4/22/2010	66	78	111	10	85.00	
NTC-SS-TSA037	4/21/2010	4/22/2010	87	49	55	10	63.67	
NTC-SS-TSA038	4/21/2010	4/22/2010	99	115	120	10	111.33	
NTC-SS-TSA039	4/21/2010	4/22/2010	100	90	119	10	103.00	
NTC-SS-TSA040	4/21/2010	4/22/2010	45	45	71	10	53.67	
NTC-SS-TSA041	4/21/2010	4/22/2010	235	76	120	10	143.67	
NTC-SS-TSA042	4/21/2010	4/22/2010	83	73	101	10	85.67	
NTC-SS-TSA043	4/21/2010	4/22/2010	79	52	56	10	62.33	
NTC-SS-TSA044	4/21/2010	4/22/2010	137	116	136	10	129.67	
NTC-SS-TSA045	4/21/2010	4/22/2010	26	21	25	10	24.00	
NTC-SS-TSA046	4/21/2010	4/22/2010	87	99	84	10	90.00	
NTC-SS-TSA047	4/21/2010	4/22/2010	63	51	107	10	73.67	
NTC-SS-TSA048	4/21/2010	4/22/2010	94	87	93	10	91.33	
NTC-SS-TSA049	4/21/2010	4/22/2010	45	49	54	10	49.33	
NTC-SS-TSA050	4/21/2010	4/22/2010	165	178	171	10	171.33	
NTC-SS-TSA051	4/21/2010	4/22/2010	160	159	177	10	165.33	
NTC-SS-TSA052	4/21/2010	4/22/2010	201	258	172	10	210.33	
NTC-SS-TSA053	4/21/2010	4/22/2010	135	144	152	10	143.67	
NTC-SS-TSA054	4/21/2010	4/22/2010	NS	NS	NS	10	NS	Did not screen - all rock, little sand in this part of the beach
NTC-SS-TSA055	4/21/2010	4/22/2010	NS	NS	NS	10	NS	Did not screen - all rock, little sand in this part of the beach
NTC-SS-TSA056	4/21/2010	4/22/2010	NS	NS	NS	10	NS	Did not screen - all rock, little sand in this part of the beach
NTC-SS-TSA057	4/21/2010	4/22/2010	--	43	52	10	47.50	
NTC-SS-TSA058	4/21/2010	4/22/2010	123	91	82	10	98.67	
NTC-SS-TSA059	4/21/2010	4/22/2010	141	159	127	10	142.33	clay pigeon fragments, shotgunshell wadding
NTC-SS-TSA060	4/21/2010	4/22/2010	129	139	171	10	146.33	

ND - Nondetect
NS - No Sample
ppm - Parts per million
-- - XRF reading was not registered
Highlighted - Sample which had an average lead concentration above the field PAL of 100 ppm

TABLE 4-3

SUMMARY OF DETECTED CONCENTRATIONS IN SURFACE SOIL
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

LOCATION SAMPLE ID SAMPLE DATE DEPTH (FT BGS)	FINAL HUMAN HEALTH CRITERIA VALUE		FEDERAL ECOLOGICAL MINIMUM OF AVIAN INVERTABRAT MAMMALIAN & PLANT SSLs [5]	TACO CHEMICALS IN BACKGROUND SOIL CRITERIA [6]	NTC-SO-TSA-001 NTC-SS-TSA-001-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-002 NTC-SS-TSA-002-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-003 NTC-SS-TSA-003-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-004 NTC-SS-TSA-004-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-005 NTC-SS-TSA-005-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-006 NTC-SS-TSA-006-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-007 NTC-SS-TSA-007-0006 04/21/2010 0 - 0.5
METALS (mg/kg)											
Antimony	31	1	0.27	4	NA	NA	NA	NA	NA	NA	NA
Arsenic	0.39	4	18	13	NA	NA	NA	NA	NA	NA	NA
Lead	400	1	11	36	NA	NA	NA	NA	NA	NA	NA
XRF (mg/kg)											
Lead	400	1	11	36	**24.33**	**14.67**	**41.67**	**27**	**29**	**17.5**	**17**
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)											
1-Methylnaphthalene	5500000	3	NC	NC	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	310000	2	29000	0.14	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	4700000	1	29000	NC	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	2300000	3	29000	0.07	NA	NA	NA	NA	NA	NA	NA
Anthracene	23000000	1	29000	400	NA	NA	NA	NA	NA	NA	NA
BaP Equivalent	90	1	1100	2100	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	900	1	1100	1800	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	90	1	1100	2100	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	900	1	1100	2100	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	2300000	3	1100	1700	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	9000	1	1100	1700	NA	NA	NA	NA	NA	NA	NA
Chrysene	88000	1	1100	2700	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	90	1	1100	420	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	3100000	1	29000	4100	NA	NA	NA	NA	NA	NA	NA
Fluorene	3100000	1	29000	180	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	900	1	1100	1600	NA	NA	NA	NA	NA	NA	NA
Naphthalene	1600000	1	29000	200	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	2300000	3	29000	2500	NA	NA	NA	NA	NA	NA	NA
Pyrene	2300000	1	1100	3000	NA	NA	NA	NA	NA	NA	NA

LOCATION SAMPLE ID SAMPLE DATE DEPTH (FT BGS)	FINAL HUMAN HEALTH CRITERIA VALUE		FEDERAL ECOLOGICAL MINIMUM OF AVIAN INVERTABRAT MAMMALIAN & PLANT SSLs [5]	TACO CHEMICALS IN BACKGROUND SOIL CRITERIA [6]	NTC-SO-TSA-008 NTC-SS-TSA-008-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-009 NTC-SS-TSA-009-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-010 NTC-SS-TSA-010-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-011 NTC-SS-TSA-011-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-012 NTC-SS-TSA-012-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-013 NTC-SS-TSA-013-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-014 NTC-SS-TSA-014-0006 04/21/2010 0 - 0.5
METALS (mg/kg)											
Antimony	31	1	0.27	4	NA	NA	NA	NA	NA	NA	NA
Arsenic	0.39	4	18	13	NA	NA	NA	NA	NA	NA	NA
Lead	400	1	11	36	NA	NA	NA	NA	NA	NA	NA
XRF (mg/kg)											
Lead	400	1	11	36	**14.33**	**17.67**	**15.67**	**34.33**	**23.33**	**20.33**	**15.67**
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)											
1-Methylnaphthalene	5500000	3	NC	NC	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	310000	2	29000	0.14	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	4700000	1	29000	NC	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	2300000	3	29000	0.07	NA	NA	NA	NA	NA	NA	NA
Anthracene	23000000	1	29000	400	NA	NA	NA	NA	NA	NA	NA
BaP Equivalent	90	1	1100	2100	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	900	1	1100	1800	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	90	1	1100	2100	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	900	1	1100	2100	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	2300000	3	1100	1700	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	9000	1	1100	1700	NA	NA	NA	NA	NA	NA	NA
Chrysene	88000	1	1100	2700	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	90	1	1100	420	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	3100000	1	29000	4100	NA	NA	NA	NA	NA	NA	NA
Fluorene	3100000	1	29000	180	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	900	1	1100	1600	NA	NA	NA	NA	NA	NA	NA
Naphthalene	1600000	1	29000	200	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	2300000	3	29000	2500	NA	NA	NA	NA	NA	NA	NA
Pyrene	2300000	1	1100	3000	NA	NA	NA	NA	NA	NA	NA

Footnotes and definitions are summarized on the final page of the table.

TABLE 4-3
SUMMARY OF DETECTED CONCENTRATIONS IN SURFACE SOIL
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

LOCATION SAMPLE ID SAMPLE DATE DEPTH (FT BGS)	FINAL HUMAN HEALTH CRITERIA VALUE		FEDERAL ECOLOGICAL MINIMUM OF AVIAN INVERTABRAT MAMMALIAN & PLANT SSLs [5]	TACO CHEMICALS IN BACKGROUND SOIL CRITERIA [6]	NTC-SO-TSA-015 NTC-SS-TSA-015-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-016 NTC-SS-TSA-016-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-017 NTC-SS-TSA-017-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-018 NTC-SS-TSA-018-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-019 NTC-SS-TSA-019-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-020 NTC-SS-TSA-020-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-021 NTC-SS-TSA-021-0006 04/21/2010 0 - 0.5
METALS (mg/kg)											
Antimony	31	1	0.27	4	**1.07 J**	**0.76 J**	**0.772 J**	**0.81 J**	NA	**1.87 J**	**1.13 J**
Arsenic	0.39	4	18	13	10.7 J	10.1 J	8.82 J	9.83 J	NA	7.8 J	5.92 J
Lead	400	1	11	36	**193**	**136**	**135**	**148**	NA	**564**	**152**
XRF (mg/kg)											
Lead	400	1	11	36	**118**	**115.67**	**120.67**	**119.33**	**24.67**	**112**	**103.33**
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)											
1-Methylnaphthalene	5500000	3	NC	NC	15 UJ	37.4 J	14.9 UJ	48.2 J	NA	4.2 J	3.87 J
2-Methylnaphthalene	310000	2	29000	0.14	15 UJ	58.5 J	14.9 UJ	72 J	NA	4.68 J	4.54 J
Acenaphthene	4700000	1	29000	NC	34.2 J	141 J	14.9 UJ	35.1 J	NA	3.09 J	5.45 J
Acenaphthylene	2300000	3	29000	0.07	15 UJ	56.9 J	14.9 UJ	14.9 UJ	NA	11 J	7.98 J
Anthracene	23000000	1	29000	400	103 J	379 J	104 J	115 J	NA	20.2 J	18.5 J
BaP Equivalent	90	1	1100	2100	**2453.93**	**20279.6**	**5619.3**	**6957.18**	NA	150.671	127.806
Benzo(a)anthracene	900	1	1100	1800	**1160 J**	**8340 J**	**3370 J**	**3900 J**	NA	88.7 J	78.7 J
Benzo(a)pyrene	90	1	1100	2100	**1810 J**	**15100 J**	**4110 J**	**5110 J**	NA	95.1 J	79.2 J
Benzo(b)fluoranthene	900	1	1100	2100	1020 J	**9560 J**	**2070 J**	**2260 J**	NA	138 J	130 J
Benzo(g,h,i)perylene	2300000	3	1100	1700	**1470 J**	**9470 J**	**3090 J**	**3460 J**	NA	92.7 J	66.8 J
Benzo(k)fluoranthene	9000	1	1100	1700	258 J	**2730 J**	547 J	462 J	NA	49.7 J	38.3 J
Chrysene	88000	1	1100	2700	**1750 J**	**13300 J**	**5830 J**	**6560 J**	NA	104 J	93 J
Dibenzo(a,h)anthracene	90	1	1100	420	360 J	**2790 J**	835 J	1070 J	NA	21.9 J	19.2 J
Fluoranthene	3100000	1	29000	4100	862 J	4690 J	1260 J	1160 J	NA	164 J	170 J
Fluorene	3100000	1	29000	180	15 UJ	75.1 J	14.9 UJ	14.9 UJ	NA	5.76 J	6.36 J
Indeno(1,2,3-cd)pyrene	900	1	1100	1600	616 J	**5590 J**	**1190 J**	**1500 J**	NA	104 J	80.6 J
Naphthalene	1600000	1	29000	200	15 UJ	35.1 J	14.9 UJ	35.3 J	NA	1.38 UJ	6.7 J
Phenanthrene	2300000	3	29000	2500	391 J	1990 J	527 J	574 J	NA	72.9 J	95.2 J
Pyrene	2300000	1	1100	3000	**1160 J**	**8060 J**	**2420 J**	**2740 J**	NA	142 J	131 J

LOCATION SAMPLE ID SAMPLE DATE DEPTH (FT BGS)	FINAL HUMAN HEALTH CRITERIA VALUE		FEDERAL ECOLOGICAL MINIMUM OF AVIAN INVERTABRAT MAMMALIAN & PLANT SSLs [5]	TACO CHEMICALS IN BACKGROUND SOIL CRITERIA [6]	NTC-SO-TSA-022 NTC-SS-TSA-022-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-023 NTC-SS-TSA-023-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-024 NTC-SS-TSA-024-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-025 NTC-SS-TSA-025-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-026 NTC-SS-TSA-026-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-027 NTC-SS-TSA-027-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-028 NTC-SS-TSA-028-0006 04/21/2010 0 - 0.5
METALS (mg/kg)											
Antimony	31	1	0.27	4	NA	**3.68 J**	NA	NA	NA	NA	**1.48 J**
Arsenic	0.39	4	18	13	NA	8.82 J	NA	NA	NA	NA	8.28 J
Lead	400	1	11	36	NA	**1310**	NA	NA	NA	NA	**295**
XRF (mg/kg)											
Lead	400	1	11	36	**40.33**	**448.33**	**65.33**	**59.67**	**57.33**	**45.33**	**116**
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)											
1-Methylnaphthalene	5500000	3	NC	NC	NA	12 J	NA	NA	NA	NA	9.29 J
2-Methylnaphthalene	310000	2	29000	0.14	NA	14.5 J	NA	NA	NA	NA	9.35 J
Acenaphthene	4700000	1	29000	NC	NA	4.74 J	NA	NA	NA	NA	2.69 J
Acenaphthylene	2300000	3	29000	0.07	NA	10.6 J	NA	NA	NA	NA	9.46 J
Anthracene	23000000	1	29000	400	NA	36.5 J	NA	NA	NA	NA	16 J
BaP Equivalent	90	1	1100	2100	NA	317.131	NA	NA	NA	NA	154.355
Benzo(a)anthracene	900	1	1100	1800	NA	199 J	NA	NA	NA	NA	86.5 J
Benzo(a)pyrene	90	1	1100	2100	NA	211 J	NA	NA	NA	NA	99.3 J
Benzo(b)fluoranthene	900	1	1100	2100	NA	274 J	NA	NA	NA	NA	145 J
Benzo(g,h,i)perylene	2300000	3	1100	1700	NA	147 J	NA	NA	NA	NA	84.7 J
Benzo(k)fluoranthene	9000	1	1100	1700	NA	102 J	NA	NA	NA	NA	46.2 J
Chrysene	88000	1	1100	2700	NA	211 J	NA	NA	NA	NA	103 J
Dibenzo(a,h)anthracene	90	1	1100	420	NA	40.1 J	NA	NA	NA	NA	21.4 J
Fluoranthene	3100000	1	29000	4100	NA	323 J	NA	NA	NA	NA	144 J
Fluorene	3100000	1	29000	180	NA	6.71 J	NA	NA	NA	NA	4.77 J
Indeno(1,2,3-cd)pyrene	900	1	1100	1600	NA	175 J	NA	NA	NA	NA	99.4 J
Naphthalene	1600000	1	29000	200	NA	11.7 J	NA	NA	NA	NA	4.24 J
Phenanthrene	2300000	3	29000	2500	NA	114 J	NA	NA	NA	NA	61.3 J
Pyrene	2300000	1	1100	3000	NA	320 J	NA	NA	NA	NA	129 J

Footnotes and definitions are summarized on the final page of the table.

TABLE 4-3
SUMMARY OF DETECTED CONCENTRATIONS IN SURFACE SOIL
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

LOCATION	FINAL HUMAN HEALTH CRITERIA VALUE		FEDERAL ECOLOGICAL MINIMUM OF AVIAN INVERTABRAT MAMMALIAN & PLANT SSLs [5]	TACO CHEMICALS IN BACKGROUND SOIL CRITERIA [6]	NTC-SO-TSA-029	NTC-SO-TSA-030	NTC-SO-TSA-031	NTC-SO-TSA-032	NTC-SO-TSA-033	NTC-SO-TSA-034	NTC-SO-TSA-035
SAMPLE ID					NTC-SS-TSA-029-0006	NTC-SS-TSA-030-0006	NTC-SS-TSA-031-0006	NTC-SS-TSA-032-0006	NTC-SS-TSA-033-0006	NTC-SS-TSA-034-0006	NTC-SS-TSA-035-0006
SAMPLE DATE					04/21/2010	04/21/2010	04/21/2010	04/21/2010	04/21/2010	04/21/2010	04/21/2010
DEPTH (FT BGS)					0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
METALS (mg/kg)											
Antimony	31	1	0.27	4	NA	**3.65 J**	**1.24 J**	NA	NA	NA	NA
Arsenic	0.39	4	18	13	NA	7.31 J	6.53 J	NA	NA	NA	NA
Lead	400	1	11	36	NA	**1460**	**368**	NA	NA	NA	NA
XRF (mg/kg)											
Lead	400	1	11	36	**45.33**	**468.33**	**163**	**81**	**42.67**	**49.67**	**45.67**
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)											
1-Methylnaphthalene	5500000	3	NC	NC	NA	7.44 J	2.69 J	NA	NA	NA	NA
2-Methylnaphthalene	310000	2	29000	0.14	NA	9.34 J	3.03 J	NA	NA	NA	NA
Acenaphthene	4700000	1	29000	NC	NA	5.34 J	1.7 J	NA	NA	NA	NA
Acenaphthylene	2300000	3	29000	0.07	NA	13.5 J	4.03 J	NA	NA	NA	NA
Anthracene	23000000	1	29000	400	NA	22 J	8.68 J	NA	NA	NA	NA
BaP Equivalent	90	1	1100	2100	NA	182.279	79.8617	NA	NA	NA	NA
Benzo(a)anthracene	900	1	1100	1800	NA	92 J	41.5 J	NA	NA	NA	NA
Benzo(a)pyrene	90	1	1100	2100	NA	116 J	51.6 J	NA	NA	NA	NA
Benzo(b)fluoranthene	900	1	1100	2100	NA	163 J	73.3 J	NA	NA	NA	NA
Benzo(g,h,i)perylene	2300000	3	1100	1700	NA	95.4 J	44.6 J	NA	NA	NA	NA
Benzo(k)fluoranthene	9000	1	1100	1700	NA	57.5 J	26.2 J	NA	NA	NA	NA
Chrysene	88000	1	1100	2700	NA	104 J	49.7 J	NA	NA	NA	NA
Dibenzo(a,h)anthracene	90	1	1100	420	NA	29.1 J	11 J	NA	NA	NA	NA
Fluoranthene	3100000	1	29000	4100	NA	156 J	78 J	NA	NA	NA	NA
Fluorene	3100000	1	29000	180	NA	6.56 J	2.13 J	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	900	1	1100	1600	NA	110 J	54.7 J	NA	NA	NA	NA
Naphthalene	1600000	1	29000	200	NA	1.41 UJ	1.42 UJ	NA	NA	NA	NA
Phenanthrene	2300000	3	29000	2500	NA	78.8 J	30.1 J	NA	NA	NA	NA
Pyrene	2300000	1	1100	3000	NA	138 J	68.9 J	NA	NA	NA	NA

LOCATION	FINAL HUMAN HEALTH CRITERIA VALUE		FEDERAL ECOLOGICAL MINIMUM OF AVIAN INVERTABRAT MAMMALIAN & PLANT SSLs [5]	TACO CHEMICALS IN BACKGROUND SOIL CRITERIA [6]	NTC-SO-TSA-036	NTC-SO-TSA-037	NTC-SO-TSA-038	NTC-SO-TSA-039	NTC-SO-TSA-040	NTC-SO-TSA-041	NTC-SO-TSA-042
SAMPLE ID					NTC-SS-TSA-036-0006	NTC-SS-TSA-037-0006	NTC-SS-TSA-038-0006	NTC-SS-TSA-039-0006	NTC-SS-TSA-040-0006	NTC-SS-TSA-041-0006	NTC-SS-TSA-042-0006
SAMPLE DATE					04/21/2010	04/21/2010	04/21/2010	04/21/2010	04/21/2010	04/21/2010	04/21/2010
DEPTH (FT BGS)					0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
METALS (mg/kg)											
Antimony	31	1	0.27	4	NA	NA	**2.2 J**	**1.51 J**	NA	**2.58 J**	NA
Arsenic	0.39	4	18	13	NA	NA	8.91 J	8.51 J	NA	**19.6 J**	NA
Lead	400	1	11	36	NA	NA	**577**	**357**	NA	**245**	NA
XRF (mg/kg)											
Lead	400	1	11	36	**85**	**63.67**	**111.33**	**103**	**53.67**	**143.67**	**85.67**
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)											
1-Methylnaphthalene	5500000	3	NC	NC	NA	NA	12.7 J	14.5 J	NA	7.06 UJ	NA
2-Methylnaphthalene	310000	2	29000	0.14	NA	NA	12.1 J	15.2 J	NA	7.06 UJ	NA
Acenaphthene	4700000	1	29000	NC	NA	NA	2.63 J	4.62 J	NA	7.06 UJ	NA
Acenaphthylene	2300000	3	29000	0.07	NA	NA	6.64 J	11.4 J	NA	21.1 J	NA
Anthracene	23000000	1	29000	400	NA	NA	14.6 J	27.1 J	NA	56.2 J	NA
BaP Equivalent	90	1	1100	2100	NA	NA	127.1173	215.553	NA	562.705	NA
Benzo(a)anthracene	900	1	1100	1800	NA	NA	73.8 J	133 J	NA	474 J	NA
Benzo(a)pyrene	90	1	1100	2100	NA	NA	81.4 J	139 J	NA	358 J	NA
Benzo(b)fluoranthene	900	1	1100	2100	NA	NA	115 J	187 J	NA	475 J	NA
Benzo(g,h,i)perylene	2300000	3	1100	1700	NA	NA	64.9 J	105 J	NA	239 J	NA
Benzo(k)fluoranthene	9000	1	1100	1700	NA	NA	37.7 J	70.1 J	NA	174 J	NA
Chrysene	88000	1	1100	2700	NA	NA	90.3 J	152 J	NA	565 J	NA
Dibenzo(a,h)anthracene	90	1	1100	420	NA	NA	19.1 J	31.4 J	NA	81.7 J	NA
Fluoranthene	3100000	1	29000	4100	NA	NA	132 J	238 J	NA	589 J	NA
Fluorene	3100000	1	29000	180	NA	NA	3.94 J	6.29 J	NA	7.06 UJ	NA
Indeno(1,2,3-cd)pyrene	900	1	1100	1600	NA	NA	72.7 J	123 J	NA	258 J	NA
Naphthalene	1600000	1	29000	200	NA	NA	4.31 J	6.64 J	NA	7.06 UJ	NA
Phenanthrene	2300000	3	29000	2500	NA	NA	76.4 J	105 J	NA	179 J	NA
Pyrene	2300000	1	1100	3000	NA	NA	119 J	211 J	NA	532 J	NA

Footnotes and definitions are summarized on the final page of the table.

TABLE 4-3
SUMMARY OF DETECTED CONCENTRATIONS IN SURFACE SOIL
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

LOCATION	FINAL HUMAN HEALTH CRITERIA VALUE		FEDERAL ECOLOGICAL MINIMUM OF AVIAN INVERTABRAT MAMMALIAN & PLANT SSLs [5]	TACO CHEMICALS IN BACKGROUND SOIL CRITERIA [6]	NTC-SO-TSA-043	NTC-SO-TSA-044	NTC-SO-TSA-045	NTC-SO-TSA-046	NTC-SO-TSA-047	NTC-SO-TSA-048
SAMPLE ID					NTC-SS-TSA-043-0006	NTC-SS-TSA-044-0006	NTC-SS-TSA-045-0006	NTC-SS-TSA-046-0006	NTC-SS-TSA-047-0006	NTC-SS-TSA-048-0006
SAMPLE DATE					04/21/2010	04/21/2010	04/21/2010	04/21/2010	04/21/2010	04/21/2010
DEPTH (FT BGS)					0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
METALS (mg/kg)										
Antimony	31	1	0.27	4	NA	**0.734 J**	NA	NA	NA	NA
Arsenic	0.39	4	18	13	NA	6.72 J	NA	NA	NA	NA
Lead	400	1	11	36	NA	**186**	NA	NA	NA	NA
XRF (mg/kg)										
Lead	400	1	11	36	**62.33**	**129.67**	**24**	**90**	**73.67**	**91.33**
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)										
1-Methylnaphthalene	5500000	3	NC	NC	NA	2.4 J	NA	NA	NA	NA
2-Methylnaphthalene	310000	2	29000	0.14	NA	2.52 J	NA	NA	NA	NA
Acenaphthene	4700000	1	29000	NC	NA	1.72 J	NA	NA	NA	NA
Acenaphthylene	2300000	3	29000	0.07	NA	2.22 J	NA	NA	NA	NA
Anthracene	23000000	1	29000	400	NA	8.37 J	NA	NA	NA	NA
BaP Equivalent	90	1	1100	2100	NA	23.4331	NA	NA	NA	NA
Benzo(a)anthracene	900	1	1100	1800	NA	20.2 J	NA	NA	NA	NA
Benzo(a)pyrene	90	1	1100	2100	NA	17.7 J	NA	NA	NA	NA
Benzo(b)fluoranthene	900	1	1100	2100	NA	28.5 J	NA	NA	NA	NA
Benzo(g,h,i)perylene	2300000	3	1100	1700	NA	1.33 UJ	NA	NA	NA	NA
Benzo(k)fluoranthene	9000	1	1100	1700	NA	10.9 J	NA	NA	NA	NA
Chrysene	88000	1	1100	2700	NA	22.6 J	NA	NA	NA	NA
Dibenzo(a,h)anthracene	90	1	1100	420	NA	1.33 UJ	NA	NA	NA	NA
Fluoranthene	3100000	1	29000	4100	NA	51.5 J	NA	NA	NA	NA
Fluorene	3100000	1	29000	180	NA	3.22 J	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	900	1	1100	1600	NA	1.33 UJ	NA	NA	NA	NA
Naphthalene	1600000	1	29000	200	NA	1.33 UJ	NA	NA	NA	NA
Phenanthrene	2300000	3	29000	2500	NA	43.3 J	NA	NA	NA	NA
Pyrene	2300000	1	1100	3000	NA	36.5 J	NA	NA	NA	NA

LOCATION	FINAL HUMAN HEALTH CRITERIA VALUE		FEDERAL ECOLOGICAL MINIMUM OF AVIAN INVERTABRAT MAMMALIAN & PLANT SSLs [5]	TACO CHEMICALS IN BACKGROUND SOIL CRITERIA [6]	NTC-SO-TSA-049	NTC-SO-TSA-050	NTC-SO-TSA-051	NTC-SO-TSA-052	NTC-SO-TSA-053	NTC-SO-TSA-057
SAMPLE ID					NTC-SS-TSA-049-0006	NTC-SS-TSA-050-0006	NTC-SS-TSA-051-0006	NTC-SS-TSA-052-0006	NTC-SS-TSA-053-0006	NTC-SS-TSA-057-0006
SAMPLE DATE					04/21/2010	04/21/2010	04/21/2010	04/21/2010	04/21/2010	04/21/2010
DEPTH (FT BGS)					0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
METALS (mg/kg)										
Antimony	31	1	0.27	4	NA	**1.6 J**	**1.79 J**	**2.46 J**	**0.943 J**	NA
Arsenic	0.39	4	18	13	NA	8.62 J	7.23 J	9 J	5.58 J	NA
Lead	400	1	11	36	NA	**204**	**161**	**408**	**200**	NA
XRF (mg/kg)										
Lead	400	1	11	36	**49.33**	**171.33**	**165.33**	**210.33**	**143.67**	**47.5**
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)										
1-Methylnaphthalene	5500000	3	NC	NC	NA	6.37 J	6.17 J	6.67 UJ	12.4 J	NA
2-Methylnaphthalene	310000	2	29000	0.14	NA	8.42 J	7.75 J	6.67 UJ	18 J	NA
Acenaphthene	4700000	1	29000	NC	NA	13.6 J	13.4 J	6.67 UJ	4.34 J	NA
Acenaphthylene	2300000	3	29000	0.07	NA	12.9 J	15.7 J	27 J	12.4 J	NA
Anthracene	23000000	1	29000	400	NA	66.9 J	60.8 J	40.8 J	1.33 UJ	NA
BaP Equivalent	90	1	1100	2100	NA	525.131	484.164	537.843	183.636	NA
Benzo(a)anthracene	900	1	1100	1800	NA	338 J	272 J	401 J	129 J	NA
Benzo(a)pyrene	90	1	1100	2100	NA	337 J	315 J	340 J	104 J	NA
Benzo(b)fluoranthene	900	1	1100	2100	NA	450 J	392 J	463 J	192 J	NA
Benzo(g,h,i)perylene	2300000	3	1100	1700	NA	248 J	243 J	254 J	101 J	NA
Benzo(k)fluoranthene	9000	1	1100	1700	NA	166 J	154 J	176 J	60.3 J	NA
Chrysene	88000	1	1100	2700	NA	371 J	324 J	483 J	133 J	NA
Dibenzo(a,h)anthracene	90	1	1100	420	NA	77.6 J	74.5 J	80.9 J	34.8 J	NA
Fluoranthene	3100000	1	29000	4100	NA	651 J	558 J	552 J	399 J	NA
Fluorene	3100000	1	29000	180	NA	12.4 J	16 J	6.67 UJ	19.3 J	NA
Indeno(1,2,3-cd)pyrene	900	1	1100	1600	NA	297 J	264 J	283 J	120 J	NA
Naphthalene	1600000	1	29000	200	NA	7.79 J	6.49 J	6.67 UJ	21.3 J	NA
Phenanthrene	2300000	3	29000	2500	NA	241 J	289 J	195 J	369 J	NA
Pyrene	2300000	1	1100	3000	NA	573 J	456 J	435 J	212 J	NA

Footnotes and definitions are summarized on the final page of the table.

TABLE 4-3
SUMMARY OF DETECTED CONCENTRATIONS IN SURFACE SOIL
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

LOCATION SAMPLE ID SAMPLE DATE DEPTH (FT BGS)	FINAL HUMAN HEALTH CRITERIA VALUE		FEDERAL ECOLOGICAL MINIMUM OF AVIAN INVERTABRAT MAMMALIAN & PLANT SSLs [5]	TACO CHEMICALS IN BACKGROUND SOIL CRITERIA [6]	NTC-SO-TSA-058 NTC-SS-TSA-058-0006 04/21/2010 0 - 0.5	NTC-SO-TSA-059 NTC-SS-TSA-059-0006 04/21/2010 0 - 0.5
METALS (mg/kg)						
Antimony	31	1	0.27	4	NA	**0.641 J**
Arsenic	0.39	4	18	13	NA	8.51 J
Lead	400	1	11	36	NA	**127**
XRF (mg/kg)						
Lead	400	1	11	36	**98.67**	**142.33**
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)						
1-Methylnaphthalene	5500000	3	NC	NC	NA	31 J
2-Methylnaphthalene	310000	2	29000	0.14	NA	51.4 J
Acenaphthene	4700000	1	29000	NC	NA	118 J
Acenaphthylene	2300000	3	29000	0.07	NA	13.7 UJ
Anthracene	23000000	1	29000	400	NA	251 J
BaP Equivalent	90	1	1100	2100	NA	**13158.6**
Benzo(a)anthracene	900	1	1100	1800	NA	**6800 J**
Benzo(a)pyrene	90	1	1100	2100	NA	**9860 J**
Benzo(b)fluoranthene	900	1	1100	2100	NA	**5590 J**
Benzo(g,h,i)perylene	2300000	3	1100	1700	NA	**6010 J**
Benzo(k)fluoranthene	9000	1	1100	1700	NA	**1380 J**
Chrysene	88000	1	1100	2700	NA	**11800 J**
Dibenzo(a,h)anthracene	90	1	1100	420	NA	**1720 J**
Fluoranthene	3100000	1	29000	4100	NA	2930 J
Fluorene	3100000	1	29000	180	NA	75.1 J
Indeno(1,2,3-cd)pyrene	900	1	1100	1600	NA	**3140 J**
Naphthalene	1600000	1	29000	200	NA	44.1 J
Phenanthrene	2300000	3	29000	2500	NA	1280 J
Pyrene	2300000	1	1100	3000	NA	**4620 J**

LOCATION SAMPLE ID SAMPLE DATE DEPTH (FT BGS)	FINAL HUMAN HEALTH CRITERIA VALUE		FEDERAL ECOLOGICAL MINIMUM OF AVIAN INVERTABRAT MAMMALIAN & PLANT SSLs [5]	TACO CHEMICALS IN BACKGROUND SOIL CRITERIA [6]	NTC-SO-TSA-060 NTC-SS-TSA-060-0006 04/21/2010 0 - 0.5
METALS (mg/kg)					
Antimony	31	1	0.27	4	**0.804 J**
Arsenic	0.39	4	18	13	9.5 J
Lead	400	1	11	36	**139**
XRF (mg/kg)					
Lead	400	1	11	36	**146.33**
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)					
1-Methylnaphthalene	5500000	3	NC	NC	2.91 J
2-Methylnaphthalene	310000	2	29000	0.14	3.45 J
Acenaphthene	4700000	1	29000	NC	2.34 J
Acenaphthylene	2300000	3	29000	0.07	5.92 J
Anthracene	23000000	1	29000	400	11.9 J
BaP Equivalent	90	1	1100	2100	121.7988
Benzo(a)anthracene	900	1	1100	1800	59.1 J
Benzo(a)pyrene	90	1	1100	2100	76 J
Benzo(b)fluoranthene	900	1	1100	2100	122 J
Benzo(g,h,i)perylene	2300000	3	1100	1700	64.1 J
Benzo(k)fluoranthene	9000	1	1100	1700	40.4 J
Chrysene	88000	1	1100	2700	74.8 J
Dibenzo(a,h)anthracene	90	1	1100	420	19.6 J
Fluoranthene	3100000	1	29000	4100	121 J
Fluorene	3100000	1	29000	180	3.62 J
Indeno(1,2,3-cd)pyrene	900	1	1100	1600	76.1 J
Naphthalene	1600000	1	29000	200	1.52 UJ
Phenanthrene	2300000	3	29000	2500	45.5 J
Pyrene	2300000	1	1100	3000	103 J

Footnotes and definitions are summarized on the final page of the table.

Shaded = exceedance of human health screening criteria.
Bold = exceedance of ecological screening criteria
Shaded and Bold = exceedance of both human health and ecological screening criteria.

bgs = below ground surface
ft = feet
J = Indicates that the chemical was detected; however, the associated numerical result is not a precise representation of
NA = Not Analyzed
mg/kg = milligram per kilogram

Source of Screening Level
1 - Illinois EPA Tiered Approach to Corrective Acitons Objectives, Residential Soil Ingestion Criteria (http://www.ipcb.state.il.us/documents.dsweb/Get/Document-38408/). (July, 2010)
2 - Proposed Illinois EPA Tier 1 Soil Remediation Objectives - Residential Criteria. (September, 2008)
3 - Illinois EPA Residential Non-TACO - Intestion Criteria. (July, 2009)
4 - US EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites - Residential Soil Values. (May, 2010)
5 - US EPA Guidance for Developing Ecological Soil Screening Level. Office of Solid Waste and Emergency and Response. OSWER Directive 92857-55. (February, 2005)
6 - Illinois EPA background concentration (Illinois EPA, Appendix A, Table G of TACO)

Associated Samples:

NTC-SS-TSA-001-0006	NTC-SS-TSA-030-0006	NTC-SD-UPG-001-0006
NTC-SS-TSA-002-0006	NTC-SS-TSA-031-0006	NTC-SD-UPG-002-0006
NTC-SS-TSA-003-0006	NTC-SS-TSA-032-0006	NTC-SD-UPG-003-0006
NTC-SS-TSA-004-0006	NTC-SS-TSA-033-0006	NTC-SD-UPG-004-0006
NTC-SS-TSA-005-0006	NTC-SS-TSA-034-0006	NTC-SD-UPG-005-0006
NTC-SS-TSA-006-0006	NTC-SS-TSA-035-0006	NTC-SD-UPG-006-0006
NTC-SS-TSA-007-0006	NTC-SS-TSA-036-0006	NTC-SD-UPG-007-0006
NTC-SS-TSA-008-0006	NTC-SS-TSA-037-0006	NTC-SD-UPG-008-0006
NTC-SS-TSA-009-0006	NTC-SS-TSA-038-0006	NTC-SD-UPG-009-0006
NTC-SS-TSA-010-0006	NTC-SS-TSA-039-0006	NTC-SD-UPG-010-0006
NTC-SS-TSA-011-0006	NTC-SS-TSA-040-0006	
NTC-SS-TSA-012-0006	NTC-SS-TSA-041-0006	
NTC-SS-TSA-013-0006	NTC-SS-TSA-042-0006	
NTC-SS-TSA-014-0006	NTC-SS-TSA-043-0006	
NTC-SS-TSA-015-0006	NTC-SS-TSA-044-0006	
NTC-SS-TSA-016-0006	NTC-SS-TSA-045-0006	
NTC-SS-TSA-017-0006	NTC-SS-TSA-046-0006	
NTC-SS-TSA-018-0006	NTC-SS-TSA-047-0006	
NTC-SS-TSA-019-0006	NTC-SS-TSA-048-0006	
NTC-SS-TSA-020-0006	NTC-SS-TSA-049-0006	
NTC-SS-TSA-021-0006	NTC-SS-TSA-050-0006	
NTC-SS-TSA-022-0006	NTC-SS-TSA-051-0006	
NTC-SS-TSA-023-0006	NTC-SS-TSA-052-0006	
NTC-SS-TSA-024-0006	NTC-SS-TSA-053-0006	
NTC-SS-TSA-025-0006	NTC-SS-TSA-057-0006	
NTC-SS-TSA-026-0006	NTC-SS-TSA-058-0006	
NTC-SS-TSA-027-0006	NTC-SS-TSA-059-0006	
NTC-SS-TSA-028-0006	NTC-SS-TSA-060-0006	
NTC-SS-TSA-029-0006		

TABLE 4-4

SUMMARY OF DETECTED CONCENTRATIONS IN SEDIMENT
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS
1 of 3

LOCATION SAMPLE ID SAMPLE DATE DEPTH (ft bss)	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-TSA-061 NTC-SD-TSA-061-0006 05/19/2010 0 - 0.5	NTC-SD-TSA-062 NTC-SD-TSA-062-0006 05/19/2010 0 - 0.5	NTC-SD-TSA-063 NTC-SD-TSA-063-0006 05/19/2010 0 - 0.5	NTC-SD-TSA-064 NTC-SD-TSA-064-0006 05/19/2010 0 - 0.5	NTC-SD-TSA-065 NTC-SD-TSA-065-0006 05/19/2010 0 - 0.5	NTC-SD-TSA-066 NTC-SD-TSA-066-0006 05/19/2010 0 - 0.5	NTC-SD-TSA-067 NTC-SD-TSA-067-0006 05/19/2010 0 - 0.5
METALS (mg/kg)								
Antimony	2	0.301 U	0.319 U	0.295 U	0.309 U	0.321 U	0.308 U	0.306 U
Arsenic	9.79	2.77 J	2.95 J	3.03 J	2.72 J	2.78 J	2.6 J	2.58 J
Copper	31.6	NA	NA	NA	NA	NA	NA	NA
Iron	20000	NA	NA	NA	NA	NA	NA	NA
Lead	35.8	20	23.5	18.5	17.5	16.6	16.8	18.7
Magnesium	NC	NA	NA	NA	NA	NA	NA	NA
Strontium	NC	NA	NA	NA	NA	NA	NA	NA
Zinc	121	NA	NA	NA	NA	NA	NA	NA
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)								
1-Methylnaphthalene	20.2	1.65 U	1.66 U	1.63 U	1.68 U	1.68 U	1.67 U	1.68 U
2-Methylnaphthalene	20.2	2.31 J	1.66 U	1.63 U	1.68 U	2.06 J	1.67 U	1.68 U
Acenaphthene	6.71	1.65 U	1.66 U	1.63 U	1.68 U	1.68 U	1.67 U	1.68 U
Anthracene	57.2	17	1.66 U	1.63 U	17.4	1.68 U	1.67 U	17.9
BaP Equivalent	150	3.304075	1.66 U	3.141965	1.68 U	1.68 U	1.67 U	1.68 U
Benzo(a)anthracene	108	1.65 U	1.66 U	1.63 U	1.68 U	1.68 U	1.67 U	1.68 U
Benzo(a)pyrene	150	1.65 U	1.66 U	1.63 U	1.68 U	1.68 U	1.67 U	1.68 U
Benzo(b)fluoranthene	10400	14.8	1.66 U	13.4	1.68 U	1.68 U	1.67 U	1.68 U
Benzo(g,h,i)perylene	170	1.65 UJ	1.66 UJ	1.63 UJ	1.68 UJ	1.68 UJ	1.67 UJ	1.68 UJ
Benzo(k)fluoranthene	240	1.65 U	1.66 U	1.63 U	1.68 U	1.68 U	1.67 U	1.68 U
Chrysene	166	1.65 U	1.66 U	1.63 U	1.68 U	1.68 U	1.67 U	1.68 U
Fluoranthene	423	11.9	8.24 J	8.24	10.6	15.3	13.1	10.4
Fluorene	77.4	1.65 U	1.66 U	1.63 U	1.68 U	1.68 U	1.67 U	1.68 U
Indeno(1,2,3-cd)pyrene	200	1.65 U	1.66 U	1.63 U	1.68 U	1.68 U	1.67 U	1.68 U
Naphthalene	176	1.65 U	1.66 U	1.63 U	1.68 U	1.68 U	1.67 U	1.68 U
Phenanthrene	204	7.73 J	5.19 J	4.38 J	8.2 J	1.68 U	9.29	6.57 J
Pyrene	195	28	25.7	25.3	27.8	30.7	29.4	27.4

LOCATION SAMPLE ID SAMPLE DATE DEPTH (ft bss)	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-TSA-068 NTC-SD-TSA-068-0006 05/19/2010 0 - 0.5	NTC-SD-TSA-069 NTC-SD-TSA-069-0006 05/19/2010 0 - 0.5	NTC-SD-TSA-070 NTC-SD-TSA-070-0006 05/19/2010 0 - 0.5	NTC-SD-TSA-071 NTC-SD-TSA-071-0006 05/19/2010 0 - 0.5	NTC-SD-TSA-072 NTC-SD-TSA-072-0006 05/23/2010 0 - 0.5	NTC-SD-TSA-073 NTC-SD-TSA-073-0006 05/23/2010 0 - 0.5	NTC-SD-TSA-074 NTC-SD-TSA-074-0006 05/23/2010 0 - 0.5
METALS (mg/kg)								
Antimony	2	0.324 U	0.313 U	0.312 U	0.32 U	0.328 J	**2.4 J**	0.289 U
Arsenic	9.79	3.19 J	2.87 J	3.35 J	2.82 J	2.91	2.7	3.02
Copper	31.6	NA	NA	NA	NA	NA	NA	NA
Iron	20000	NA	NA	NA	NA	NA	NA	NA
Lead	35.8	17.3	18.8	25.3	17.6	**109 J**	**48.1 J**	**44.4 J**
Magnesium	NC	NA	NA	NA	NA	NA	NA	NA
Strontium	NC	NA	NA	NA	NA	NA	NA	NA
Zinc	121	NA	NA	NA	NA	NA	NA	NA
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)								
1-Methylnaphthalene	20.2	1.7 U	1.67 U	2.06 J	1.96 J	1.93 J	1.6 U	1.74 J
2-Methylnaphthalene	20.2	1.7 U	1.67 U	2 J	3.04 J	2.41 J	1.6 U	2.13 J
Acenaphthene	6.71	1.7 U	1.67 U	1.66 U	1.66 U	1.61 U	1.6 U	1.94 J
Anthracene	57.2	1.7 U	1.67 U	18	1.66 U	1.61 U	6.29 J	7.44 J
BaP Equivalent	150	1.7 U	1.67 U	24.095	1.66 U	20.29942	18.74214	3.2388
Benzo(a)anthracene	108	1.7 U	1.67 U	58.3	1.66 U	16.6	16.1	1.6 U
Benzo(a)pyrene	150	1.7 U	1.67 U	15.7	1.66 U	16.1	13.5	1.6 UJ
Benzo(b)fluoranthene	10400	1.7 U	1.67 U	16.3	1.66 U	16.4	1.6 U	14.7
Benzo(g,h,i)perylene	170	1.7 UJ	1.67 UJ	1.66 UJ	1.66 UJ	3.8 J	2.45 J	1.93 J
Benzo(k)fluoranthene	240	1.7 U	1.67 U	1.66 U	1.66 U	1.61 U	1.6 U	1.6 U
Chrysene	166	1.7 U	1.67 U	13.7	1.66 U	5.87 J	4.14 J	1.6 U
Fluoranthene	423	10.1	8.05 J	16.2	9.31	13.4	1.6 U	1.6 U
Fluorene	77.4	1.7 U	1.67 U	2.16 J	1.66 U	3.41 J	1.6 U	1.6 U
Indeno(1,2,3-cd)pyrene	200	1.7 U	1.67 U	1.66 U	1.66 U	1.61 U	27.4	1.6 U
Naphthalene	176	1.7 U	1.67 U	1.66 U	1.66 U	1.61 U	1.6 U	1.6 U
Phenanthrene	204	6.25 J	4.65 J	11.5	6.93 J	15.2	8.1	10.6
Pyrene	195	27.8	25.2	31.2	27.5	12.1	9.02	9.63

Footnotes and definitions are summarized on the final page of the table.

TABLE 4-4

SUMMARY OF DETECTED CONCENTRATIONS IN SEDIMENT
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

LOCATION SAMPLE ID SAMPLE DATE DEPTH (ft bss)	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-TSA-075 NTC-SD-TSA-075-0006 05/23/2010 0 - 0.5	NTC-SD-TSA-076 NTC-SD-TSA-076-0006 05/23/2010 0 - 0.5	NTC-SD-TSA-077 NTC-SD-TSA-077-0006 05/23/2010 0 - 0.5	NTC-SD-TSA-078 NTC-SD-TSA-078-0006 05/23/2010 0 - 0.5	NTC-SD-UPG-001* NTC-SD-UPG-001-0006 05/19/2010 0 - 0.5	NTC-SD-UPG-002* NTC-SD-UPG-002-0006 05/19/2010 0 - 0.5	NTC-SD-UPG-003* NTC-SD-UPG-003-0006 05/19/2010 0 - 0.5
METALS (mg/kg)								
Antimony	2	0.313 U	0.302 U	0.311 U	1.06 J	0.337 U	0.312 U	0.304 U
Arsenic	9.79	2.26	2.29	2.64	2.89	2.67	3.14	3.17
Copper	31.6	NA	NA	NA	NA	3.52	4.53	4.05
Iron	20000	NA	NA	NA	NA	4100	4090	4560
Lead	35.8	20.3 J	18.2	**36**	**204**	16.8	16.3	8.98
Magnesium	NC	NA	NA	NA	NA	31500 J	34900	27800 J
Strontium	NC	NA	NA	NA	NA	24.6	27.3	27.7
Zinc	121	NA	NA	NA	NA	36.2	30.4	27.3
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)								
1-Methylnaphthalene	20.2	1.71 U	1.66 U	4.73 J	2.41 J	1.75 UR	1.74 UR	5.07 J
2-Methylnaphthalene	20.2	1.71 U	1.66 U	9.54	2.26 J	1.75 UR	1.74 UR	6.25 J
Acenaphthene	6.71	1.71 U	1.66 U	1.65 U	1.61 U	1.75 UR	1.74 UR	1.69 UR
Anthracene	57.2	1.71 U	1.66 U	6.58 J	6.38 J	3.46 J	1.74 UR	1.69 UR
BaP Equivalent	150	3.230405	19.30729	4.94976	3.109855	1.75 UR	6.72052	19.08
Benzo(a)anthracene	108	1.71 U	17.6	16.1	1.61 U	1.75 UR	4.22 J	12.2 J
Benzo(a)pyrene	150	1.71 U	15	1.65 U	1.61 U	1.75 UR	1.74 UR	12.2 J
Benzo(b)fluoranthene	10400	13.4	16.2	15.7	13.3	1.75 UR	26.2 J	37.6 J
Benzo(g,h,i)perylene	170	1.71 U	3.08 J	1.65 U	1.61 U	1.75 UR	1.74 UR	11.6 J
Benzo(k)fluoranthene	240	1.71 U	1.66 U	3.36 J	1.61 U	1.75 UR	1.74 UR	1.69 UR
Chrysene	166	1.71 U	5.99 J	3.66 J	1.61 U	1.75 UR	7.12 J	24.1 J
Fluoranthene	423	1.71 U	1.66 U	1.65 U	1.61 U	10.4 J	15.2 J	58.8 J
Fluorene	77.4	1.82 J	3.09 J	1.76 J	1.61 U	2.29 J	2.92 J	1.69 UR
Indeno(1,2,3-cd)pyrene	200	1.71 U	1.66 U	1.65 U	1.61 U	1.75 UR	1.74 UR	1.69 UR
Naphthalene	176	1.71 U	1.66 U	9.08	1.61 U	1.75 UR	1.74 UR	1.69 UR
Phenanthrene	204	5.37 J	10.4	6.8 J	5.13 J	8.72 J	10.3 J	40.3 J
Pyrene	195	6.52 J	11.9	8.38	6.11 J	8.91 J	11.2 J	43.7 J

LOCATION SAMPLE ID SAMPLE DATE DEPTH (ft bss)	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-UPG-004* NTC-SD-UPG-004-0006 05/20/2010 0 - 0.5	NTC-SD-UPG-005* NTC-SD-UPG-005-0006 05/20/2010 0 - 0.5	NTC-SD-UPG-006* NTC-SD-UPG-006-0006 05/20/2010 0 - 0.5	NTC-SD-UPG-007* NTC-SD-UPG-007-0006 05/20/2010 0 - 0.5	NTC-SD-UPG-008* NTC-SD-UPG-008-0006 05/20/2010 0 - 0.5	NTC-SD-UPG-009* NTC-SD-UPG-009-0006 05/20/2010 0 - 0.5	NTC-SD-UPG-010* NTC-SD-UPG-010-0006 05/20/2010 0 - 0.5
METALS (mg/kg)								
Antimony	2	0.309 U	0.306 U	0.298 U	0.326 U	0.345 U	0.293 UJ	0.308 U
Arsenic	9.79	3.89	9.56	5.22	3.04	4.26	6.42	**10.7**
Copper	31.6	2.53	15.2	4.44	5.5	3.53	2.08	6.66
Iron	20000	3610	14900	5800	4620	4560	5260	6630
Lead	35.8	4.05	9.01	7.31	11.5	11.1	5.05	27.3
Magnesium	NC	9860 J	36300	22500 J	32000 J	14600 J	15100 J	12700 J
Strontium	NC	12.1	40.6	25	25.1	15.5	11.4	12.4
Zinc	121	15.7	34.8	26.1	27.9	24.3	14.2 J	44.9
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)								
1-Methylnaphthalene	20.2	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	20.2	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	6.71	NA	NA	NA	NA	NA	NA	NA
Anthracene	57.2	NA	NA	NA	NA	NA	NA	NA
BaP Equivalent	150	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	108	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	150	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	10400	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	170	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	240	NA	NA	NA	NA	NA	NA	NA
Chrysene	166	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	423	NA	NA	NA	NA	NA	NA	NA
Fluorene	77.4	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	200	NA	NA	NA	NA	NA	NA	NA
Naphthalene	176	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	204	NA	NA	NA	NA	NA	NA	NA
Pyrene	195	NA	NA	NA	NA	NA	NA	NA

Footnotes and definitions are summarized on the final page of the table.

Bold = exceedance of ecological screening criteria

* PAH analysis for upgradient samples (UPG001 - UPG003) were collected in accordance with the UFP-SAP. However, the laboratory did not analyze the samples until after the holding time had expired. Therefore a majority of the results for these samples are qualified with an R and rejected. The data is included for informational purposes but will not be used in descision making.

bss = below sediment surface
ft = feet
J = Indicates that the chemical was detected; however, the associated numerical result is not a precise representation of
NA = Not Analyzed
mg/kg = milligram per kilogram
R = Indicates that the chemical was detected; however, the results are rejected because of holding time exceedances.
U = Indicates that the chemical was not detected at the numerical detection limit noted.
µg/kg = microgram per kilogram

Source of Screening Level
1 - USEPA Guidance for Developing Ecological Soil Screening Level. Office of Solid Waste and Emergency and Response. OSWER Directive 92857-55. (February, 2005)

Associated Samples:

NTC-SD-TSA-061-0006	NTC-SD-TSA-076-0006
NTC-SD-TSA-062-0006	NTC-SD-TSA-077-0006
NTC-SD-TSA-063-0006	NTC-SD-TSA-078-0006
NTC-SD-TSA-064-0006	NTC-SD-UPG-001-0006
NTC-SD-TSA-065-0006	NTC-SD-UPG-002-0006
NTC-SD-TSA-066-0006	NTC-SD-UPG-003-0006
NTC-SD-TSA-067-0006	NTC-SD-UPG-004-0006
NTC-SD-TSA-068-0006	NTC-SD-UPG-005-0006
NTC-SD-TSA-069-0006	NTC-SD-UPG-006-0006
NTC-SD-TSA-070-0006	NTC-SD-UPG-007-0006
NTC-SD-TSA-071-0006	NTC-SD-UPG-008-0006
NTC-SD-TSA-072-0006	NTC-SD-UPG-009-0006
NTC-SD-TSA-073-0006	NTC-SD-UPG-010-0006
NTC-SD-TSA-074-0006	
NTC-SD-TSA-075-0006	

TABLE 4-5

CONCEPTUAL SITE MODEL INFORMATION PROFILE
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS
PAGE 1 OF 4

Profile Type	Information Needs	Findings
Range/Site Profile	Installation Name	Naval Station Great Lakes (NSGL)
	Installation Location	Great Lakes, Lake County, Illinois
	Range/Site Name	Trap, Skeet, and Archery (TSA) Ranges
	Range/Site Location	The site is located on the eastern side of NSGL. The site is a lakefront location along the western shore of Lake Michigan, north of the naval Training Center (NTC) Lakefront site.
	Range/Site History	The site was built as a training and recreational facility for servicemen to be proficient at leading, timing, and firing on moving targets. The trap range was likely constructed during WWII, and the skeet and archery ranges were built in 1968. Over the years, the equipment storage building and trap/skeet houses that were originally located at the site were demolished, and the ranges were decommissioned. Construction began on an recreational vehicle (RV) park in July 2000 within the TSA Ranges site to provide a recreational draw to the installation, offering a beach area and other amenities.
	Range/Site Area and Layout	The site encompasses 29.4 acres. The land portion of the site is approximately 1.1 acres and was divided into a trap range, a skeet range, and an archery range. The surface danger zone (SDZs) for the trap and skeet ranges (a total of 29.4 acres) extend into Lake Michigan.
	Range/Site Structures	The former Trap Range consisted of shooting stations and a pull house for the target thrower. The skeet range had shooting stations along a firing arc and low and high houses to dispense the clay targets. The archery range had no structures. Currently, an RV park with bathroom facilities is located at the site.
	Range/Site Boundaries	See Figures 1-2 and 4-1 N: Foss Acres Forest Preserve S: NTC Lakefront E: Lake Michigan W: Ziegemeier Street
	Range/Site Security	The site is located within the installation, which is patrolled by base security; however, there are no access controls specific to the site itself or to the water portion of the site in Lake Michigan.
Munitions/ Release Profile	Munitions Types	Small arms (shot gun ammunition)
	Maximum Probability Penetration Depth	Maximum penetration depth of 0 to 6 inches (surface) for small arms on the land portion of the site. Potential penetration depth in sediments of Lake Michigan is unknown.
	MEC Density	MEC presence is not suspected since munitions use

TABLE 4-5

CONCEPTUAL SITE MODEL INFORMATION PROFILE
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

		was limited to small arms.
	Munitions Debris	Surficial material documented as safe (MDAS) was not found at this site. There is direct evidence of surface munitions scrap/range debris fragments on the land portion of the site (clay pigeon fragments and shotgun shell wadding). In addition, no subsurface munitions scrap/fragments/MDAS were identified to be present in the sediments of the lake during the geophysics investigation in Lake Michigan.
	Associated MC	Primary munitions constituent (MC) of concern includes lead, antimony, arsenic (lead shot) and polynulcear aromatic hydrocarbons (PAHs) (clay targets).
	Migration Routes/Release Mechanisms	Natural release mechanisms and migration mechanisms for potential MC on the land portion of the site include erosion and surface water runoff. Human activities, such as soil excavation and vegetation removal, may also redistribute MC in soil. Migration mechanisms for MC potentially in sediment of Lake Michigan include wave action, lake turnover, and potential dredging activities. Bioaccumulation of MC in sediment dwelling biota may also occur.
Physical Profile (see Section 2)	Climate	The lakefront is strongly influenced by its proximity to Lake Michigan and by southerly Gulf Stream winds. Average temperatures range from 20.3 °F in January to 71.5 °F in July. The average annual precipitation is 34.1 inches, and the mean seasonal snowfall is 37.9 inches.
	Topography	Bluffs and ravines surround the range to the west.
	Geology	Poorly sorted, unstratified sediments of the Wadsworth formation underlain by Silurian dolomite bedrock.
	Soil	Soil borings completed within NSGL consisted of silt, clay, and sand. Course sands and gravels were evident in the Skeet Range along the undeveloped beach area.
	Hydrogeology	The hydrogeologic framework of NSGL consists of an overburden aquifer, with depth to groundwater averaging 2 to 5 feet bgs. Groundwater flow direction is generally to the east toward Lake Michigan. Groundwater is not used as a drinking water source for the installation. Any MC in groundwater discharging into the lake is expected to be very diluted and not to be a concern to the potable water use of the lake.
	Hydrology	There are no surface water bodies on the land portion of the TSA Ranges site. However, the SDZs for the TSA Ranges extend into Lake Michigan.
	Vegetation	Predominantly landscaped grasses with some

TABLE 4-5

CONCEPTUAL SITE MODEL INFORMATION PROFILE
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

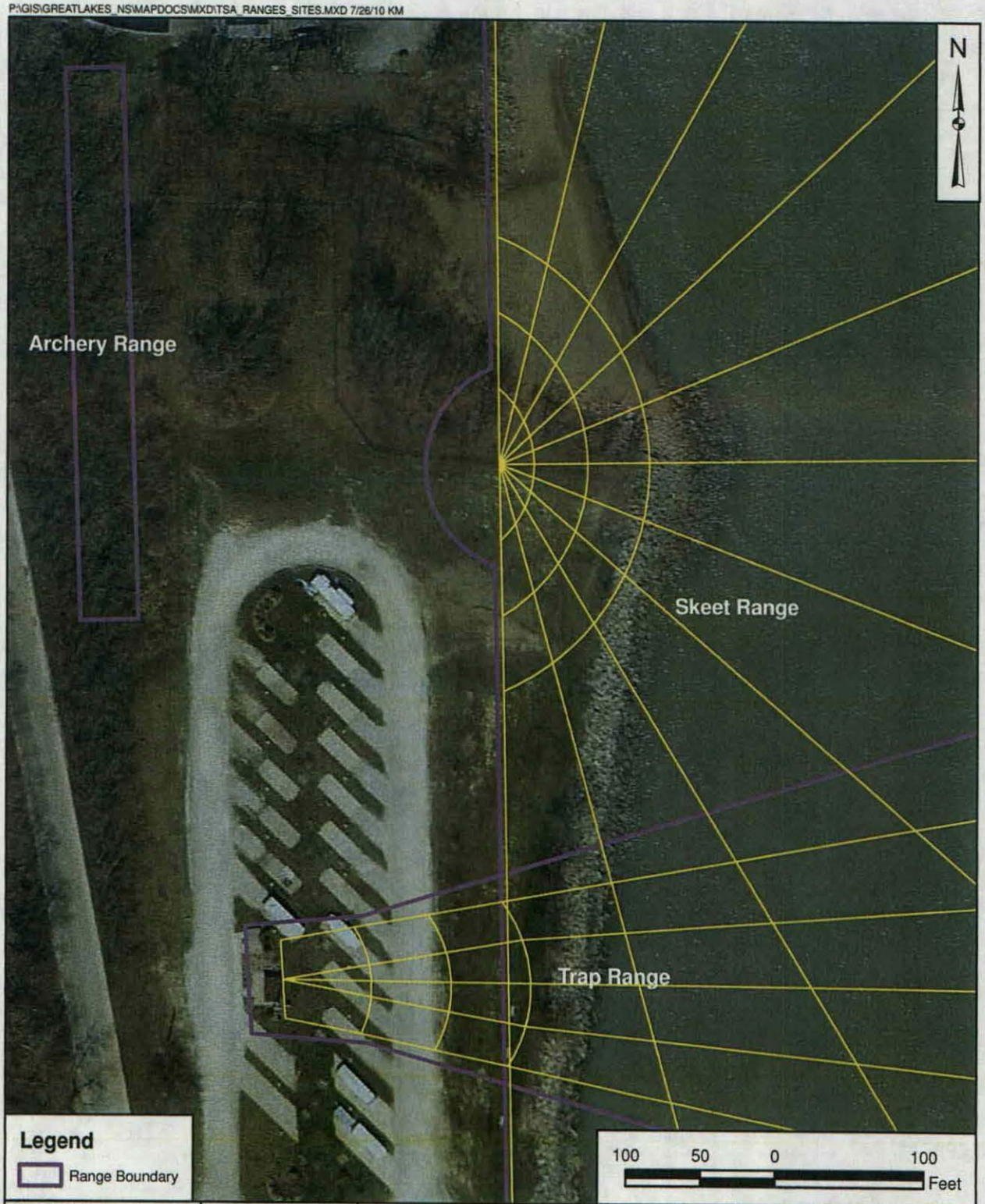
		woodland species.
Land Use and Exposure Profile	Current Land Use	The land portion of the site is used as an RV park and campground location for Navy personnel and their visitors. The water portion of the site is used for transportation, recreation, and as a potable water source.
	Current Human Receptors	Authorized Navy personnel, Navy-escorted contractors and visitors, unauthorized trespassers (land portion of the site), and recreationists and commercial fishermen (water portion of the site).
	Current Activities	Activities on the land portion of the site are moderate in frequency and include grounds maintenance, recreational activities, and camping. The water portion of the site is used for transportation, commercial fishing, and recreation (e.g., diving, swimming, or fishing). Dredging has occurred in Lake Michigan in the past (USACE, 2001).
	Potential Future Land Use	Potential future land use is assumed to be the same as present land use. Continued use as an RV park and campground is expected. There are no plans for use external to the Navy.
	Potential Future Human Receptors	Authorized Navy personnel, Navy-escorted contractors and visitors, unauthorized trespassers (land portion of the site), and recreationists and commercial fishermen (water portion of the site).
	Potential Future Land Use Related Activities	The land portion of the site is expected to experience continued grounds maintenance and potential construction for recreational activities, and environmental or other types of intrusive investigations may occur at the site. Use of the water portion of the site is expected to remain the same as current use: for transportation, commercial fishing, and recreation. It is unknown if additional dredging activities are planned.
	Zoning/Land Use Restrictions	A formal land use restriction prohibiting the installation of groundwater wells (with the exception of environmental monitoring wells) and the consumption of groundwater at NSGL was issued in September 2002. Water use restrictions are likely in place for Lake Michigan to protect the potable water supply source.
	Demographics/Zoning	Lake County population density is approximately 1,300 persons per square mile, while NSGL employs approximately 25,000 military and civilian personnel.
	Beneficial Resources	Lake Michigan is a major fishery with over 22,000 square miles of both commercial and recreational fishing adjacent to NSGL. Lake Michigan is also a municipal potable water source and a recreational resource.

TABLE 4-5

CONCEPTUAL SITE MODEL INFORMATION PROFILE
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Ecological Profile	Habitat Type	There is grassland at the location of the former ranges. Some forested habitat is present on the bluff and in the Foss Acres Forest Preserve north of the site. Lake Michigan provides aquatic habitat.
	Degree of Disturbance	Moderate – The site has undergone extensive grading over a majority of the site and current activities at the land portion of the site include moderate disturbance (e.g., grounds maintenance and infrequent use for vehicle storage/placement for personnel with RVs). Disturbance of sediments in Lake Michigan is expected to be low to moderate due to wave action in the shallow near shore sediments.
	Ecological Receptors and Species of Special Concern	Grassland and forest species (e.g., vegetation, birds, small mammals, reptiles/amphibians) are expected to utilize the available habitat on the land portion of the site. Aquatic flora and fauna are expected to be present in the water portion of the site (i.e., Lake Michigan). Avian species are expected to be present in the land and water portions of the site.
General Exposure Profile	Relationship of MEC/MC Sources to Habitat and Potential Receptors	Munitions of explosive concern (MEC) are not suspected since munitions use was limited to small arms. The MC Pathway for surface soil (lead and PAHs) is complete for human and ecological receptors. Human and ecological receptors may come into direct contact with potential MC in surface soil at the land portion of the site. The MC Pathway for sediment is complete for aquatic biota in the TSA Ranges.

P:\GIS\GREATLAKES_NS\MAPDOCS\MXD\TSA_RANGES_SITES.MXD 7/26/10 KM



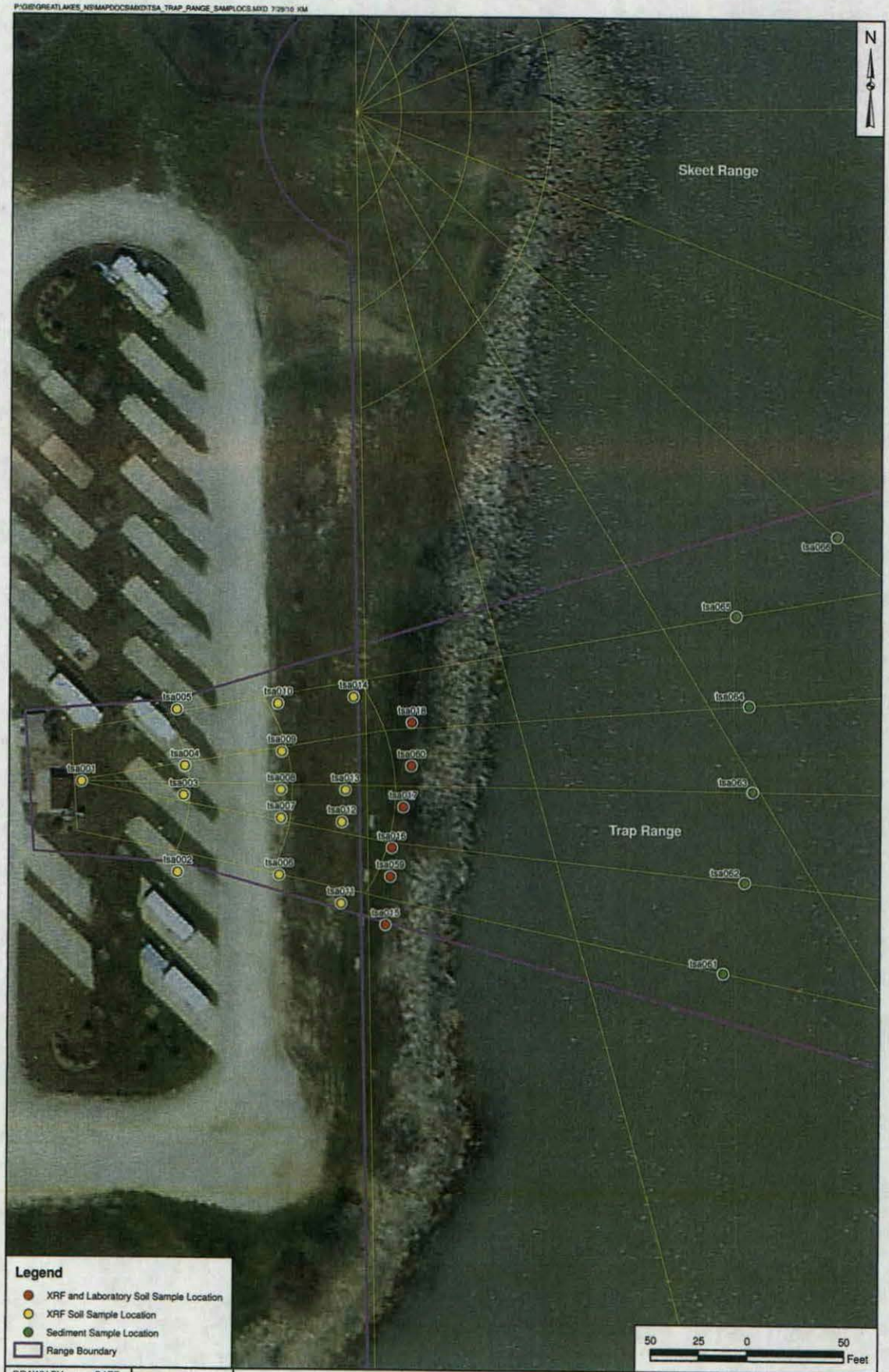
DRAWN BY	DATE
K. MOORE	11/12/09
CHECKED BY	DATE
J. DUCAR	7/26/10
REVISED BY	DATE
—	—
SCALE	
AS NOTED	

NAVFAC

SITE LOCATION
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER	
CTO F274	
OWNER NUMBER	
—	
APPROVED BY	DATE
—	—
FIGURE NO.	REV
FIGURE 4-1	0

P:\GIS\GREATLAKES_NS\MAPDOCS\MXD\TSA_TRAP_RANGE_SAMPLOCS.MXD 7/29/10 KM



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J. DUCAR	7/29/10
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SOIL AND SEDIMENT SAMPLING LOCATIONS
TSA RANGES - TRAP RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER	
CTO F274	
OWNER NUMBER	
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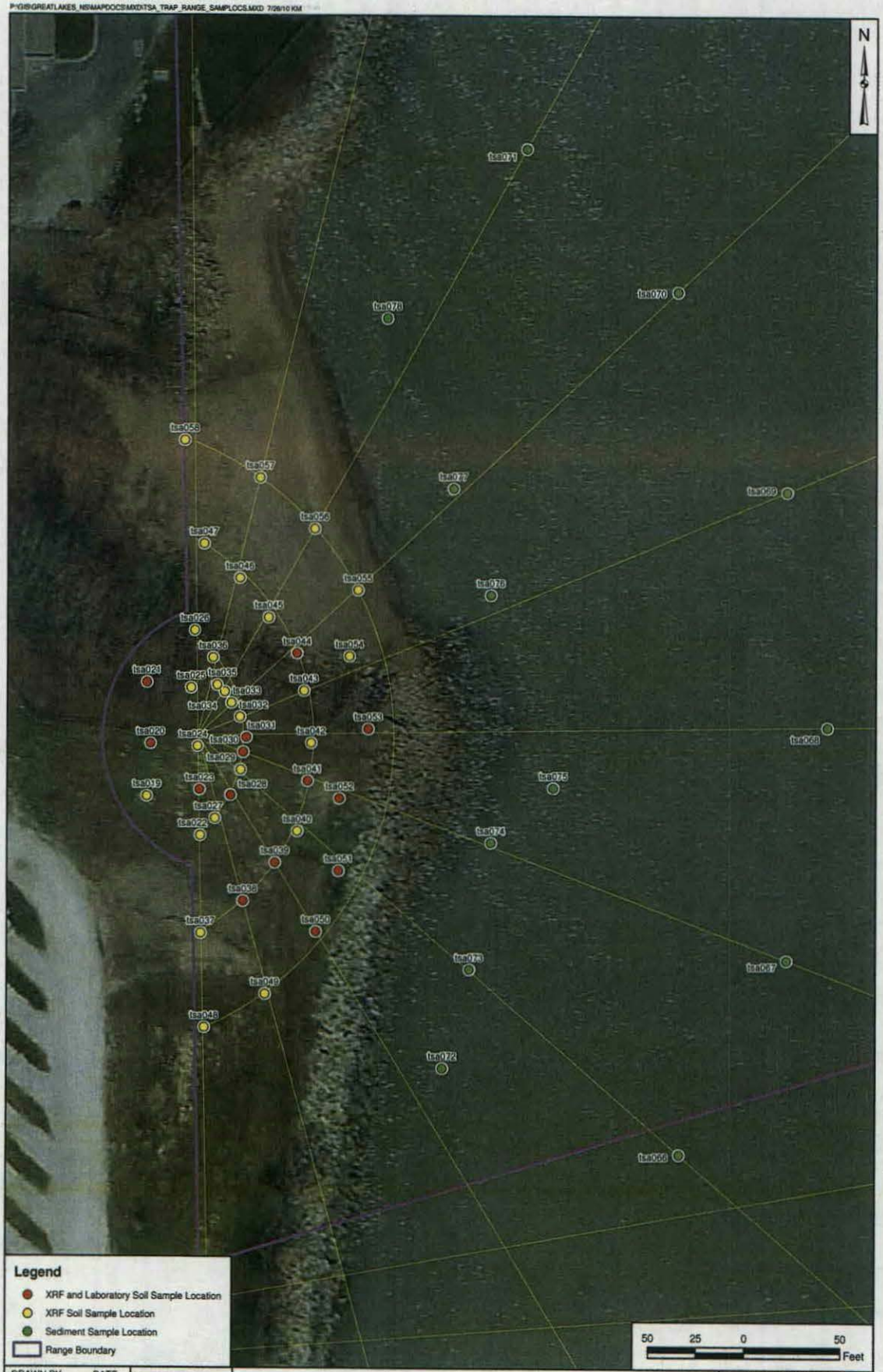
FIGURE NO.	REV
FIGURE 4-2	0

P:\GIS\GREATLAKES_NS\MAPDOCS\MXD\TSA_TRAP_RANGE_SAMPLOCS.MXD 7/29/10 KM



Legend

- XRF and Laboratory Soil Sample Location
- XRF Soil Sample Location
- Sediment Sample Location
- Range Boundary

50 25 0 50 Feet

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J. ENGLISH	07/20/10
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J. DUCAR	7/29/10
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SCALE	
AS NOTED	

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SOIL AND SEDIMENT SAMPLING LOCATIONS MAP
TSA RANGES - SKEET RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER	
CTO F274	
OWNER NUMBER	
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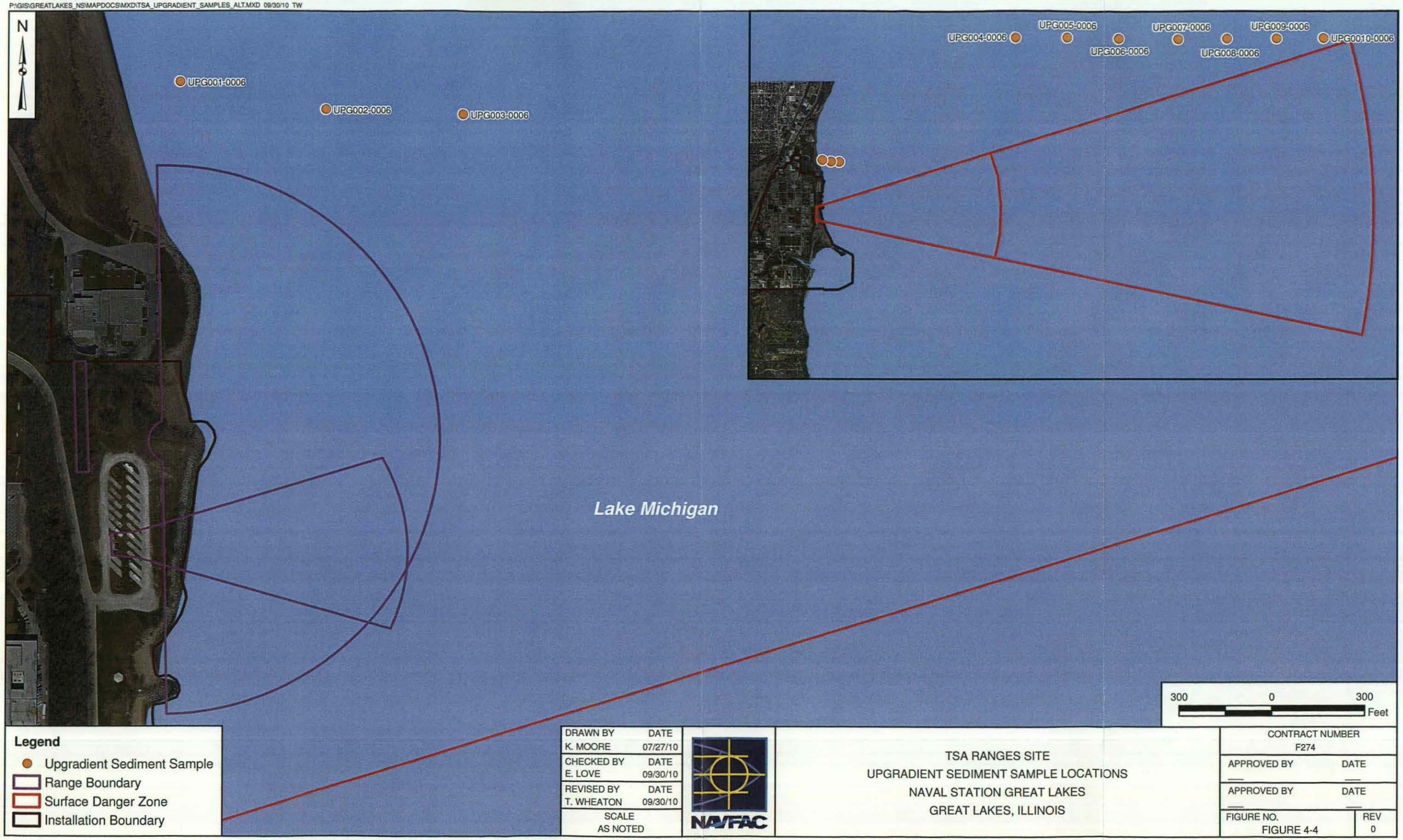
APPROVED BY	DATE
—	—
FIGURE NO.	REV
FIGURE 4-3	0

P:\GIS\GREATLANDS_NS\MAPDOCS\MXD\TSA_UPGRADIENT_SAMPLES_ALT.MXD 09/30/10 TW



Legend

- Upgradient Sediment Sample
- Range Boundary
- Surface Danger Zone
- Installation Boundary

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K. MOORE	07/27/10
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E. LOVE	09/30/10
REVISED BY	DATE
T. WHEATON	09/30/10
SCALE	
AS NOTED	

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TSA RANGES SITE
UPGRADIENT SEDIMENT SAMPLE LOCATIONS
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER	
F274	
APPROVED BY	DATE
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APPROVED BY	DATE
___	___
FIGURE NO.	REV
FIGURE 4-4	0

P:\GIS\GREATLAKES_NS\MAPDOCS\MXD\TSA_TRAP_RANGE_METALS.MXD 8/2/10 KM

NOTES:
Bold indicates exceedances of the Human Health Screening Criteria
Red indicates exceedances of the Ecological Criteria
J - estimated values
NA - not analyzed

N

NTC-SO-TSA-014
XRF (mg/kg)
LEAD 15.67

NTC-SO-TSA-010
XRF (mg/kg)
LEAD 15.67

NTC-SO-TSA-005
XRF (mg/kg)
LEAD 29

NTC-SO-TSA-018
Inorganics (mg/kg)
ANTIMONY 0.81 J
ARSENIC **9.83 J**
LEAD 148
XRF (mg/kg)
LEAD 119.33

NTC-SO-TSA-009
XRF (mg/kg)
LEAD 17.67

NTC-SO-TSA-060
Inorganics (mg/kg)
ANTIMONY 0.804 J
ARSENIC **9.5 J**
LEAD 139
XRF (mg/kg)
LEAD 146.33

NTC-SO-TSA-004
XRF (mg/kg)
LEAD 27

NTC-SO-TSA-001
XRF (mg/kg)
LEAD 24.33

NTC-SO-TSA-013
XRF (mg/kg)
LEAD 20.33

NTC-SO-TSA-003
XRF (mg/kg)
LEAD 41.67

NTC-SO-TSA-008
XRF (mg/kg)
LEAD 14.33

NTC-SO-TSA-017
Inorganics (mg/kg)
ANTIMONY 0.772 J
ARSENIC **8.82 J**
LEAD 135
XRF (mg/kg)
LEAD 120.67

NTC-SO-TSA-007
XRF (mg/kg)
LEAD 17

NTC-SO-TSA-012
XRF (mg/kg)
LEAD 23.33

NTC-SO-TSA-002
XRF (mg/kg)
LEAD 14.67

NTC-SO-TSA-006
XRF (mg/kg)
LEAD 17.5

NTC-SO-TSA-016
Inorganics (mg/kg)
ANTIMONY 0.76 J
ARSENIC **10.1 J**
LEAD 136
XRF (mg/kg)
LEAD 115.67

NTC-SO-TSA-011
XRF (mg/kg)
LEAD 34.33

NTC-SO-TSA-059
Inorganics (mg/kg)
ANTIMONY 0.641 J
ARSENIC **8.51 J**
LEAD 127
XRF (mg/kg)
LEAD 142.33

NTC-SO-TSA-015
Inorganics (mg/kg)
ANTIMONY 1.07 J
ARSENIC **10.7 J**
LEAD 193
XRF (mg/kg)
LEAD 118

Legend

- Soil Sample Location with Exceedance of Human Health Screening Criteria
- Soil Sample Location without Exceedance of Human Health Screening Criteria
- Range Boundary

30 15 0 30
Feet

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CHECKED BY / DATE	J. DUCAR 8/2/10
REVISED BY / DATE	
SCALE	AS NOTED

NAVFAC

SELECT METALS AND XRF DETECTIONS IN SOIL
TSA RANGES - TRAP RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER	CTO F274
OWNER NUMBER	—
APPROVED BY / DATE	— / —
FIGURE NO.	FIGURE 4-5
REV	0

P:\GIS\GREATLAKES_NS\MAPDOCS\MXD\TSA_SKEET_RANGE_METALS.MXD 8/2/10 KM

NOTES:
Bold indicates exceedances of the Human Health Screening Criteria
Red indicates exceedances of the Ecological Criteria
* indicates exceedance of both Human Health and Ecological Criteria
J - estimated values
NA - not analyzed

N

NTC-SO-TSA-034
XRF (mg/kg)
LEAD 49.67

NTC-SO-TSA-045
XRF (mg/kg)
LEAD 24

NTC-SO-TSA-033
XRF (mg/kg)
LEAD 42.67

NTC-SO-TSA-057
XRF (mg/kg)
LEAD 47.5

NTC-SO-TSA-032
XRF (mg/kg)
LEAD 81

NTC-SO-TSA-058
XRF (mg/kg)
LEAD 98.67

NTC-SO-TSA-044
Inorganics (mg/kg)
ANTIMONY 0.734 J
ARSENIC **6.72 J**
LEAD 186
XRF (mg/kg)
LEAD 129.67

NTC-SO-TSA-046
XRF (mg/kg)
LEAD 90

NTC-SO-TSA-031
Inorganics (mg/kg)
ANTIMONY 1.24 J
ARSENIC **6.53 J**
LEAD 368
XRF (mg/kg)
LEAD 163

NTC-SO-TSA-047
XRF (mg/kg)
LEAD 73.67

NTC-SO-TSA-043
XRF (mg/kg)
LEAD 62.33

NTC-SO-TSA-026
XRF (mg/kg)
LEAD 57.33

NTC-SO-TSA-030
Inorganics (mg/kg)
ANTIMONY 3.65 J
ARSENIC **7.31 J**
LEAD **1460***
XRF (mg/kg)
LEAD **468.33***

NTC-SO-TSA-036
XRF (mg/kg)
LEAD 85

NTC-SO-TSA-035
XRF (mg/kg)
LEAD 45.67

NTC-SO-TSA-042
XRF (mg/kg)
LEAD 85.67

NTC-SO-TSA-025
XRF (mg/kg)
LEAD 59.67

NTC-SO-TSA-053
Inorganics (mg/kg)
ANTIMONY 0.943 J
ARSENIC **5.58 J**
LEAD 200
XRF (mg/kg)
LEAD 143.67

NTC-SO-TSA-021
Inorganics (mg/kg)
ANTIMONY 1.13 J
ARSENIC **5.92 J**
LEAD 152
XRF (mg/kg)
LEAD 103.33

NTC-SO-TSA-029
XRF (mg/kg)
LEAD 45.33

NTC-SO-TSA-020
Inorganics (mg/kg)
ANTIMONY 1.87 J
ARSENIC **7.8 J**
LEAD **564***
XRF (mg/kg)
LEAD 112

NTC-SO-TSA-041
Inorganics (mg/kg)
ANTIMONY 2.58 J
ARSENIC **19.6 J***
LEAD 245
XRF (mg/kg)
LEAD 143.67

NTC-SO-TSA-024
XRF (mg/kg)
LEAD 65.33

NTC-SO-TSA-019
XRF (mg/kg)
LEAD 24.67

NTC-SO-TSA-052
Inorganics (mg/kg)
ANTIMONY 2.46 J
ARSENIC **9 J**
LEAD **408***
XRF (mg/kg)
LEAD 210.33

NTC-SO-TSA-023
Inorganics (mg/kg)
ANTIMONY 3.68 J
ARSENIC **8.82 J**
LEAD **1310***
XRF (mg/kg)
LEAD **448.33***

NTC-SO-TSA-028
Inorganics (mg/kg)
ANTIMONY 1.48 J
ARSENIC **8.28 J**
LEAD 295
XRF (mg/kg)
LEAD 116

NTC-SO-TSA-027
XRF (mg/kg)
LEAD 45.33

NTC-SO-TSA-040
XRF (mg/kg)
LEAD 53.67

NTC-SO-TSA-022
XRF (mg/kg)
LEAD 40.33

NTC-SO-TSA-051
Inorganics (mg/kg)
ANTIMONY 1.79 J
ARSENIC **7.23 J**
LEAD 161
XRF (mg/kg)
LEAD 165.33

NTC-SO-TSA-037
XRF (mg/kg)
LEAD 63.67

NTC-SO-TSA-038
Inorganics (mg/kg)
ANTIMONY 2.2 J
ARSENIC **8.91 J**
LEAD **577***
XRF (mg/kg)
LEAD 111.33

NTC-SO-TSA-039
Inorganics (mg/kg)
ANTIMONY 1.51 J
ARSENIC **8.51 J**
LEAD 357
XRF (mg/kg)
LEAD 103

NTC-SO-TSA-048
XRF (mg/kg)
LEAD 91.33

NTC-SO-TSA-050
Inorganics (mg/kg)
ANTIMONY 1.6 J
ARSENIC **8.62 J**
LEAD 204
XRF (mg/kg)
LEAD 171.33

NTC-SO-TSA-049
XRF (mg/kg)
LEAD 49.33

Legend

- Soil Sample Location with Exceedance of Human Health Screening Criteria for Lead
- Soil Sample Location without Exceedance of Human Health Screening Criteria for Lead
- Range Boundary

50 25 0 50 Feet

DRAWN BY K. MOORE	DATE 7/21/10
CHECKED BY J. DUCAR	DATE 8/2/10
REVISED BY	DATE
SCALE AS NOTED	

NAVFAC

SELECT METALS AND XRF DETECTIONS IN SOIL
TSA RANGES - SKEET RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER CTO F274	
OWNER NUMBER —	
APPROVED BY —	DATE —
FIGURE NO. FIGURE 4-6	REV 0

P:\GIS\GREATLAKES_NS\MAPDOCS\MXD\TSA_TRAP_RANGE_PAH.MXD 8/4/10 KM

NOTES:
Bold indicates exceedances of the Human Health Screening Criteria
Red indicates exceedances of the Ecological Criteria
* indicates exceedance of both Human Health and Ecological Criteria
J - estimated values
NA - not analyzed
Concentrations are in micrograms per kilogram (ug/kg)
Clay pigeons and shotgun shell wadding identified along shore line erosional surface

N

TSA001
TSA002
TSA003
TSA004
TSA005
TSA006
TSA007
TSA008
TSA009
TSA010
TSA011
TSA012
TSA013
TSA014

NTC-SO-TSA-018	
BAP EQUIVALENT	6957.18*
BENZO(A)ANTHRACENE	3900 J*
BENZO(A)PYRENE	5110 J*
BENZO(B)FLUORANTHENE	2260 J*
BENZO(G,H,I)PERYLENE	3460 J
CHRYSENE	6560 J
DIBENZO(A,H)ANTHRACENE	1070 J
INDENO(1,2,3-CD)PYRENE	1500 J*
PYRENE	2740 J

NTC-SO-TSA-060	
BAP EQUIVALENT	121.7988

NTC-SO-TSA-017	
BAP EQUIVALENT	5619.3*
BENZO(A)ANTHRACENE	3370 J*
BENZO(A)PYRENE	4110 J*
BENZO(B)FLUORANTHENE	2070 J*
BENZO(G,H,I)PERYLENE	3090 J
CHRYSENE	5830 J
DIBENZO(A,H)ANTHRACENE	835 J
INDENO(1,2,3-CD)PYRENE	1190 J*
PYRENE	2420 J

NTC-SO-TSA-016	
BAP EQUIVALENT	20279.6*
BENZO(A)ANTHRACENE	8340 J*
BENZO(A)PYRENE	15100 J*
BENZO(B)FLUORANTHENE	9560 J*
BENZO(G,H,I)PERYLENE	9470 J
BENZO(K)FLUORANTHENE	2730 J
CHRYSENE	13300 J
DIBENZO(A,H)ANTHRACENE	2790 J*
INDENO(1,2,3-CD)PYRENE	5590 J*
PYRENE	8060 J

NTC-SO-TSA-015	
BAP EQUIVALENT	2453.93*
BENZO(A)ANTHRACENE	1160 J*
BENZO(A)PYRENE	1810 J*
BENZO(B)FLUORANTHENE	1020 J
BENZO(G,H,I)PERYLENE	1470 J
CHRYSENE	1750 J
DIBENZO(A,H)ANTHRACENE	360 J
PYRENE	1160 J

NTC-SO-TSA-059	
BAP EQUIVALENT	13158.6*
BENZO(A)ANTHRACENE	6800 J*
BENZO(A)PYRENE	9860 J*
BENZO(B)FLUORANTHENE	5590 J*
BENZO(G,H,I)PERYLENE	6010 J
BENZO(K)FLUORANTHENE	1380 J
CHRYSENE	11800 J
DIBENZO(A,H)ANTHRACENE	1720 J*
INDENO(1,2,3-CD)PYRENE	3140 J*
PYRENE	4620 J

Legend
- Soil Sample Location with Exceedance of Screening Criteria
- Sample Location without Exceedance of Screening Criteria
- Firing Range

30 15 0 30 Feet

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K. MOORE	7/29/10
CHECKED BY	DATE
J. DUCAR	8/4/10
REVISED BY	DATE
SCALE	
AS NOTED	

NAVFAC

PAH EXCEEDANCES IN SOIL
TSA RANGES - TRAP RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER	
CTO F274	
OWNER NUMBER	
—	
APPROVED BY	DATE
—	—
FIGURE NO.	REV
FIGURE 4-7	0

P:\GIS\GREATLAKES_NS\MAPDOCS\MXD\TSA_SKEET_RANGE_PAH.MXD 8/4/10 KM

NOTES:
Bold indicates exceedances of the Human Health Screening Criteria
J - estimated values
Concentrations are in micrograms per kilogram (ug/kg)

N

TSA058
TSA057
TSA056
TSA047
NTC-SO-TSA-021
BAP EQUIVALENT 127.806
TSA046
NTC-SO-TSA-020
BAP EQUIVALENT 150.671
BENZO(A)PYRENE 95.1 J
TSA026
TSA045
TSA036
TSA044
TSA054
NTC-SO-TSA-030
BAP EQUIVALENT 182.279
BENZO(A)PYRENE 116 J
TSA025
TSA035
TSA034
TSA043
TSA033
NTC-SO-TSA-053
BAP EQUIVALENT 183.636
BENZO(A)PYRENE 104 J
TSA032
TSA031
TSA042
TSA024
NTC-SO-TSA-041
BAP EQUIVALENT 562.705
BENZO(A)PYRENE 358 J
TSA029
NTC-SO-TSA-023
BAP EQUIVALENT 317.131
BENZO(A)PYRENE 211 J
TSA019
TSA027
TSA040
NTC-SO-TSA-052
BAP EQUIVALENT 537.843
BENZO(A)PYRENE 340 J
NTC-SO-TSA-028
BAP EQUIVALENT 154.355
BENZO(A)PYRENE 99.3 J
TSA022
NTC-SO-TSA-039
BAP EQUIVALENT 215.553
BENZO(A)PYRENE 139 J
NTC-SO-TSA-051
BAP EQUIVALENT 484.164
BENZO(A)PYRENE 315 J
TSA037
TSA049
NTC-SO-TSA-038
BAP EQUIVALENT 127.1173
TSA048
NTC-SO-TSA-050
BAP EQUIVALENT 525.131
BENZO(A)PYRENE 337 J

Legend
- Soil Sample Location with Exceedance of Human Health Screening Criteria
- Sample Location without Exceedance of Human Health Screening Criteria
- Firing Range

50 25 0 50 Feet

DRAWN BY / DATE	K. MOORE 7/29/10
CHECKED BY / DATE	J. DUCAR 8/4/10
REVISED BY / DATE	
SCALE	AS NOTED

NAVFAC

PAH EXCEEDANCES IN SOIL
TSA RANGES - SKEET RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER	CTO F274
OWNER NUMBER	—
APPROVED BY / DATE	— / —
FIGURE NO.	FIGURE 4-8
REV	0

P:\GIS\GREATLAKES_NS\MXD\TSA_RANGES_SD.MXD 8/4/10 KM

NOTES:
Red indicates exceedances of the Ecological Criteria
J - estimated values
Concentrations are in milligrams per kilogram (mg/kg)

N

TSA071
TSA070
NTC-SD-TSA-078
LEAD 204
NTC-SD-TSA-077
LEAD 36
TSA069
TSA076
TSA068
TSA075
Skeet Range
NTC-SD-TSA-074
LEAD 44.4 J
NTC-SD-TSA-073
ANTIMONY 2.4 J
LEAD 46.1 J
TSA067
NTC-SD-TSA-072
LEAD 109 J
TSA066
TSA065
TSA064
TSA063
Trap Range
TSA062
TSA061

Legend

- Sediment Sample Location with Exceedance of Ecological Screening Criteria
- Sample Location without Exceedance of Ecological Screening Criteria
- Firing Range

80 40 0 80
Feet

DRAWN BY	DATE
K. MOORE	7/29/10
CHECKED BY	DATE
J. DUCAR	8/4/10
REVISED BY	DATE
—	—
SCALE	
AS NOTED	

NAVFAC

SELECT METALS EXCEEDANCES IN SEDIMENT
TSA RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER	
CTO F274	
OWNER NUMBER	
—	
APPROVED BY	DATE
—	—
FIGURE NO.	REV
FIGURE 4-9	0

LEGEND

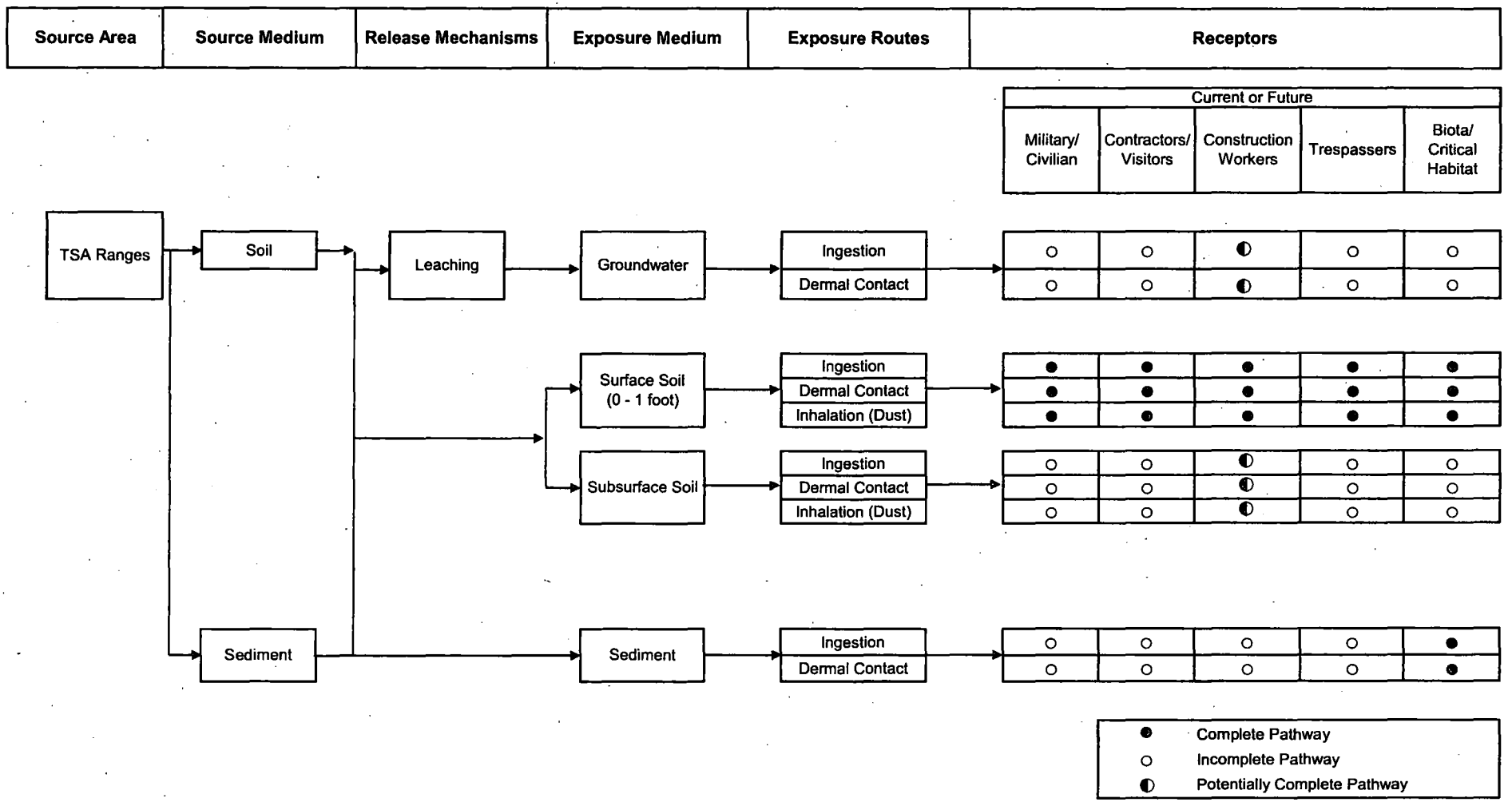
- FIRING RANGE
- CONCRETE RIP–RAP (EROSION CONTROL)
- FENCE
- CLAY PIGEON FRAGMENTS AND SHOT GUN SHELL WADDING
- POTENTIOMETER SURFACE
- RUNOFF/ INFILTRATION/ GROUNDWATER FLOW
- AQUATIC BIOTA

DRAWN BY ND	DATE 7–26–10	CONCEPTUAL SITE MODEL TSA RANGES NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NO. CTO F274
CHECKED BY	DATE		OWNER NO.
REVISED BY	DATE		APPROVED BY / DATE
SCALE NOT TO SCALE		NAVFAC	DRAWING NO. FIGURE 4–10 / REV. 0

R:\1638\CSM\1638CSM03.dwg PIT CARLY.KRAMER 8/2/2010 3:27:58 PM

FIGURE 4-11

MC EXPOSURE PATHWAY ANALYSIS
TSA RANGES
NS GREAT LAKES, GREAT LAKES, ILLINOIS



5.0 PISTOL BUTTS

5.1 SITE BACKGROUND

The former Pistol Butts Site is located in a flat area on the shore of the NSGL Outer Harbor, south of the installation's former sewage treatment plant and is approximately 0.75 acre in size. The site is bordered on the west by an approximately 50-foot high bluff and on the east by Lake Michigan. North of the Pistol Butts Site is the storage building used to house landing craft and to the south is the area known as SeaBee Park. Currently the site is covered by the concrete retention pond, vegetated strip, and paved roadway southwest of the landing craft storage building (see Figure 5-1). There are very limited records available on the history of this site, which only appears on one archival map from 1909 (Appendix A of the UFP-SAP). There is no evidence of the Pistol Butts remaining on the surface of NSGL; and key features, such as a nearby seawall which would aid in locating the exact location of the berm/butts, no longer exist. The 1909 map indicates that the range was located immediately west of a seawall found at the edge of Lake Michigan. It is assumed that the firing direction was to the west into the natural hillside. Individual firing lines were not noted on the map; however, the firing lanes are indicated and appear to be approximately 40-yards long. Only small arms training occurred on this site. MEC would not be expected to be present at a pistol range. No prior site investigations have been conducted at the NSGL Pistol Butts site.

Figure 5-1 depicts the Pistol Butts Site and associated range features.

5.1.1 Historical Munitions Usage Information

The small arms range most likely included a primary impact berm/butt, a range floor and firing line. If present, expended bullets passing through the targets or passing above the targets would continue on a trajectory into the impact berm/butt behind the range targets. Bullets aimed below the range targets would impact the soil near the toe of the berm/butt slope. Range fire that overshot the targets would impact the soil above and behind the targets, but most likely within the surficial soil of the impact berm/butt. However, the primary impacts from MC would be expected at the berms/butts.

The penetration depth of small arms on the range floor is generally 1 foot or less. The ITRC document (ITRC, 2003) states that ammunition rounds that impact the range floor typically traveled at a flat trajectory that fell short of or missed the target, those that resulted from ricochet are usually found within

the top 6 inches of soil. Penetration depths within the side of the berms/butts may vary depending on the soil type and other conditions, but are expected to be as deep as 1 foot.

5.1.2 Munitions Constituents

Lead is the primary metal of concern for small arms ammunition because it is the primary constituent in the munitions and because of its documented toxicity to human and ecological receptors. Other metals (antimony and arsenic) may be present to a lesser extent in lead. Lead accounts for more that 95 percent of the weight of the projectile (ITRC, 2003). Antimony is added to bullets as a hardening agent in quantities ranging from 0.1 to 2 percent. Arsenic is naturally present in lead at trace levels (0.001 to 0.06 percent). Antimony and arsenic, if present, would be spatially correlated with the lead because they are associated with lead in the bullets. The USEPA screening value commonly used to indicate the presence of potentially unacceptable levels of antimony in soil and sediment is 31 mg/kg; the screening value for arsenic is 0.39 mg/kg and is within the typical soil and sediment background concentrations according to TACO of 13 mg/kg. Using the relative concentrations of these metals in projectiles, lead would have to be present in soil or sediment at a concentration greater than 600 mg/kg for arsenic or antimony from bullets to be present at potentially unacceptable levels. Therefore, lead, which is easier to measure, is a useful indicator of potentially unacceptable concentrations of any of these five metals in soil or sediment.

Past investigations at similar small arms ranges also indicate that NG may be present at firing lines. However, at NSGL, the former Pistol Butts firing lines associated with this range have been highly disturbed by excavation and the area has been developed into a concrete stormwater retention pond and access roadway; therefore, NG is no longer expected to be present (Figure 5-1). The former berm/butts were potentially disturbed and buried during the redevelopment of the area as a wastewater treatment plant then as a stormwater retention pond (Figure 5-1). If present, antimony, arsenic, and lead are suspected in the subsurface approximately 6 to 16 feet bgs near the western edge of the stormwater retention pond. This depth corresponds to the approximate location of the hillside prior to redevelopment based on the location of site features shown on the 1909 map identified during the development of the UFP-SAP.

5.2 SITE FIELDWORK

5.2.1 Site Field Activities

The SI field program for the Pistol Butts Site included collection of subsurface soil samples (6 to 16 feet bgs) to identify COPCs (i.e., select metals) that may exist because of past operations at the range. All

subsurface sample locations at the former Pistol Butts were collected with the use of the DPT sampling technique. The DPT field sampling activities were documented in accordance with SOP-07 of the UFP-SAP. Photographs associated with the sampling activities at the Pistol Butts Site are presented in Appendix B.

Table 5-1 provides a summary of the samples collected and their respective analysis at the Pistol Butts Site. Figure 5-2 presents the sample locations for the Pistol Butts Site. Soil boring and soil sample log sheets are included in Appendix A of this document. All subsurface soil samples were analyzed in the field using XRF, with a subset of those samples selected for submittal to the FBL for select metals analysis (lead, antimony, and arsenic). A correlation study comparing XRF and the FBL analytical data was completed after the field efforts to establish laboratory equivalent lead concentrations based on the field measurements, and to use as a correlation analysis between XRF and the FBL lead concentrations. This correlation is discussed in Section 5.5.

Subsurface soil sample locations were selected based on a bias toward the former berm area, which was believed to be the area most likely contaminated by past operations at the site. Figure 5-2 presents the subsurface soil sample locations. Sample locations identified in the approved UFP-SAP were located using a Trimble GeoHX sub-meter GPS unit. Upon collection of all the samples at the ranges, the GPS was used to update the sample coordinates using the horizontal datum: NAD 83 Illinois State Plane Coordinate System east.

5.2.2 Work Plan Deviations

Deviations from the UFP-SAP (Tetra Tech, 2010) for the Pistol Butts Site SI included moving five sampling locations due to the physical constraints for drill rig access (location of fence and gabion baskets to prevent hillside erosion) west of the storm water retention basin (see Appendix B). Sample locations were initially planned in a zigzag pattern within the vegetative strip located between the concrete storm water retention basin and the tree line, in the approximate location of the former berm/butts area. However, due to a security fence and erosion control features (vegetation and gabion baskets) sample locations PBR-001 through PBR-005 were shifted north of the proposed sample locations, the remaining five sample locations (PBR-006 through PBR-010) were collected as planned.

All borings were planned to be completed to a depth of approximately 16 feet bgs; however, at several of the shifted sample locations subsurface refusal prevented the DPT from advancing to the desired depth. Sample locations PBR-002, through PBR-005 encountered DPT refusal ranging from 2.5 to 7 feet bgs due to limestone cobble fill material used in the constructing the access road to the storm water retention

pond. Therefore, subsurface soil samples were not collected for XRF screening or laboratory analyses since the targeted depths of 6- to 16-feet bgs were not reached.

5.2.3 Field Data Collection

Subsurface Soil

Thirty discrete subsurface soil samples were collected from six boring locations during the SI at the Pistol Butts Site for field screening purposes (PBR-001 and PBR-006 through PBR-010). All soil borings were logged and screened with a PID continuously from the surface to the completed boring depth. Beginning at 6 feet bgs, 2-foot intervals were collected and analyzed for lead using XRF, in accordance with SOP-10 of the UFP-SAP. All collected samples underwent field XRF analysis for lead in accordance with SOP 10 of the UFP-SAP, and 20 samples were subsequently chosen for select metals (antimony, arsenic, and lead) analyses at the Empirical, the FBL, by Method SW-846 6010B.

All samples for metals analyses were placed in large Ziploc® bags and thoroughly homogenized prior to processing a portion for XRF analysis. For samples selected for laboratory analysis, a portion of the sample was placed in the appropriate sample jar and shipped to the FBL for select metals analyses.

Table 5-2 summarizes the XRF lead results for the subsurface soil samples collected at the Pistol Butts Site. XRF concentrations ranged from non-detect (less than 10 mg/kg) to 40.67 mg/kg, with the majority of the samples less than 20 mg/kg. Due to the low XRF concentrations observed, the basis for determining which samples were sent to the laboratory for analysis was based on the default sampling locations indicated in the UFP-SAP. All samples submitted to Empirical were prepared and analyzed according to the normal laboratory protocol identified in the UFP-SAP.

5.3 SITE INSPECTION DATA COLLECTION RESULTS

5.3.1 Munitions Constituents Sampling Results

Subsurface soil samples collected at the Pistol Butts Site were compared to respective PALs, as listed in Worksheet #15 of the UFP-SAP (Tetra Tech, 2010). The chemical reference limits and background evaluation table and the complete validated FBL data tables are presented in Appendix D.

Table 5-3 presents the metals (antimony, arsenic, and lead) detections and Figure 5-3 presents the metals detections and XRF lead concentrations in the soil samples at the Pistol Butts Site. The data comparison to PALs is discussed in Section 5.6.

5.4 DATA PRESENTATION/DATA USABILITY

5.4.1 Data Quality Review of Samples at the Pistol Butts site

This section contains a description of the data review processes used to determine whether analytical laboratory data collected during the sampling field effort for the Pistol Butts site were of acceptable quality for use in decision-making. The review began with data validation, which is a comparison of DQIs against the prescribed acceptance criteria. The DQIs are measures used to assess the completeness, sensitivity, accuracy, precision, comparability, and representativeness of the sample collection and sample analysis process. The output of this review was a set of alphabetic flags such as "U," "J", "R," or combinations thereof, assigned to individual results based on the validation effort. These flags were used to infer the general quality of the data and if data quality meets the DQOs of the project. The DQOs presented in the approved UFP-SAP (Tetra Tech, 2010) were maintained through the course of the sampling event. Worksheets #15 and #19 of the UFP-SAP present the analytical methods and compounds analyzed.

5.4.1.1 Data Validation Process

All of the FBL sample results were validated according to several specifications. Assignment of data qualification flags conformed to rules established in USEPA National Functional Guidelines for Organic Data Validation (October 1999), USEPA National Functional Guidelines for Inorganic Data Validation (October 2004), and DoD document entitled QSM for Environmental Laboratories (January 2006 and April 2009) to the greatest extent practicable for non-contract laboratory program data.

Several samples analyzed for various parameters were qualified due to numerous issues. Appendix D contains the data validation reports, which outline the specific qualification reasons for each sample according to the parameter.

5.4.1.2 Data Quality Review

Some of the DQIs are generated from the analysis of field samples (e.g., field duplicates) while others are from the analysis of Empirical samples (e.g., laboratory duplicates). Individually, field and Empirical DQIs provide measures of the performance of the respective investigative operations (field or laboratory). If individual QC results were unacceptable, there was an assignment of a validation flag indicating the type of QC deficiency impacting the result. Supporting documentation regarding the data presentation and usability for the Pistol Butts site is presented in Appendix E.

5.4.1.3 Completeness

The field XRF field screening of surface soil and sample collection completeness for the Pistol Butts Site were 60 percent due to refusal of soil borings prior to reaching the target depth. However, the remaining samples were sufficient to characterize the site (see Figure 5-2). The samples that were not collected were primarily side gradient while the collected samples were located in the most likely impacted area. The sample analytical completeness for the Pistol Butts Site is 100 percent.

5.4.1.4 Sensitivity

The PQLGs for each analyte are listed in Worksheet #15 of the UFP-SAP (Tetra Tech, 2010). Analytical sensitivity for the Pistol Butts Site data was satisfactory to meet the DQOs presented in the UFP-SAP.

5.4.1.5 Field and Laboratory Accuracy

There were no quality control deficiencies noted for field or FBL accuracy for the Pistol Butts Site data.

5.4.1.6 Field and Laboratory Precision

There were no quality control deficiencies noted for field and FBL precision in the Pistol Butts Site data. Field duplicate results were acceptable.

5.4.1.7 Comparability

Comparability is defined as the confidence with which one data set can be compared with another (e.g., among sampling points and among sampling events). Comparability was achieved by using standardized sampling and analysis methods, as well as standardized data reporting formats. Comparability of laboratory measurements was achieved primarily through the use and documentation of standard sampling and analytical methods. Results were reported in units that ensured comparability with current state and federal standards and guidelines. Comparability of laboratory measurements was assessed primarily through the use of QC samples and through adherence to the QA plan. The data comparability for the Pistol Butts Site was deemed acceptable.

5.4.1.8 Representativeness

The UFP-SAP (Tetra Tech, 2010) and the use of standardized sampling, sample handling, sample analysis, and data reporting procedures were designed so that the final data would be accurate

representations of actual site conditions. Based upon the field logs indicating the conditions during sample collection and Empirical audits, all reported data are adequately representative of site conditions of the Pistol Butts Site.

5.5 LEAD CORRELATION BETWEEN FIELD X-RAY FLOURESCENCE ANALYSIS AND FIXED BASE LABORATORY

All 30 of the soil samples collected from the Pistol Butts Site underwent XRF analyses in the field. None of the soil samples exhibited XRF concentrations above the XRF field screening value of 100 mg/kg (Worksheet #10 of the UFP-SAP). Therefore, default analysis locations indicated in the UFP-SAP were used as the basis for selecting samples to be sent to Empirical for select metals analysis. From the samples that were analyzed in the field using XRF and at Empirical, a regression analysis was conducted to evaluate the correlation between the Empirical lead results and XRF lead results. To evaluate the regression analysis, the Pearson Correlation and the R-squared value were calculated. The Pearson Correlation is a measure of the strength of the linear relationship between two or more variables with a range of -1 to +1. The value of -1 represents a perfect negative correlation (as one variable decreases the other increases proportionally); whereas, a value of +1 represents a perfect positive correlation (as one variable increases the other increases proportionally). A value of 0 represents a lack of correlation.

The correlation between the XRF and Empirical concentrations at the Pistol Butts Site is 0.96 and the corresponding R^2 value is 0.95, which indicates a strong linear relationship. The correlation between the XRF and FBL is acceptable as outlined by the UFP-SAP. Since the correlation is acceptable, predicted lab values for those sample locations that were not analyzed at the FBL, were calculated for all XRF concentrations ranging from 7.67 to 40.67 mg/kg (Table 5-2). The regression analysis is included in Appendix F.

5.6 DATA COMPARISON TO PROJECT ACTION LIMITS

5.6.1 Identification of Chemicals Exceeding Project Action Limits

Table 5-3 summarizes the XRF and analytical detection results for each sample location as compared to the PALs. The PAL screening criteria were developed in the UFP-SAP and considered federal, state, and facility background values for human health and ecological receptors, as applicable for a given site. The metal laboratory concentrations were compared to the human health-derived PAL for screening purposes to determine if further investigation is necessary. The concentrations were not compared to the ecological-derived PAL, since all the soil samples collected from the Pistol Butts site were subsurface (6

to 16 feet bgs) and are unlikely to pose significant pathway concerns for terrestrial ecological receptors. In addition, the Illinois EPA TACO area soil background concentrations for each metal were listed in the table for evaluation purposes. Concentrations, which exceed the respective PAL, are highlighted/shaded in the table.

Select Metals

Twenty samples were chosen for select metals laboratory analyses based on the default sample locations in the UFP-SAP (Worksheet #18). Below is a discussion of the select metals FBL results:

Lead

Lead laboratory analytical concentrations ranged from 8.16 to 44.1 mg/kg. None of the soil samples submitted for laboratory analyses exhibited lead concentrations exceeding the human health PAL of 400 mg/kg (Figure 5-3 and Table 5-3).

Antimony

Antimony was not detected above the laboratory detection limit in any of the 20 samples analyzed at Empirical for the Pistol Butts site. The human health PAL for antimony is 31 mg/kg.

Arsenic

Arsenic laboratory analytical concentrations ranged from 5.24 to 9.73 mg/kg. All 20 of the soil samples submitted for laboratory analyses exhibited concentrations of arsenic exceeding the Human Health PAL of 0.39 mg/kg (Figure 5-3 and Table 5-3). However, all samples were below the Illinois EPA TACO area background concentrations of 13 mg/kg.

In addition, the arsenic concentrations were compared to the TACO construction worker ingestion criteria of 61 mg/kg, since the hypothetical construction worker would be the only likely receptor of the subsurface soil in the area of the site. No soil samples had concentrations of arsenic above this criterion.

5.7 UPDATED CONCEPTUAL SITE MODEL

The tabular CSM is presented in Table 5-4. Figure 5-4 presents a graphical CSM. Figure 5-5 provides a graphical representation of the current understanding of the Pistol Butts. The figures identify the exposure pathways where site receptors could be exposed to in contact with, or be impacted by, MC.

5.8 CONCLUSIONS

The initial environmental data collected during the SI sampling activities are sufficient to determine the presence of MC associated with the former use of the ranges in the subsurface soils. However, all laboratory lead detections were less than the Human Health PAL of 400 mg/kg. Antimony was not detected above the laboratory detection limit in any of the samples for the Pistol Butts site. While all of the soil samples submitted for laboratory analyses exhibited concentrations of arsenic exceeding the Human Health PAL of 0.39 mg/kg; all concentrations were below the Illinois EPA TACO area soil background concentrations of 13 mg/kg. Therefore, it has been determined that the concentrations of arsenic detected in the soil samples collected from the Pistol Butts site are not indicative of MC associated with the historical range activities conducted at the site.

5.9 RECOMMENDATIONS

The purpose of the SI phase of this project is to identify possible contaminant releases resulting from past munitions related range activities that require further investigation or pose a threat to human health and/or the environment. Sites that do not require further investigation and do not pose an unacceptable risk to human health and the environment may be designated as "no further action" (NFA), and may be eliminated from further consideration.

Based on the SI results, NFA at the Pistol Butts site is recommended.

TABLE 5-1

SUMMARY OF SAMPLES COLLECTED
NTC LAKEFRONT RANGE (WATER PORTION)
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Location	Sample ID	Date Collected	Medium	Depth	Analysis[1]
	NTC-SB- PBR001-0608	4/20/2010	Soil	6 - 8	XRF Analysis and Select Metals
	NTC-SB- PBR001-0810	4/20/2010	Soil	8 - 10	XRF Analysis only
	NTC-SB- PBR001-1012	4/20/2010	Soil	10 - 12	XRF Analysis and Select Metals
	NTC-SB- PBR001-1214	4/20/2010	Soil	12 - 14	XRF Analysis and Select Metals
PBR001	NTC-SB- PBR001-1416	4/20/2010	Soil	14 - 16	XRF Analysis only
	NTC-SB- PBR006-0608	4/22/2010	Soil	6 - 8	XRF Analysis and Select Metals
	NTC-SB- PBR006-0810	4/22/2010	Soil	8 - 10	XRF Analysis only
	NTC-SB- PBR006-1012	4/22/2010	Soil	10 - 12	XRF Analysis only
	NTC-SB- PBR006-1214	4/22/2010	Soil	12 - 14	XRF Analysis and Select Metals
PBR006	NTC-SB- PBR006-1416	4/22/2010	Soil	14 - 16	XRF Analysis and Select Metals
	NTC-SB- PBR007-0608	4/22/2010	Soil	6 - 8	XRF Analysis and Select Metals
	NTC-SB- PBR007-0810	4/22/2010	Soil	8 - 10	XRF Analysis only
	NTC-SB- PBR007-1012	4/22/2010	Soil	10 - 12	XRF Analysis only
	NTC-SB- PBR007-1214	4/22/2010	Soil	12 - 14	XRF Analysis and Select Metals
PBR007	NTC-SB- PBR007-1416	4/22/2010	Soil	14 - 16	XRF Analysis and Select Metals
	NTC-SB- PBR008-0608	4/22/2010	Soil	6 - 8	XRF Analysis only
	NTC-SB- PBR008-0810	4/22/2010	Soil	8 - 10	XRF Analysis and Select Metals
	NTC-SB- PBR008-1012	4/22/2010	Soil	10 - 12	XRF Analysis only
	NTC-SB- PBR008-1214	4/22/2010	Soil	12 - 14	XRF Analysis and Select Metals
PBR008	NTC-SB- PBR008-1416	4/22/2010	Soil	14 - 16	XRF Analysis and Select Metals
	NTC-SB- PBR009-0608	4/22/2010	Soil	6 - 8	XRF Analysis and Select Metals
	NTC-SB- PBR009-0810	4/22/2010	Soil	8 - 10	XRF Analysis only
	NTC-SB- PBR009-1012	4/22/2010	Soil	10 - 12	XRF Analysis and Select Metals
	NTC-SB- PBR009-1214	4/22/2010	Soil	12 - 14	XRF Analysis and Select Metals
PBR009	NTC-SB- PBR009-1416	4/22/2010	Soil	14 - 16	XRF Analysis and Select Metals
	NTC-SB- PBR010-0608	4/22/2010	Soil	6 - 8	XRF Analysis and Select Metals
	NTC-SB- PBR010-0810	4/22/2010	Soil	8 - 10	XRF Analysis and Select Metals
	NTC-SB- PBR010-1012	4/22/2010	Soil	10 - 12	XRF Analysis only
	NTC-SB- PBR010-1214	4/22/2010	Soil	12 - 14	XRF Analysis and Select Metals
PBR010	NTC-SB- PBR010-1416	4/22/2010	Soil	14 - 16	XRF Analysis and Select Metals

1 Select metals for Pistol Ranges soil and sediment include antimony, arsenic, and lead.

Table 5-2

XRF LEAD RESULTS
PISTOL BUTTS RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

SAMPLE ID	SAMPLE COLLECTION DATE	XRF ANALYSIS DATE	1st (ppm)	2nd (ppm)	3rd (ppm)	DETECTION LIMIT (ppm)	AUTO GENERATED AVERAGE (ppm)	Predicted Laboratory Concentration (ppm)
NTC-SB-PBR001-0608	4/20/2010	4/22/2010	42	38	38	10	39.33	4.9
NTC-SB-PBR001-0810	4/20/2010	4/22/2010	20	ND	19	10	14.67	ND
NTC-SB-PBR001-1012	4/20/2010	4/22/2010	19	14	17	10	16.67	ND
NTC-SB-PBR001-1214	4/20/2010	4/22/2010	18	16	17	10	17.00	ND
NTC-SB-PBR001-1416	4/20/2010	4/22/2010	12	15	13	10	13.33	ND
NTC-SB-PBR006-0608	4/22/2010	4/22/2010	ND	9	9	10	7.67	ND
NTC-SB-PBR006-0810	4/22/2010	4/22/2010	13	14	ND	10	10.67	ND
NTC-SB-PBR006-1012	4/22/2010	4/22/2010	ND	12	10	10	9.00	ND
NTC-SB-PBR006-1214	4/22/2010	4/22/2010	11	13	17	10	13.67	ND
NTC-SB-PBR006-1416	4/22/2010	4/22/2010	16	13	ND	10	11.33	ND
NTC-SB-PBR007-0608	4/22/2010	4/22/2010	25	28	37	10	30.00	2.6
NTC-SB-PBR007-0810	4/22/2010	4/22/2010	18	19	12	10	16.33	ND
NTC-SB-PBR007-1012	4/22/2010	4/22/2010	12	9	11	10	10.67	ND
NTC-SB-PBR007-1214	4/22/2010	4/22/2010	16	11	18	10	15.00	ND
NTC-SB-PBR007-1416	4/22/2010	4/22/2010	17	9	17	10	14.33	ND
NTC-SB-PBR008-0608	4/22/2010	4/22/2010	16	18	16	10	16.67	ND
NTC-SB-PBR008-0810	4/22/2010	4/22/2010	15	13	11	10	13.00	ND
NTC-SB-PBR008-1012	4/22/2010	4/22/2010	15	15	9	10	13.00	ND
NTC-SB-PBR008-1214	4/22/2010	4/22/2010	14	16	12	10	14.00	ND
NTC-SB-PBR008-1416	4/22/2010	4/22/2010	15	14	17	10	15.33	ND
NTC-SB-PBR009-0608	4/22/2010	4/22/2010	19	13	10	10	14.00	ND
NTC-SB-PBR009-0810	4/22/2010	4/22/2010	13	12	16	10	13.67	ND
NTC-SB-PBR009-1012	4/22/2010	4/22/2010	12	14	15	10	13.67	ND
NTC-SB-PBR009-1214	4/22/2010	4/22/2010	19	11	13	10	14.33	ND
NTC-SB-PBR009-1416	4/22/2010	4/22/2010	11	16	14	10	13.67	ND
NTC-SB-PBR010-0608	4/22/2010	4/22/2010	41	38	43	10	40.67	5.3
NTC-SB-PBR010-0810	4/22/2010	4/22/2010	20	ND	14	10	13.00	ND
NTC-SB-PBR010-1012	4/22/2010	4/22/2010	20	ND	13	10	12.67	ND
NTC-SB-PBR010-1214	4/22/2010	4/22/2010	ND	9	21	10	11.67	ND
NTC-SB-PBR010-1416	4/22/2010	4/22/2010	18	12	16	10	15.33	ND

ND - Nondetect
ppm - Parts per million

SUMMARY OF DETECTED CONCENTRATIONS IN SUBSURFACE SOIL
PISTOL BUTTS
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS
1 of 2

LOCATION	HUMAN HEALTH CRITERIA		TACO CHEMICALS IN BACKGROUND SOILS [3]	NTC-SO-PBR-001				
SAMPLE ID				NTC-SB-PBR-001-0608	NTC-SB-PBR-001-0810	NTC-SB-PBR-001-1012	NTC-SB-PBR-001-1214	NTC-SB-PBR-001-1416
SAMPLE DATE				04/20/2010	04/20/2010	04/20/2010	04/20/2010	04/20/2010
DEPTH (FT BGS)				6 - 8	8 - 10	10 - 12	12 - 14	14 - 16
METALS (mg/kg)								
Arsenic	0.39	(1)	13	7.15 J	NA	6.02 J	7.36 J	NA
Lead	400	(2)	36	39.3	NA	14.7	10.4	NA
Lead-Calc	400	(2)	36	39.33	14.67	16.67	17	13.33
XRF (mg/kg)								
Lead	400	(2)	36	39.33	14.67	16.67	17	13.33

LOCATION	HUMAN HEALTH CRITERIA		TACO CHEMICALS IN BACKGROUND SOILS [3]	NTC-SO-PBR-006				
SAMPLE ID				NTC-SB-PBR-006-0608	NTC-SB-PBR-006-0810	NTC-SB-PBR-006-1012	NTC-SB-PBR-006-1214	NTC-SB-PBR-006-1416
SAMPLE DATE				04/22/2010	04/22/2010	04/22/2010	04/22/2010	04/23/2010
DEPTH (ft bgs)				6 - 8	8 - 10	10 - 12	12 - 14	14 - 16
METALS (mg/kg)								
Arsenic	0.39	(1)	13	6.67 J	NA	NA	7.59 J	8.13 J
Lead	400	(2)	36	8.16	NA	NA	11.2	10.5
Lead-Calc	400	(2)	36	10 U	10 U	10 U	10 U	10 U
XRF (mg/kg)								
Lead	400	(2)	36	7.67	10.67	9	13.67	11.33

LOCATION	HUMAN HEALTH CRITERIA		TACO CHEMICALS IN BACKGROUND SOILS [3]	NTC-SO-PBR-007				
SAMPLE ID				NTC-SB-PBR-007-0608	NTC-SB-PBR-007-0810	NTC-SB-PBR-007-1012	NTC-SB-PBR-007-1214	NTC-SB-PBR-007-1416
SAMPLE DATE				04/22/2010	04/22/2010	04/22/2010	04/22/2010	04/22/2010
DEPTH (ft bgs)				6 - 8	8 - 10	10 - 12	12 - 14	14 - 16
METALS (mg/kg)								
Arsenic	0.39	(1)	13	7.98 J	NA	NA	8.57 J	NA
Lead	400	(2)	36	29.6	NA	NA	11.4	NA
Lead-Calc	400	(2)	36	2.6	10 U	10 U	10 U	10 U
XRF (mg/kg)								
Lead	400	(2)	36	30	16.33	10.67	15	14.33

LOCATION	HUMAN HEALTH CRITERIA		TACO CHEMICALS IN BACKGROUND SOILS [3]	NTC-SO-PBR-008				
SAMPLE ID				NTC-SB-PBR-008-0608	NTC-SB-PBR-008-0810	NTC-SB-PBR-008-1012	NTC-SB-PBR-008-1214	NTC-SB-PBR-008-1416
SAMPLE DATE				04/23/2010	04/22/2010	04/22/2010	04/22/2010	04/22/2010
DEPTH (ft bgs)				6 - 8	8 - 10	10 - 12	12 - 14	14 - 16
METALS (mg/kg)								
Arsenic	0.39	(1)	13	9.53 J	NA	8.72 J	9.73 J	8.64 J
Lead	400	(2)	36	11.2	NA	11.5	10.1	11.4
Lead-Calc	400	(2)	36	10 U	10 U	10 U	10 U	10 U
XRF (mg/kg)								
Lead	400	(2)	36	16.67	13	13	14	15.33

TABLE 5-3

SUMMARY OF DETECTED CONCENTRATIONS IN SUBSURFACE SOIL
PISTOL BUTTS
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS
2 of 2

LOCATION	HUMAN HEALTH CRITERIA		TACO CHEMICALS IN BACKGROUND SOILS [3]	NTC-SO-PBR-009				
SAMPLE ID				NTC-SB-PBR-009-0608	NTC-SB-PBR-009-0810	NTC-SB-PBR-009-1012	NTC-SB-PBR-009-1214	NTC-SB-PBR-009-1416
SAMPLE DATE				04/22/2010	04/22/2010	04/23/2010	04/23/2010	04/23/2010
DEPTH (ft bgs)				6 - 8	8 - 10	10 - 12	12 - 14	14 - 16
METALS (mg/kg)								
Arsenic	0.39	(1)	13	5.24 J	NA	6.9 J	8.95 J	7.57 J
Lead	400	(2)	36	9.88	NA	9.4	10.5	11.2
Lead-Calc	400	(2)	36	10 U	10 U	10 U	10 U	10 U
XRF (mg/kg)								
Lead	400	(2)	36	14	13.67	13.67	14.33	13.67

LOCATION	HUMAN HEALTH CRITERIA		TACO CHEMICALS IN BACKGROUND SOILS [3]	NTC-SO-PBR-010				
SAMPLE ID				NTC-SB-PBR-010-0608	NTC-SB-PBR-010-0810	NTC-SB-PBR-010-1012	NTC-SB-PBR-010-1214	NTC-SB-PBR-010-1416
SAMPLE DATE				04/22/2010	04/22/2010	04/23/2010	04/22/2010	04/22/2010
DEPTH (ft bgs)				6 - 8	8 - 10	10 - 12	12 - 14	14 - 16
METALS (mg/kg)								
Arsenic	0.39	(1)	13	8.11 J	NA	7.41 J	8.32 J	7.77 J
Lead	400	(2)	36	44.1	NA	9.06	12.2	8.9
Lead-Calc	400	(2)	36	5.3	10 U	10 U	10 U	10 U
XRF (mg/kg)								
Lead	400	(2)	36	40.67	13	12.67	11.67	15.33

Shaded = exceedance of human health screening criteria

bgs = below ground surface
ft = feet
J = Indicates a positive result greater than the method detection limit (MDL), but less than the limit of quantitation (LOQ).
NA = Not Analyzed
mg/kg = milligram per kilogram
U = Indicates that the chemical was not detected at the numerical detection limit noted.

Source of Screening Level
1 - US EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites - Residential Soil Values (May, 2010)
2 - Illinois EPA Tier 1 Soil Remediation Objectives - Residential/Industrial/Commercial (Online, 2009)
3 - Illinois EPA background concentration (Illinois EPA, Appendix A, Table G of TACO)

Associated Samples:

NTC-SO-PBR-001-0608	NTC-SO-PBR-007-0608	NTC-SO-PBR-009-0608
NTC-SO-PBR-001-0810	NTC-SO-PBR-007-0810	NTC-SO-PBR-009-0810
NTC-SO-PBR-001-1012	NTC-SO-PBR-007-1012	NTC-SO-PBR-009-1012
NTC-SO-PBR-001-1214	NTC-SO-PBR-007-1214	NTC-SO-PBR-009-1214
NTC-SO-PBR-001-1416	NTC-SO-PBR-007-1416	NTC-SO-PBR-009-1416
NTC-SO-PBR-006-0608	NTC-SO-PBR-008-0608	NTC-SO-PBR-010-0608
NTC-SO-PBR-006-0810	NTC-SO-PBR-008-0810	NTC-SO-PBR-010-0810
NTC-SO-PBR-006-1012	NTC-SO-PBR-008-1012	NTC-SO-PBR-010-1012
NTC-SO-PBR-006-1214	NTC-SO-PBR-008-1214	NTC-SO-PBR-010-1214
NTC-SO-PBR-006-1416	NTC-SO-PBR-008-1416	NTC-SO-PBR-010-1416

TABLE 5-4

CONCEPTUAL SITE MODEL INFORMATION PROFILE
PISTOL BUTTS
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Profile Type	Information Needs	Findings
Range/Site Profile	Installation Name	Naval Station Great Lakes (NSGL)
	Installation Location	Great Lakes, Lake County, Illinois
	Range/Site Name	Pistol Butts
	Range/Site Location	The former Pistol Butts site is located in a flat area on the shore of the NSGL Outer Harbor, south of the installation's former sewage treatment plant. Currently, the site is covered by the northern end of a concrete retention pond and paved roadway southwest of the landing craft storage building. The location of the former firing points and range floor has been developed into a concrete retention pond, vegetated grass strip, and a roadway and is currently several feet below the current ground surface. The location of the former bullet stop/butt (the natural bluff to the west of the site) appears to have been buried during redevelopment.
	Range/Site History	There are very limited records available on the history of this site, which only appears on one archival map from 1909. The small arms range most likely included a primary impact berm/butt, a range floor, and a safety fan, which is a fan-shaped area around the site within which projectiles may fall under a wide range of conditions. There is no evidence of the Pistol Butts remaining on the surface of NSGL and key features, such as a nearby seawall, which would aid in locating the exact location of the berm/butts, are no longer in existence. It is assumed that only small arms training occurred on this site.
	Range/Site Area and Layout	Currently the site is covered by a concrete retention pond, vegetated strip, and paved roadway southwest of the landing craft storage building (see Figure 5-1). The 1909 map indicates that the range was located immediately west of a seawall at the edge of Lake Michigan. However, there remains some uncertainty regarding the exact location of the berm/butts based on current site features, and it is assumed that the firing direction was to the west into the natural hillside. Individual firing lines were not noted on the map; however, the firing lanes are indicated and appear to be approximately 40-yards long.
	Range/Site Structures	Currently the site is covered by a concrete retention pond, vegetated strip, and paved roadway.
	Range/Site Boundaries	See Figures 1-2 and 5-1 N: Storage building used to house landing craft S: Installation's former sewage treatment plant E: Lake Michigan W: Approximately 50-ft high bluff

TABLE 5-4

CONCEPTUAL SITE MODEL INFORMATION PROFILE
PISTOL BUTTS
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

	Range/Site Security	The site is located within the installation, which is patrolled by base security; however, there are no access controls specific to the site itself or to the water portion of the site in Lake Michigan.
Munitions/ Release Profile	Munitions Types	Small arms (pistol ammunition)
	Maximum Probability Penetration Depth	The penetration depth of small arms on the range floor is generally 1 foot or less. The Interstate Technology and Regulatory Council (ITRC) document states that rounds that impact the range floor are typically at a flat trajectory that fell short of or missed the target, or those that resulted from ricochet usually found within the top 6 inches of soil. Penetration depths within the side of the berms/butts may vary depending on the soil type and other conditions, but are expected to be as deep as one foot. Because fill has been placed above the original grade elevation, the actual depth of the range is now 6 to 16 feet bgs.
	MEC Density	Munitions of explosive concern (MEC) presence is not suspected since munitions use was limited to small arms.
	Munitions Debris	Surficial or subsurface range debris was not found at this site. There is no direct evidence of subsurface munitions scrap/fragments/MDAS at the Pistol Butts site.
	Associated MC	Primary munitions of concern (MC) of concern includes lead, antimony, and arsenic. Past investigations at other small arms ranges also indicate that nitroglycerin (NG) has been detected at firing lines. At NSGL, the former Pistol Butts firing lines associated with this range have been excavated and the area has been developed into a concrete retention pond and access roadway; therefore, NG is no longer expected to be present. Samples collected during the site inspection (SI) show that concentrations of MCs (lead, arsenic and antimony) are below screening levels.
	Migration Routes/Release Mechanisms	The former firing points and range floor have been redeveloped into a concrete retention pond, vegetated grass strip, and a roadway, and is currently several feet below the current ground surface. The location of the former bullet stop butt/berm (the natural bluff to the west of the site) appears to have been buried during redevelopment. The removal of the potential contaminant source at the firing lines precludes it as a complete contaminant migration pathway because there is no source. The primary impacts from MC would be expected at the berms/butts. Human activities, such as soil excavation, may redistribute MC in soil.

TABLE 5-4

CONCEPTUAL SITE MODEL INFORMATION PROFILE
PISTOL BUTTS
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

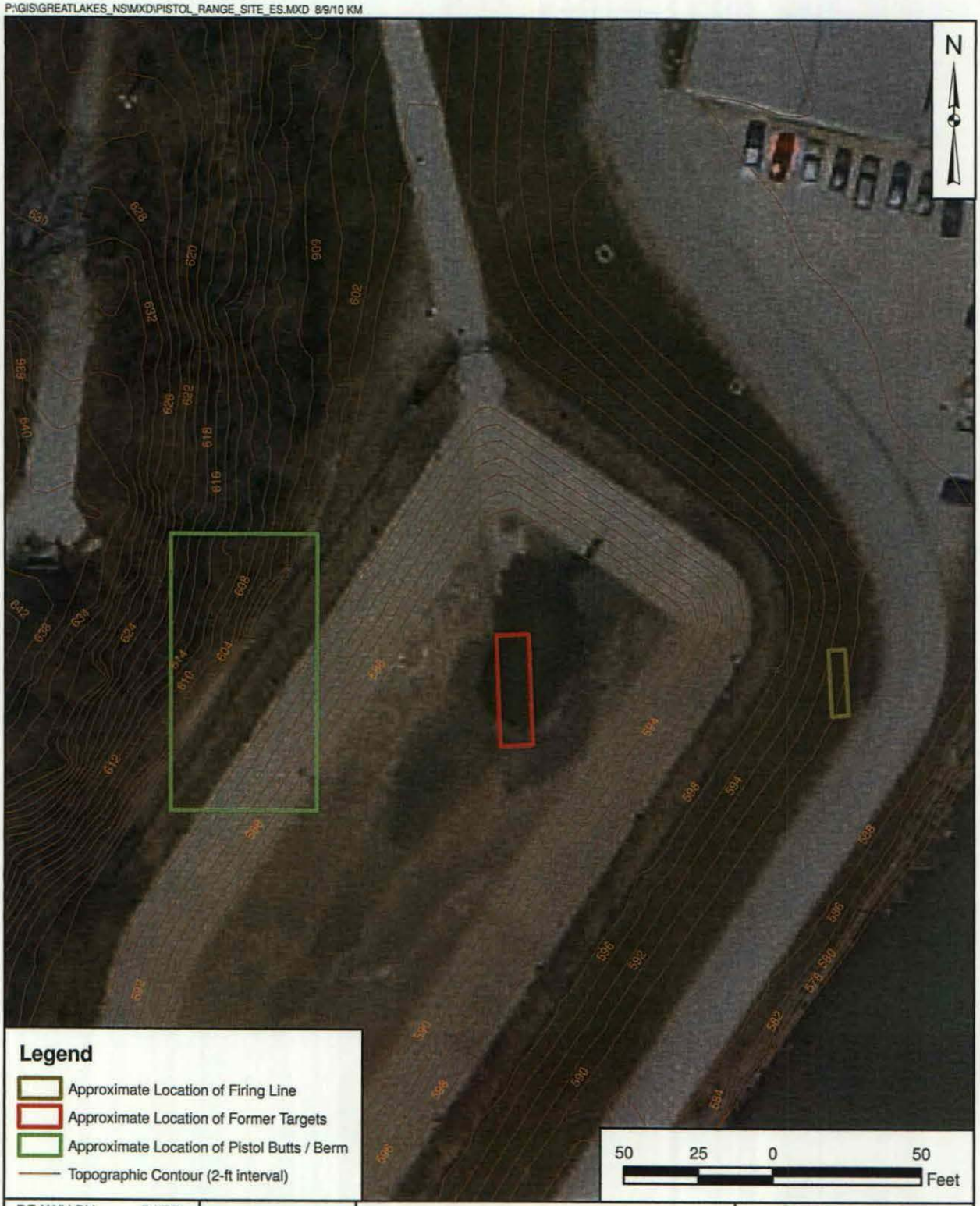
Physical Profile (see Section 2)	Climate	The lakefront is strongly influenced by its proximity to Lake Michigan and by southerly Gulf Stream winds. Average temperatures range from 20.3 °F in January to 71.5 °F in July. The average annual precipitation is 34.1 inches, and the mean seasonal snowfall is 37.9 inches.
	Topography	Bluffs and ravines surround the range.
	Geology	Poorly sorted, unstratified sediments of the Wadsworth formation underlain by Silurian dolomite bedrock.
	Soil	Soil borings collected within the Pistol Butts site consisted of silt, clay, and sand.
	Hydrogeology	There are no wells within the boundary of the Pistol Butts site; therefore, site-specific hydrogeology is not available. The hydrogeologic framework of the NSGL area consists of an overburden aquifer, with depth to groundwater averaging 2 to 5 feet bgs in level areas. However, the Pistol Butts site is located along the bluff and soils borings indicated groundwater depths varied across the site. Groundwater flow direction is generally to the east toward Lake Michigan. Groundwater is not used as a drinking water source for the installation. Any MC in groundwater discharging into the lake is expected to be very diluted and not to be a concern to the potable water use of the lake.
	Hydrology	A concrete retention pond is located within the Pistol Butts site.
	Vegetation	A vegetated grass strip is located within the Pistol Butts site area between the edge of the concrete retention pond and the hillside.
Land Use and Exposure Profile	Current Land Use	The former firing points and range floor has been redeveloped into a concrete retention pond, vegetated grass strip, and a roadway.
	Current Human Receptors	The only potential human receptor under current site conditions would be the construction worker.
	Current Activities	There are no current activities conducted in the subsurface location of the Pistol Butts site.
	Potential Future Land Use	Potential future land use is assumed the same as present land use. There are no plans for use external to the Navy.
	Potential Future Human Receptors	The only human receptor under potential future land use scenarios is the construction worker.
	Potential Future Land Use Related Activities	The Pistol Butts site is expected to experience continued grounds maintenance and environmental or other types of intrusive investigations may occur at the site.
	Zoning/Land Use Restrictions	A formal land use restriction prohibiting the installation of groundwater wells (with the exception of environmental monitoring wells) and the consumption of

TABLE 5-4

CONCEPTUAL SITE MODEL INFORMATION PROFILE
PISTOL BUTTS
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

		groundwater at NSGL was issued in September 2002.
	Demographics/Zoning	Lake County population density is approximately 1,300 persons per square mile, while Naval Station Great Lakes employs approximately 25,000 military and civilian personnel.
	Beneficial Resources	Lake Michigan is a major fishery with over 22,000 square miles of both commercial and recreational fishing adjacent to NSGL. Lake Michigan is also a municipal potable water source and a recreational resource.
Ecological Profile	Habitat Type	There is no ecological habitat at the location of the Pistol Butts site located about 6 to 16 feet bgs. Some forested habitat is present on the bluff and in the Foss Acres Forest Preserve north of the site. Lake Michigan provides aquatic habitat.
	Degree of Disturbance	Low – Potential soil disturbance activities at the Pistol Butts site include subsurface construction or environmental sampling activities.
	Ecological Receptors and Species of Special Concern	No ecological receptors are expected to come in contact with MC at the Pistol Butts site since the area of the site is located about 6 to 16 feet bgs and covered by a concrete retention pond and road.
General Exposure Profile	Relationship of MEC/MC Sources to Habitat and Potential Receptors	MEC presence is not suspected since munitions use was limited to small arms. The MC Pathway for subsurface soils (arsenic) is incomplete for human (construction workers and approved Navy contractors) and ecological receptors because arsenic concentrations are attributable to naturally occurring conditions. The arsenic is not related to MC related to the Pistol Butts site due to the lack of collocated lead concentrations, which would indicate munitions-related contamination.

P:\GIS\GREATLAKES_NS\MXD\PISTOL_RANGE_SITE_ES.MXD 8/9/10 KM



DRAWN BY: K. MOORE	DATE: 11/17/09
CHECKED BY: J. DUCAR	DATE: 8/9/10
REVISED BY: —	DATE: —
SCALE: AS NOTED	

NAVFAC

SITE LOCATION
PISTOL BUTTS
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER: CTO F274	
OWNER NUMBER: —	
APPROVED BY: —	DATE: —
FIGURE NO.: FIGURE 5-1	REV: 0

P:\GIS\GREATLAKES_NS\MAPDOCS\MXD\PISTOL_BUTTS_SAMPLOCS.MXD 7/26/10 KM

DRAWN BY J. ENGLISH	DATE 07/20/10
CHECKED BY J. DUCAR	DATE 7/26/10
REVISED BY K. MOORE	DATE 7/26/10
SCALE AS NOTED	

NAVFAC

SOIL BORING LOCATIONS
PISTOL BUTTS
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER CTO F274	
OWNER NUMBER —	
APPROVED BY —	DATE —
FIGURE NO. FIGURE 5-2	REV 0

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NOTES:
Bold indicates exceedances of the Human Health Screening Criteria
J - estimated value
NA - not analyzed

N

NTC-SO-PBR-001	[6 - 8]	[10 - 12]	[12 - 14]	[14 - 16]
Inorganics (mg/kg)				
ARSENIC	**7.15 J**	**6.02 J**	**7.36 J**	NA
LEAD	39.3	14.7	10.4	NA
XRF (mg/kg)				
LEAD	39.33	16.67	17	13.33

NTC-SO-PBR-010	[6 - 8]	[10 - 12]	[12 - 14]	[14 - 16]
Inorganics (mg/kg)				
ARSENIC	**8.11 J**	**7.41 J**	**8.32 J**	**7.77 J**
LEAD	44.1	9.06	12.2	8.9
XRF (mg/kg)				
LEAD	40.67	12.67	11.67	15.33

NTC-SO-PBR-009	[6 - 8]	[10 - 12]	[12 - 14]	[14 - 16]
Inorganics (mg/kg)				
ARSENIC	**5.24 J**	**6.9 J**	**8.95 J**	**7.57 J**
LEAD	9.88	9.4	10.5	11.2
XRF (mg/kg)				
LEAD	14	13.67	14.33	13.67

NTC-SO-PBR-008	[6 - 8]	[10 - 12]	[12 - 14]	[14 - 16]
Inorganics (mg/kg)				
ARSENIC	**9.53 J**	**8.72 J**	**9.73 J**	**8.64 J**
LEAD	11.2	11.5	10.1	11.4
XRF (mg/kg)				
LEAD	16.67	13	14	15.33

NTC-SO-PBR-007	[6 - 8]	[10 - 12]	[12 - 14]	[14 - 16]
Inorganics (mg/kg)				
ARSENIC	**7.98 J**	NA	**8.57**	NA
LEAD	29.6	NA	11.4	NA
XRF (mg/kg)				
LEAD	30	10.67	15	14.33

NTC-SO-PBR-006	[6 - 8]	[10 - 12]	[12 - 14]	[14 - 16]
Inorganics (mg/kg)				
ARSENIC	**6.67 J**	NA	**7.59 J**	**8.13 J**
LEAD	8.16	NA	11.2	10.5
XRF (mg/kg)				
LEAD	7.67	9	13.67	11.33

Legend

- Soil Boring Location
- Approximate Location of Firing Line
- Approximate Location of Pistol Butts / Berm
- Approximate Location of Targets Area

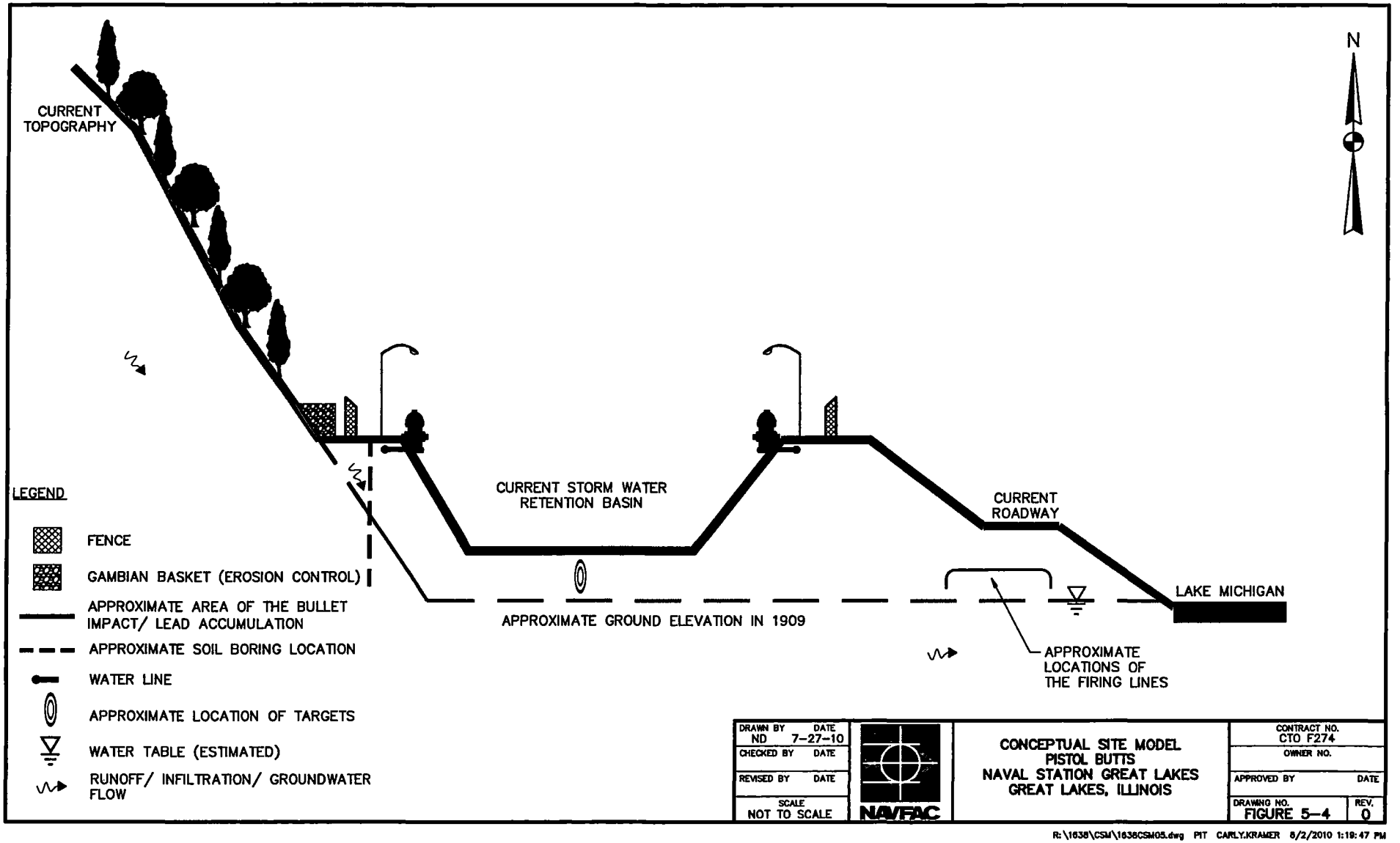
40 20 0 40 Feet

DRAWN BY: K. MOORE	DATE: 7/21/10
CHECKED BY: J. DUCAR	DATE: 8/9/10
REVISED BY: —	DATE: —
SCALE: AS NOTED	

NAVFAC

SELECT METALS AND XRF EXCEEDANCES IN SOIL
PISTOL BUTTS
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER: CTO F274	
OWNER NUMBER: —	
APPROVED BY: —	DATE: —
FIGURE NO.: FIGURE 5-3	REV: 0



DRAWN BY ND DATE 7-27-10	NAVFAC	CONCEPTUAL SITE MODEL PISTOL BUTTS NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NO. CTO F274
CHECKED BY DATE			OWNER NO.
REVISED BY DATE			APPROVED BY DATE
SCALE NOT TO SCALE			DRAWING NO. FIGURE 5-4 / REV. 0

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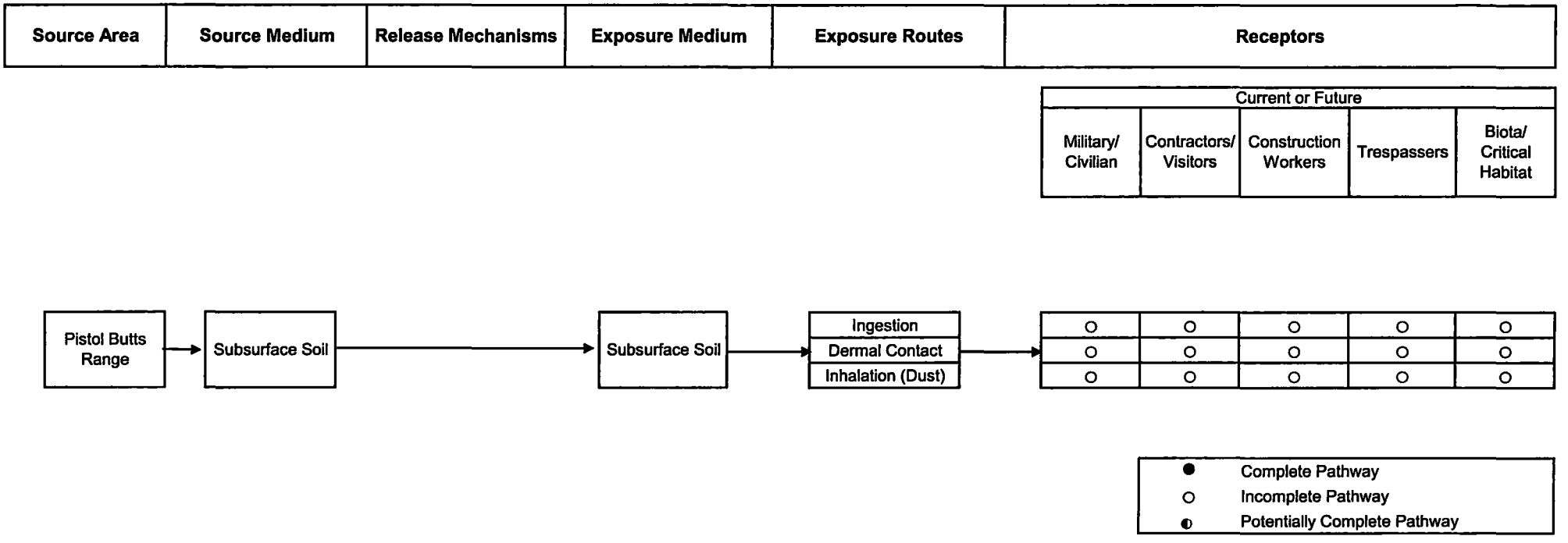
FIGURE 5-5

MC EXPOSURE PATHWAY ANALYSIS
PISTOL BUTTS RANGE
NS GREAT LAKES, GREAT LAKES ILLINOIS



6.0 MACHINE GUN RANGE

6.1 SITE BACKGROUND

The Machine Gun Range was located immediately south of Building 13 (the Boat House) and the man-made boat channel at the harbor in the southern portion of the installation. Figure 6-1 depicts the Machine Gun Range and associated range features. The range was used for the training of naval personnel on small arms of 0.50-caliber or less. The dates of operation are unknown; however, an archival map (dated 1909) indicates that the Navy used the range during the early years of the Naval Station (Appendix A of the UFP-SAP). The Machine Gun Range was not previously investigated.

Based on the 1909 archival map, targets were placed on the breakwater for the Inner Harbor and were fired upon from the land on the western side of the harbor (over the water). There were two firing lines associated with the range, one at 200-yards and one at 300-yards. The 200-yard range was located on the western edge of the Inner Harbor immediately west of the water's edge, and the 300-yard range was located across the Boat Basin south of the western edge of the Boat House. The majority of the range floor consists of the Inner Harbor and the primary impact from MC (lead) is expected to be near the breakwater and would contain concentrated metal from the expended bullets. A paved road covers the majority of the 300-yard firing line. The 200-yard firing line is now an open grassy area with picnic tables near the area where landing craft are housed, as shown on Figure 6-1.

The area east of the Inner Harbor is within the range fan for the Machine Gun Range; however, MC concentrations in the Outer Harbor and beyond, resulting from use of munitions at the range, would likely become extremely diluted by sediment transport and the large body of surface water. Elevated levels of lead were not expected to be detectable in Lake Michigan sediment because of the scattered nature of the shots, lake currents, storm surges, and other erosional forces on the unconsolidated sediments, in the shallow water column of the lake.

6.1.1 Historical Munitions Usage Information

The Machine Gun Range was dedicated to the use of small arms (0.50-caliber or less), which do not contain explosive components. Based on the information obtained during the data collection process, no special consideration munitions are known or suspected to have been used at the site. Therefore, the Machine Gun Range is not suspected to contain chemical warfare material filled munitions, electrically fuzed munitions, or depleted uranium associated munitions.

6.1.2 Munitions Constituents

Lead is the primary metal of concern because it is the primary constituent in bullets used at small arms ranges and because of its documented toxicity to human and ecological receptors. Other metals (antimony and arsenic, which may be present in lead bullets) contamination will be spatially correlated with lead. Although these metals are associated with lead in bullets, their concentrations are expected to be much less than lead concentrations. Lead accounts for more that 95 percent of the weight of the projectile. Antimony is added to bullets as a hardening agent in quantities ranging from 0.1 to 2 percent. Arsenic is naturally present in lead at trace levels (0.001 to 0.06 percent). Antimony and arsenic, if present, would be spatially correlated with the lead. The USEPA human health screening value commonly used to indicate the presence of potentially unacceptable levels of antimony in soil is 31 mg/kg; the screening value for arsenic is 0.39 mg/kg and is within the typical soil background concentrations according to TACO of 13 mg/kg. Using the relative concentrations of these metals in projectiles, lead would have to be present in soil or sediment at a concentration greater than 600 mg/kg for arsenic, antimony, copper, or zinc from bullets to be present at potentially unacceptable levels. Therefore, lead, which is easier to measure, is a useful indicator of potentially unacceptable concentrations of any of these five metals in soil or sediment.

In addition, past investigations at other small arms ranges also indicate that NG has been detected at firing lines.

The 200-yard and 300-yard firing lines have been disturbed since the use of the range. The 300-yard firing line has been graded and paved to allow access to the shoreline, while the 200-yard firing line is a grass-covered area beside the harbor seawall. Potential MC suspected at the firing lines are lead and NG. These constituents may remain in shallow soil beside the road at the 300-yard firing line or in the soil exposed at the 200-yard firing line.

The Machine Gun Range did not use a berm/butt and targets were placed on, or in front of, the harbor breakwater. Bullets impacting the breakwater in target areas would be expected to collect in the lake sediment west of the breakwater of the Inner Harbor. The sediment east of the breakwater are subjected to lake currents and storm events which redistribute and dilute the bullet distribution, thereby decreasing the possibility of MC remaining in the sediment immediately beyond the target area.

6.2 SITE FIELDWORK

6.2.1 Site Field Activities

The SI field program for the Machine Gun Range included collection of surface soil samples (0 to 0.5-foot bgs) on the land portion of the site, from the 200-yard and 300-yard firing lines, to identify COPCs (e.g., select metals and NG) that may exist as a result of past operations at the range.

In addition, the SI field program for the Machine Gun Range included collection of sediment samples from Lake Michigan at one depth interval (0 to 0.5 foot bss) at each sample location to identify COPCs (e.g., select metals) that may exist as a result of past operations.

Surface Soil Sampling

Three discrete surface soil samples (0 to 0.5-foot bgs) were collected at the former 200-yard firing line and three at the former 300-yard firing line of the Machine Gun Range(six total), as shown on Figure 6-2. Sample locations were generated in a spatial grid pattern to cover the approximate location of the former 200-yard firing line. The 300-yard firing line is somewhat covered by the existing roadway; therefore, samples were collected from surface soil on the south side of the access road and just below the spread gravel on the north side of the road.

Sediment Sampling

Ten discrete sediment samples were collected at 10 sample locations at the former Machine Gun Range target area as shown on Figure 6-2. Sample locations were determined using a spatial grid pattern to cover the water portion of the site immediately west of the former target locations on the existing breakwater. Sediment samples were collected between 3 to approximately 40 feet west of the existing Inner Harbor breakwater due to difficulty maintaining the Zodiac™ in a stationary position near the breakwater. All sediment samples were collected from 0 to 0.5 feet bss.

Field sampling forms are presented in Appendix A. Photographs associated with the sampling activities at the Machine Gun Range are presented in Appendix B.

6.2.2 Work Plan Deviations

A minor deviation from the UFP-SAP (Tetra Tech, 2010) for the Machine Gun Range SI was the proposed 0.5 to 1 foot depth interval for the sediment samples were not collected, as discussed in

Section 3.2.1.4. Therefore, 10 sediment samples proposed in the UFP-SAP were not collected for the site. However, the primary receptors for the MCs present in the lake sediment are aquatic biota. Ecological risk assessments only consider the top 0.5 feet (or less) of sediment when evaluating exposure pathways for aquatic biota, because that is considered the biotic zone. Therefore, the lack of sediment analytical data from the 0.5 to 1 foot bss depth interval does not adversely affect the ability to meet the data objectives and develop the CSM for the Machine Gun Range site.

6.2.3 Field Data Collection

Surface Soil

Six discrete surface soil samples were collected from six sample locations during the SI at the Machine Gun Range; three from the former 200-yard firing line, and three from the former 300-yard firing line. Sample locations were selected based on a spatial grid pattern to cover the land portion of the site immediately in front of the former firing point. A 0 to 0.5-foot bgs sample was collected at each sample location via hand auger. All six soil samples were submitted to the FBL for select metals (antimony, arsenic, and lead) analyses by Method SW-846 6010B, and NG analyses by Method SW-846 8330.

Sediment

Sediment samples were collected in accordance with SOP-06 and SOP-08 of the UFP-SAP. Ten sediment samples were collected within the Inner Harbor area of Lake Michigan for the Machine Gun Range from 10 sample locations. The sediment samples were collected using a petite Ponar dredge from a Zodiac™ inflatable boat.

All 10 sediment samples were submitted to the FBL for select metals (antimony, arsenic, and lead) analyses by Method SW-846 6010B.

Tables 6-2 and 6-3 provide a summary of the soil and sediment samples collected and their respective analysis at the Machine Gun Range, respectively. Figure 6-2 shows the soil sampling and sediment sampling locations. Soil and sediment sample log sheets are included in Appendix A of this document.

6.3 SITE INSPECTION DATA COLLECTION RESULTS

6.3.1 Munitions Constituents Sampling Results

Soil and sediment samples collected at the Machine Gun Range were compared to respective PALs, as listed in Worksheet #15 of the UFP-SAP (Tetra Tech, 2010). The chemical reference limits and background evaluation table and the complete validated FBL data tables are presented in Appendix D.

Tables 6-2 and 6-3 summarize the laboratory analytical detection results for the soil and sediment data as compared to the PALs, respectively. Concentrations of the samples, which exceed the respective PAL, are highlighted (Human Health) and/or bolded (Ecological) in the table. The data comparison to PALs is discussed in Section 6.6. Figure 6-3 presents the select metals (antimony, arsenic, and lead) detections in the soil samples at the Machine Gun Range. Figure 6-4 presents the select metals (antimony, arsenic, and lead) detections in the sediment samples at the Machine Gun Range. The data comparison to PALs is discussed in Section 6.5.

6.4 DATA PRESENTATION/DATA USABILITY

6.4.1 Data Quality Review of Samples at the Machine Gun Range

This section contains a description of the data review processes used to determine whether analytical laboratory data collected during the sampling field effort for the Machine Gun Range were of acceptable quality for use in decision-making. The review began with data validation, which is a comparison of DQIs against the prescribed acceptance criteria. The DQIs are measures used to assess the completeness, sensitivity, accuracy, precision, comparability, and representativeness of the sample collection and sample analysis process. The output of this review was a set of alphabetic flags such as "U," "J", "R," or combinations thereof, assigned to individual results based on the validation effort. These flags were used to infer the general quality of the data and if data quality meets the DQOs of the project. The DQOs presented in the approved UFP-SAP (Tetra Tech, 2010) were maintained through the course of the sampling event. Worksheets #15 and #19 of the UFP-SAP present the analytical methods and compounds analyzed.

6.4.1.1 Data Validation Process

All of the FBL sample results were validated according to several specifications. Assignment of data qualification flags conformed to rules established in USEPA National Functional Guidelines for Organic Data Validation (October 1999), USEPA National Functional Guidelines for Inorganic Data Validation

(October 2004), and DoD document entitled QSM for Environmental Laboratories (January 2006 and April 2009) to the greatest extent practicable for non-contract laboratory program data.

Several samples analyzed for various parameters were qualified due to numerous issues. Appendix D contains the data validation reports, which outline the specific qualification reasons for each sample according to the parameter.

6.4.1.2 Data Quality Review

Some of the DQIs are generated from the analysis of field samples (e.g., field duplicates) while others are from the analysis of FBL samples (e.g., laboratory duplicates). Individually, field and FBL DQIs provide measures of the performance of the respective investigative operations (field or laboratory). If individual QC results were unacceptable, there was an assignment of a validation flag indicating the type of QC deficiency impacting the result. Supporting documentation regarding the data presentation and usability for the Machine Gun Range is presented in Appendix E.

6.4.1.3 Completeness

The surface soil FBL sample collection and analytical completeness for the Machine Gun Range was 100 percent. The sediment FBL sample collection and analytical completeness for the Machine Gun Range was 50 percent because samples were not collected from 0.5 to 1 foot bss. However, the primary receptors for the MCs present in the lake sediment are aquatic biota. Ecological risk assessments only consider the top 0.5 feet of sediment when evaluating exposure pathways for aquatic biota. Therefore, the lack of sediment analytical data from the 0.5 to 1 foot bss depth interval does not adversely affect the ability to meet the data objectives and develop the CSM for the Machine Gun Range.

6.4.1.4 Sensitivity

The PQLGs for each analyte are listed in Worksheet #15 of the UFP-SAP (Tetra Tech, 2010). Analytical sensitivity for the Machine Gun Range data was satisfactory to meet the DQOs presented in the UFP-SAP.

6.4.1.5 Field and Laboratory Accuracy

There were no quality control deficiencies noted for field or FBL accuracy for the Machine Gun Range.

6.4.1.6 Field and Laboratory Precision

There were no quality control deficiencies noted for the field and FBL precision in the Machine Gun Range data. Field duplicate results were acceptable.

6.4.1.7 Comparability

Comparability is defined as the confidence with which one data set can be compared with another (e.g., among sampling points and among sampling events). Comparability was achieved by using standardized sampling and analysis methods, as well as standardized data reporting formats. Comparability of laboratory measurements was achieved primarily through the use and documentation of standard sampling and analytical methods. Results were reported in units that ensured comparability with current state and federal standards and guidelines. Comparability of laboratory measurements was assessed primarily through the use of QC samples and through adherence to the QA plan. The data comparability for the Machine Gun Range was deemed acceptable.

6.4.1.8 Representativeness

The UFP-SAP (Tetra Tech, 2010) and the use of standardized sampling, sample handling, sample analysis, and data reporting procedures were designed so that the final data would be accurate representations of actual site conditions. Based upon the field logs indicating the conditions during sample collection and FBL audits, all reported data are adequately representative of site conditions of the Machine Gun Range.

6.5 DATA COMPARISON TO PROJECT ACTION LIMITS

6.5.1 Identification of Chemicals Exceeding Project Action Limits

All six of the surface soil samples collected from the Machine Gun Ranges were submitted to the FBL for select metals and NG analysis. In addition, 10 sediment samples collected from the Machine Gun Ranges within Lake Michigan were submitted to the FBL for select metals analysis.

The laboratory concentrations for the soil samples were compared to both the human health-derived PAL and the ecological-derived PAL for screening purposes to determine if further investigation is necessary. All of the soil samples collected from the Machine Gun Ranges were surface samples (0 to 0.5 feet bgs). In addition, the Illinois EPA background concentrations for each metal were listed in the data summary tables for comparison purposes.

The laboratory concentrations for the sediment samples were compared to the ecological PAL for screening purposes to determine if further investigation is necessary. All sediment samples collected from the Machine Gun Ranges were collected 0 to 0.5 feet bss from the lake bottom. In addition, the data was compared to the site-specific background concentrations for select metals evaluation purposes.

Tables 6-2 and 6-3 summarize the laboratory analytical detection results for the soil and sediment data as compared to the PALs, respectively. Concentrations of the samples, which exceed the respective PAL, are highlighted (human health) and/or bolded (ecological) in the tables.

Select Metals in Soil

Lead

Lead laboratory analytical concentrations ranged from 16.2 to 145 mg/kg. None of the soil samples submitted for laboratory analyses exhibited lead concentrations exceeding the human health PAL of 400 mg/kg (Figure 6-3 and Table 6-2). However, all six samples exhibited exceedances of the ecological PAL of 11 mg/kg. In addition, five of the samples showed concentrations which exceeded the Illinois EPA background concentration for lead of 36 mg/kg.

The ecological PAL for lead (11 mg/kg) is the USEPA Ecological Soil Screening level (Eco SSL) for insectivorous birds (USEPA, March 2005). The Eco SSLs for other receptors are as follows: insectivorous mammals (56 mg/kg), plants (120 mg/kg) and soil invertebrates (1,700 mg/kg). Although five of the six lead detections were greater than the mammal Eco SSL, all of the detections were less than the invertebrate Eco SSL, and only one detection was greater than the plant Eco SSL. The potentially impacted areas are likely very small and limited to the areas immediately adjacent to the firing lines. The Eco SSLs for wildlife are conservative screening levels based on no observed adverse effects levels and conservative exposure assumptions; therefore, concentrations below the Eco SSLs are not expected to impact wildlife. Typically, when conducting food chain modeling, concentrations have to be much greater (an order of magnitude or more) than the Eco SSL to indicate a potential risk to wildlife. This coupled with the fact that it is not likely that birds and mammals will obtain significant amounts of invertebrates from these areas makes it unlikely that birds and mammals will be impacted from lead at the site. In addition, because only one detection was slightly greater than the plant Eco SSL, in an area that is vegetated, it is unlikely that significant impacts to plants are occurring at the site.

Antimony

Antimony laboratory analytical concentrations ranged from non-detected to 0.98 mg/kg. None of the soil samples submitted for laboratory analyses exhibited antimony concentrations exceeding the human health PAL of 31 mg/kg (Appendix D). However, the four samples with antimony concentrations above the laboratory detection limits exhibited exceedances of the ecological PAL of 0.27 mg/kg. In addition, all six samples showed concentrations below the Illinois EPA background concentration for antimony of 4 mg/kg. A statistical comparison of the EPC, represented by the 95 percent UCL of the mean, to the Illinois EPA background concentrations for antimony indicates that the concentrations of antimony detected in the soil samples collected from the Machine Gun Range are within the range of naturally occurring antimony concentrations in the area of the site (Appendix G).

Arsenic

Arsenic laboratory analytical concentrations ranged from 7 to 9.09 mg/kg. All six surface soil samples submitted for laboratory analyses exhibited arsenic concentrations exceeding the human health PAL of 0.39 mg/kg (Figure 6-3 and Table 6-2). However, additional screening of the arsenic concentrations against the TACO construction worker ingestion criteria of 61 mg/kg indicated no exceedances (Appendix D).

No samples exhibited exceedances of the ecological PAL of 18 mg/kg. In addition, all six samples showed concentrations below the Illinois EPA soil background concentration for arsenic of 13 mg/kg. A statistical comparison of the EPC, represented by the 95 percent UCL of the mean, to the Illinois EPA soil background concentrations for arsenic indicates that the concentrations of arsenic detected in the soil samples collected from the Machine Gun Range are within the range of naturally occurring arsenic concentrations in the area of the site (Appendix G).

Nitroglycerin in Soil

NG laboratory analytical concentrations ranged from non-detected (<0.25 mg/kg) to 0.688 mg/kg. None of the soil samples submitted for laboratory analyses exhibited NG concentrations exceeding the human health PAL of 6.1 mg/kg (Appendix D).

Select Metals in Sediment

Lead

Lead laboratory analytical concentrations ranged from 67.1 to 85.6 mg/kg. All 10 of the sediment samples submitted for laboratory analyses exhibited lead concentrations exceeding the ecological PAL of 35.8 mg/kg (Table 6-3 and Figure 6-4). In addition, a statistical comparison of the Machine Gun Range sediment data to the data from the upgradient/background sediment samples, collected north, and upgradient of the Machine Gun Range site (Appendix G). Based on this comparison, the concentrations of lead detected in the sediment samples collected from the Machine Gun Ranges are above the upgradient/background concentrations for lead (Appendix G).

As presented in Section 4.6.1.4, the Eco SSL is based on the TEC from MacDonald et al. (2000). All of the detected concentrations were lower than the PEC for lead of 128 mg/kg (MacDonald et al., 2000) (see Figure 6-3). Although the locations with lead concentrations between the TEC and the PEC represent an area of uncertainty with regards to toxic effects to sediment invertebrates, most of the detections are closer to the TEC, the concentration below which effects to sediment invertebrates are not expected, than they are to the PEC, concentration above which effects to sediment invertebrates are likely to be observed. Therefore, significant impacts to sediment invertebrates are not likely. In addition, this area is now bounded on two sides by the breakwater and on two sides by areas that have been recently dredged making it a small and relatively insignificant relative to the size of the Inner and Outer Harbor Area in terms of available invertebrate habitat.

Antimony

No concentrations of antimony were detected above the laboratory detection limits (0.53 mg/kg or lower) in any of the sediment samples collected from the Machine Gun Ranges site (Table 6-3 and Figure 6-4). The ecological PAL for antimony is 2 mg/kg.

Arsenic

Arsenic laboratory analytical concentrations ranged from 7.92 to 10.1 mg/kg. Two of the sediment samples submitted for laboratory analyses exhibited arsenic concentrations exceeding the ecological PAL of 9.79 mg/kg (Table 6-3 and Figure 6-4). In addition, a statistical comparison of the Machine Gun Range sediment data to the data from the upgradient/background sediment samples, collected north and upgradient of the Machine Gun Range site (Appendix G). Based on this comparison, the concentrations

of arsenic detected in the sediment samples collected from the Machine Gun Ranges are above the upgradient/background concentrations for arsenic (Appendix G).

The ecological screening level for arsenic is also based on the TEC from MacDonald et al. (2000). Two of the arsenic detections at the site just slightly exceeded the TEC, but were much lower than the PEC of 33 mg/kg (MacDonald et al., 2000) (see Figure 6-3). Although there is some uncertainty in risk to sediment invertebrates when sediment concentrations are between the TEC and the PEC, it is very unlikely that significant impacts to sediment invertebrates are occurring because most of the detections only slightly exceeded the TEC and were much less than the PEC.

6.6 UPDATED CSM

Table 6-4 contains the tabular CSM and Figure 6-5 contains the graphical CSM, both outline the current understanding of the Machine Gun Range. Figure 6-6 identifies the exposure pathways where site receptors could be exposed to, come in contact with, or be impacted by, MC. Based on the analytical information obtained during the SI, MC does exist at the Machine Gun Range.

6.7 CONCLUSIONS

The environmental data collected during the SI sampling activities are sufficient to determine the presence of MC associated with the former use of the Machine Gun Range site in the surface soils, and sediment.

The focused SI sampling activities characterized the local site conditions of surface soils (0 to 0.5 feet) and identified concentrations of MC associated with small arms ammunition in surface soil and sediment. MCs (arsenic and lead) were identified at concentrations above PALs in the surface soil of the Machine Gun Range. None of the soil samples submitted for laboratory analyses exhibited lead concentrations exceeding the human health PAL of 400 mg/kg but did exceed the ecological PAL of 11 mg/kg. All of the soil samples submitted for laboratory analyses exhibited arsenic concentrations exceeding the human health PAL of 0.39 mg/kg, but no samples exceeded the TACO construction worker ingestion criteria of 61 mg/kg. In addition, no samples exhibited exceedances of the ecological PAL of 18 mg/kg, or concentrations above the Illinois EPA soil background concentration of 13 mg/kg, for arsenic. None of the soil samples exhibited concentrations above the respective PALs for antimony and NG.

Ten sediment samples were collected from 10 discrete locations at depths of 0 to 0.5 feet bss within Lake Michigan at the Machine Gun Range were submitted to the FBL for select metals (antimony, arsenic, and

lead) analysis. All 10 of the sediment samples submitted for laboratory analyses exhibited lead concentrations exceeding the ecological PAL of 35.8 mg/kg. Two of the sediment samples submitted for laboratory analyses exhibited arsenic concentrations exceeding the ecological PAL of 9.79 mg/kg. Both lead and arsenic concentrations were statistically above site-specific upgradient/background sediment concentrations. None of the sediment samples had detected concentrations above the PAL for antimony.

6.8 RECOMMENDATIONS

The purpose of the SI phase of this project is to identify the presence of contaminated environmental media that require further investigation or pose a threat to human health and/or the environment. Sites that do not require further investigation and do not pose an unacceptable risk to human health and/or the environment may be designated as NFA sites and may be eliminated from further consideration.

SOIL

The SI identified a limited area of lead concentrations in surface soil below the human health PAL, but above the ecological PAL.

Further action is recommended for soil because soil concentrations for lead and arsenic exceed their respective ecological PALs for terrestrial biota. However, the potentially impacted soil area is relatively small, and impact to terrestrial ecological receptors appears to be insignificant further evaluation of ecological risk is warranted and recommended.

SEDIMENT

The focused SI identified a limited area of sediment near the former target area with lead and arsenic concentrations greater than their respective ecological PALs and the site-specific upgradient/background sediment sample data but at concentrations close to the TEC - the concentration below which effects to sediment invertebrates are not expected. The potentially impacted area is relatively small and relatively insignificant relative to the size of the Inner and Outer Harbor area in terms of available invertebrate habitat. However, further evaluation of ecological risks is warranted and recommended.

TABLE 6-1

SUMMARY OF SAMPLES COLLECTED
MACHINE GUN RANGE
NAVAL STATIONS GREAT LAKES
GREAT LAKES, ILLINOIS

Location	Sample ID	Date Collected	Medium	Depth (inches)	Analysis [1]
MGR001	NTC-SB-MGR001-0006	4/21/2010	Soil	0 - 6	Select Metals and NG
MGR002	NTC-SB-MGR002-0006	4/21/2010	Soil	0 - 6	Select Metals and NG
MGR003	NTC-SB-MGR003-0006	4/21/2010	Soil	0 - 6	Select Metals and NG
MGR004	NTC-SB-MGR004-0006	4/21/2010	Soil	0 - 6	Select Metals and NG
MGR005	NTC-SB-MGR005-0006	4/21/2010	Soil	0 - 6	Select Metals and NG
MGR006	NTC-SB-MGR006-0006	4/21/2010	Soil	0 - 6	Select Metals and NG
MGR007	NTC-SD-MGR007-0006	5/21/2010	Sediment	0 - 6	Select Metals
MGR008	NTC-SD-MGR008-0006	5/21/2010	Sediment	0 - 6	Select Metals
MGR009	NTC-SD-MGR009-0006	5/21/2010	Sediment	0 - 6	Select Metals
MGR010	NTC-SD-MGR010-0006	5/21/2010	Sediment	0 - 6	Select Metals
MGR011	NTC-SD-MGR011-0006	5/21/2010	Sediment	0 - 6	Select Metals
MGR012	NTC-SD-MGR012-0006	5/21/2010	Sediment	0 - 6	Select Metals
MGR013	NTC-SD-MGR013-0006	5/21/2010	Sediment	0 - 6	Select Metals
MGR014	NTC-SD-MGR014-0006	5/21/2010	Sediment	0 - 6	Select Metals
MGR015	NTC-SD-MGR015-0006	5/21/2010	Sediment	0 - 6	Select Metals
MGR016	NTC-SD-MGR016-0006	5/21/2010	Sediment	0 - 6	Select Metals

1 Select metals for Pistol Ranges soil and sediment include antimony, arsenic, and lead.

TABLE 6-2
SUMMARY OF DETECTED CONCENTRATIONS IN SURFACE SOIL
MACHINE GUN RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

LOCATION SAMPLE ID SAMPLE DATE DEPTH (FT BGS)	FINAL HUMAN HEALTH CRITERIA VALUE		FEDERAL ECOLOGICAL MINIMUM OF AVIAN INVERTABRAT MAMMALIAN & PLANT SSLs [5]	TACO CHEMICALS IN BACKGROUND SOIL CRITERIA [6]	NTC-SO-MGR-001 NTC-SS-MGR-001-0006 04/21/2010 0 - 0.5	NTC-SO-MGR-002 NTC-SS-MGR-002-0006 04/21/2010 0 - 0.5	NTC-SO-MGR-003 NTC-SS-MGR-003-0006 04/21/2010 0 - 0.5	NTC-SO-MGR-004 NTC-SS-MGR-004-0006 04/21/2010 0 - 0.5	NTC-SO-MGR-005 NTC-SS-MGR-005-0006 04/21/2010 0 - 0.5	NTC-SO-MGR-006 NTC-SS-MGR-006-0006 04/21/2010 0 - 0.5
EXPLOSIVES (mg/kg)										
NITROGLYCERIN	7.8	3	NC	NC	0.298 J	0.333 J	0.338 J	0.688 J	0.25 U	0.33 J
METALS (mg/kg)										
ANTIMONY	31	1	0.27	4	**0.866 J**	**0.343 J**	**0.413 J**	0.313 UJ	**0.98 J**	0.282 UJ
ARSENIC	0.39	4	18	13	8.34 J	7.4 J	9.09 J	7.58 J	8.17 J	8.37 J
LEAD	400	1	11	36	**101**	**109**	**87.1**	**83.4**	**145**	**16.2**

Shaded = exceedance of human health screening criteria
Bold = exceedance of ecological screening criteria

J = Indicates a positive result greater than the method detection limit (MDL), but less than the limit of quantitation (LOQ).
NA = Not Analyzed
mg/kg = milligram per kilogram

Source of Screening Level
1 - Illinois EPA Tiered Approach to Corrective Acitons Objectives, Residential Soil Ingestion Criteria (http://www.ipcb.state.il.us/documents.dsweb/Get/Document-38408/). (July, 2010)
2 - Proposed Illinois EPA Tier 1 Soil Remediation Objectives - Residential Criteria. (September, 2008)
3 - Illinois EPA Residential Non-TACO - Intestion Criteria. (July, 2009)
4 - US EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites - Residential Soil Values. (May, 2010)
5 - US EPA Guidance for Developing Ecological Soil Screening Level. Office of Solid Waste and Emergency and Response. OSWER Directive 92857-55. (February, 2005)
6 - Illinois EPA background concentration (Illinois EPA, Appendix A, Table G of TACO)

Associated Samples:
NTC-SS-MGR-001-0006
NTC-SS-MGR-002-0006
NTC-SS-MGR-003-0006
NTC-SS-MGR-004-0006
NTC-SS-MGR-005-0006
NTC-SS-MGR-006-0006

TABLE 6-3
SUMMARY OF DETECTED CONCENTRATIONS IN SEDIMENT
MACHINE GUN RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

LOCATION SAMPLE ID SAMPLE DATE DEPTH (ft bss)	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-MGR-007 NTC-SD-MGR-007-0006 05/21/2010 0 - 0.5	NTC-SD-MGR-008 NTC-SD-MGR-008-0006 05/21/2010 0 - 0.5	NTC-SD-MGR-009 NTC-SD-MGR-009-0006 05/21/2010 0 - 0.5	NTC-SD-MGR-010 NTC-SD-MGR-010-0006 05/21/2010 0 - 0.5	NTC-SD-MGR-011 NTC-SD-MGR-011-0006 05/21/2010 0 - 0.5
METALS (mg/kg)						
Antimony	2	0.486 UJ	0.488 UJ	0.491 UJ	0.53 UJ	0.501 U
Arsenic	9.79	**9.86**	8	8.23	**10.1**	9.13
Lead	35.8	**85.6**	**68.1**	**67.1**	**79**	**77.6**

LOCATION SAMPLE ID SAMPLE DATE DEPTH (ft bss)	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-MGR-012 NTC-SD-MGR-012-0006 05/21/2010 0 - 0.5	NTC-SD-MGR-013 NTC-SD-MGR-013-0006 05/21/2010 0 - 0.5	NTC-SD-MGR-014 NTC-SD-MGR-014-0006 05/21/2010 0 - 0.5	NTC-SD-MGR-015 NTC-SD-MGR-015-0006 05/21/2010 0 - 0.5	NTC-SD-MGR-016 NTC-SD-MGR-016-0006 05/21/2010 0 - 0.5
METALS (mg/kg)						
Antimony	2	0.494 U	0.467 U	0.434 U	0.459 U	0.45 U
Arsenic	9.79	9.08	8.17	7.92	8.63	8.57
Lead	35.8	**77.1**	**73.7**	**68.7**	**74.8**	**71.9**

Bold = exceedance of ecological screening criteria

bss = below sediment surface
ft = feet
J = Indicates that the chemical was detected; however, the associated numerical result is not a precise representation of the concentration that is actually present in the sample
mg/kg = milligram per kilogram
R = Indicates that the chemical was detected; however, the results are rejected because of holding time exceedances.
U = Indicates that the chemical was not detected at the numerical detection limit noted.
µg/kg = microgram per kilogram

Source of Screening Level
1 - USEPA Guidance for Developing Ecological Soil Screening Level. Office of Solid Waste and Emergency and Response. OSWER Directive 92857-55. (February, 2005)

Associated Samples:
NTC-SD-MGR-007-0006
NTC-SD-MGR-008-0006
NTC-SD-MGR-009-0006
NTC-SD-MGR-010-0006
NTC-SD-MGR-011-0006
NTC-SD-MGR-012-0006
NTC-SD-MGR-013-0006
NTC-SD-MGR-014-0006
NTC-SD-MGR-015-0006
NTC-SD-MGR-016-0006

TABLE 6-4

CONCEPTUAL SITE MODEL INFORMATION PROFILE
MACHINE GUN RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Profile Type	Information Needs	Findings
Range/Site Profile	Installation Name	Naval Station Great Lakes (NSGL)
	Installation Location	Great Lakes, Lake County, Illinois
	Range/Site Name	Machine Gun Range
	Range/Site Location	The Machine Gun Range was located immediately south of Building 13 (the Boat House) and the man-made boat channel at the harbor in the southern portion of the installation.
	Range/Site History	The range was used for the training of naval personnel on small arms of 0.50-caliber or less. The dates of operation are unknown; however, an archival map (dated 1909) indicates that the Navy used the range during the early years of the Naval Station.
	Range/Site Area and Layout	Based on the 1909 archival map, electronic targets were placed on the breakwater for the Inner Harbor and were fired upon from the land on the western side of the harbor (over the water). There were two firing lines associated with the range - at 200-yards and 300-yards. The 200-yard range was located on the western edge of the Inner Harbor immediately west of the water's edge and the 300-yard range was located across the Boat Basin south of the western edge of the Boat House. The majority of the range floor consists of the Inner Harbor. A paved road covers the majority of the 300-yard firing line and the 200-yard firing line is now an open grassy area with picnic tables near the area where landing craft are housed.
	Range/Site Structures	The machine gun range consisted of two firing lines; one at 200-yards and one at 300-yards. Current site structures include: Naval Reserve docks, picnic pavilion, storage structures and utility shed.
	Range/Site Boundaries	See Figures 1-2 and 6-1 N: Building 13 (Boat House) and Inner Harbor of Lake Michigan S: Naval Reserve building and Outer Harbor of Lake Michigan E: Outer Harbor of Lake Michigan W: Undeveloped, vegetative land
	Range/Site Security	The site is located within the installation, which is patrolled by base security; however, there are no access controls specific to the site itself or to the water portion of the site in Lake Michigan.
Munitions/ Release Profile	Munitions Types	Small arms (0.50-caliber or less)
	Maximum Probability Penetration Depth	The Machine Gun Range did not use a berm/butt and targets were placed on, or in front of, the harbor breakwater. Potential penetration depth in sediments of Lake Michigan is unknown.

TABLE 6-4

CONCEPTUAL SITE MODEL INFORMATION PROFILE
MACHINE GUN RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Profile Type	Information Needs	Findings
	MEC Density	Munitions of explosive concern (MEC) presence is not suspected since munitions use was limited to small arms.
	Munitions Debris	Surficial material potentially presenting an explosive hazard (MPPEH) was not found at this site. There is no direct evidence of subsurface munitions scrap / fragments / MPPEH on the land portion of the site. However, based on anomalies detected during the geophysics investigation in Lake Michigan subsurface munitions scrap / fragments / MPPEH may be present in the sediments of the lake.
	Associated MC	Primary munitions constituents (MC) of concern includes lead. It is anticipated that other metals (antimony and arsenic) contamination will be spatially correlated with lead. Although these metals are associated with lead in bullets, their concentrations are expected to be much less than lead concentrations. Past investigations at other small-arms ranges also indicate that nitroglycerin (NG) has been detected at firing lines.
	Migration Routes/Release Mechanisms	Natural release mechanisms and migration mechanisms for potential MC on the land portion of the site include erosion and surface water runoff. Human activities, such as soil excavation and vegetation removal, may also redistribute MC in soil. Migration mechanisms for MC potentially in sediment of Lake Michigan include wave action, lake turnover, and potential dredging activities. Potential MC may also migrate in surface water within the lake.
Physical Profile (see Section 2)	Climate	The lakefront is strongly influenced by its proximity to Lake Michigan and by southerly Gulf Stream winds. Average temperatures range from 20.3 °F in January to 71.5 °F in July. The average annual precipitation is 34.1 inches, and the mean seasonal snowfall is 37.9 inches.
	Topography	Bluffs and lakeshore surround the range.
	Geology	Poorly sorted, unstratified sediments of the Wadsworth formation underlain by Silurian dolomite bedrock.
	Soil	Soil borings completed within NSGL consisted of silt, clay, and sand.

TABLE 6-4

CONCEPTUAL SITE MODEL INFORMATION PROFILE
MACHINE GUN RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Profile Type	Information Needs	Findings
	Hydrogeology	The hydrogeologic framework of NSGL consists of an overburden aquifer, with depth to groundwater averaging 2 to 5 feet bgs. Groundwater flow direction is generally to the east toward Lake Michigan. However, the site is bordered by the Boat Basin and Inner Harbor seawall, which may inhibit lateral flow of shallow groundwater. Groundwater is not used as a drinking water source for the installation. Any MC in groundwater discharging into the lake is expected to be very diluted and not to be a concern to the potable water use of the lake.
	Hydrology	There are no surface water bodies on the land portion of the Machine Gun Range. However, the Boat Basin and Inner Harbor border the site and the SDZs ranges extend into Lake Michigan.
	Vegetation	Predominantly grasses.
Land Use and Exposure Profile	Current Land Use	The majority of the range floor consists of the Inner Harbor. A paved road covers the majority of the 300-yard firing line and the 200-yard firing line is now an open grassy area with picnic tables near the area where landing craft are housed.
	Current Human Receptors	Authorized Navy personnel, Navy-escorted contractors and visitors, unauthorized trespassers (land portion of the site), and recreationists and commercial fishermen (water portion of the site).
	Current Activities	Activities on the land portion of the site are low in frequency and include grounds maintenance. The water portion of the site east of the Inner Harbor wall is used for transportation, commercial fishing, and recreation (e.g., diving, swimming, or fishing). Within the Inner Harbor the site is used for boat mooring, transportation, and storage. Dredging has occurred in the Boat Basin, Inner Harbor, and Lake Michigan in the past (USACE, 2001).
	Potential Future Land Use	Potential future land use is assumed to be the same as present land use. There are no plans for use external to the Navy.
	Potential Future Human Receptors	Authorized Navy personnel, Navy-escorted contractors and visitors, unauthorized trespassers (land portion of the site), and recreationists and commercial fishermen (water portion of the site).

TABLE 6-4

CONCEPTUAL SITE MODEL INFORMATION PROFILE
MACHINE GUN RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS
PAGE 4 OF 4

Profile Type	Information Needs	Findings
	Potential Future Land Use Related Activities	The land portion of the site is expected to experience continued grounds maintenance, and environmental or other types of intrusive investigations may occur at the site. Use of the water portion of the site is expected to remain the same as current use: for boat storage, transportation, commercial fishing, and recreation. It is unknown if additional dredging activities are planned.
	Zoning/Land Use Restrictions	A formal land use restriction prohibiting the installation of groundwater wells (with the exception of environmental monitoring wells) and the consumption of groundwater at Naval Station Great Lakes was issued in September 2002. Water use restrictions are likely in place for Lake Michigan to protect the potable water supply source.
	Demographics/Zoning	Lake County population density is approximately 1,300 persons per square mile, while Naval Station Great Lakes employs approximately 25,000 military and civilian personnel.
	Beneficial Resources	Lake Michigan is a major fishery with over 22,000 square miles of both commercial and recreational fishing adjacent to NSGL. Lake Michigan is also a municipal potable water source and a recreational resource.
Ecological Profile	Habitat Type	There is grassland at the location of the former range. Lake Michigan provides aquatic habitat.
	Degree of Disturbance	Low - Activities at the land portion of the site include moderate disturbance (e.g., grounds maintenance). Disturbance of sediments in Lake Michigan is expected to be low.
	Ecological Receptors and Species of Special Concern	Grassland and forest species (e.g., vegetation, birds, small mammals, reptiles/amphibians) are expected to utilize the available habitat on the land portion of the site. Aquatic flora and fauna are expected to be present in the water portion of the site (i.e., Lake Michigan). Avian species are expected to be present in the land and water portions of the site.
General Exposure Profile	Relationship of MEC/MC Sources to Habitat and Potential Receptors	MEC presence is not suspected since munitions use was limited to small arms. The MC Pathway for surface soil is incomplete for humans. The MC Pathway for surface soil is incomplete for ecological receptors due to insignificant risk for lead and concentrations below background for arsenic, and antimony. The MC Pathway for sediment is complete for ecological receptors due exceedances of PALs for lead and arsenic.

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DRAWN BY K. MOORE	DATE 11/17/09	SITE LOCATION MACHINE GUN RANGE NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NUMBER CTO F274
CHECKED BY J. DUCAR	DATE 7/26/10		OWNER NUMBER —
REVISED BY —	DATE —		APPROVED BY — DATE —
SCALE AS NOTED			FIGURE NO. FIGURE 6-1 REV 0

NAVFAC

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DRAWN BY J. ENGLISH	DATE 07/20/10	SAMPLING LOCATIONS MACHINE GUN RANGE NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NUMBER CTO F274
CHECKED BY J. DUCAR	DATE 7/27/10		OWNER NUMBER —
REVISED BY —	DATE —		APPROVED BY — DATE —
SCALE AS NOTED			FIGURE NO. FIGURE 6-2 REV 0

NAVFAC

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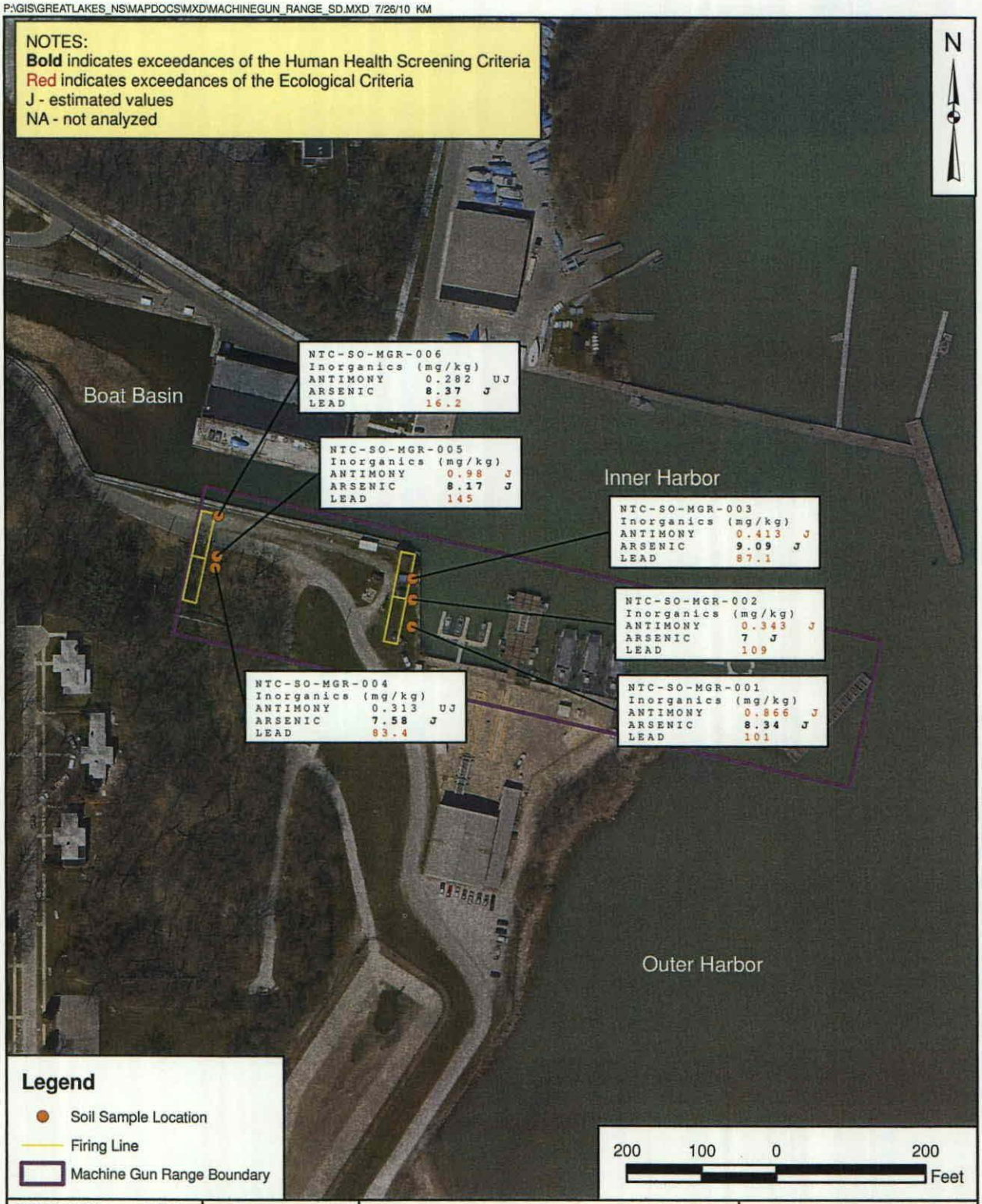

DRAWN BY / DATE	K. MOORE 7/21/10
CHECKED BY / DATE	J. DUCAR 7/26/10
REVISED BY / DATE	— —
SCALE	AS NOTED

NAVFAC

SELECT METALS EXCEEDANCES
IN SOIL
MACHINE GUN RANGE
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER	CTO F274
OWNER NUMBER	—
APPROVED BY / DATE	— —
FIGURE NO.	FIGURE 6-3
REV	0

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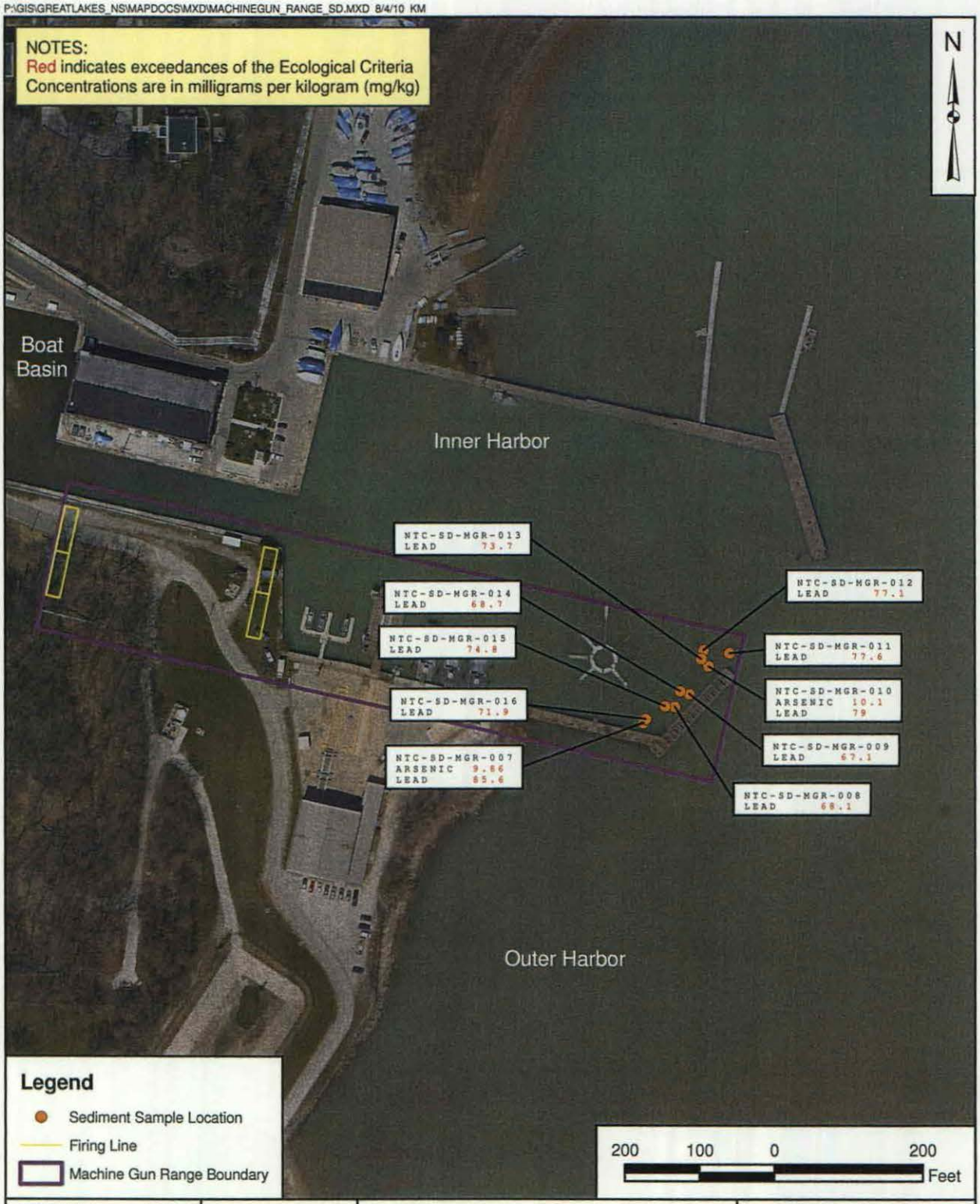
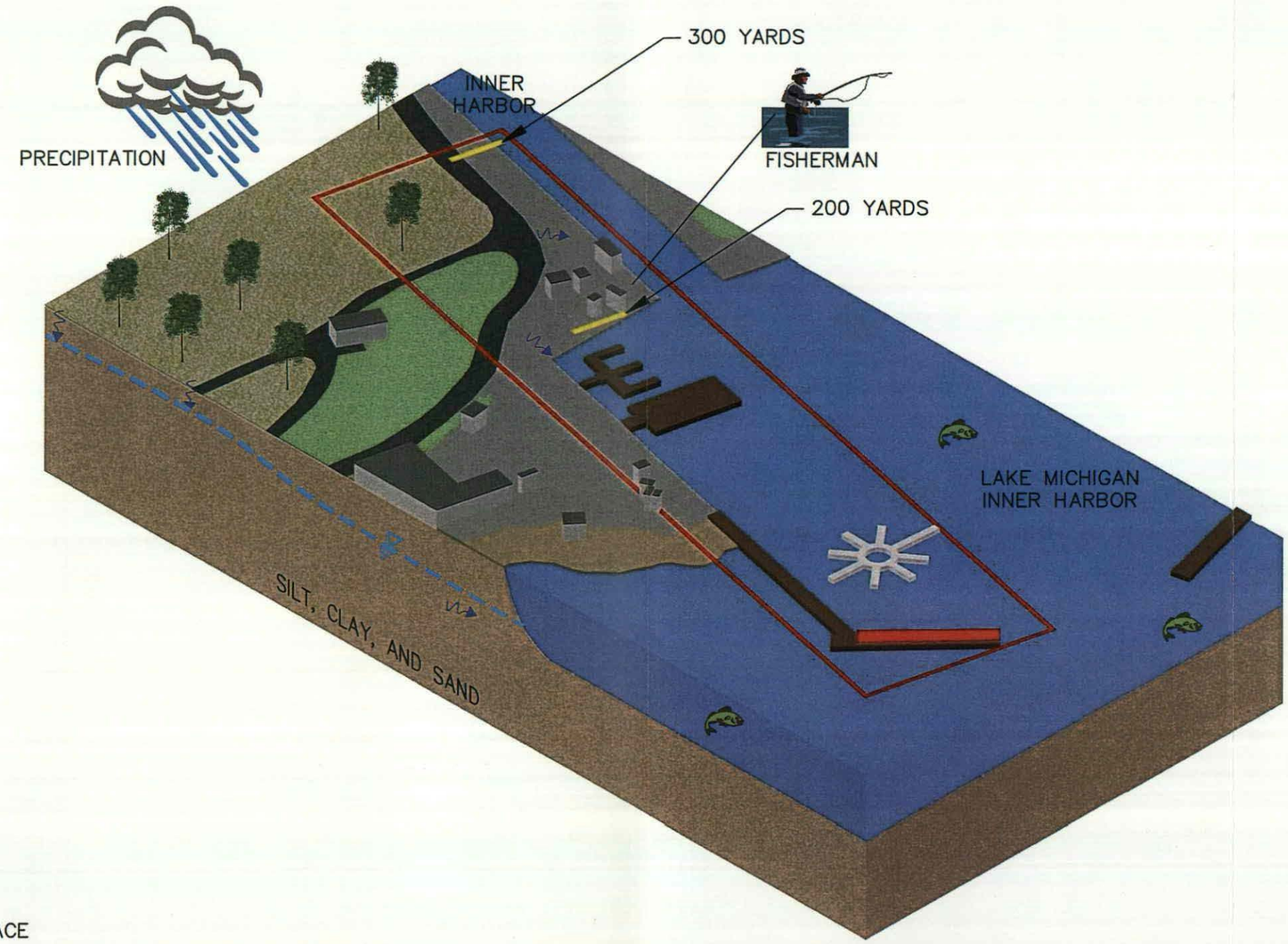


DRAWN BY K. MOORE	DATE 7/29/10	SELECT METALS EXCEEDANCES IN SEDIMENT MACHINE GUN RANGE NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NUMBER CTO F274
CHECKED BY J. DUCAR	DATE 8/4/10		OWNER NUMBER —
REVISED BY —	DATE —		APPROVED BY — DATE —
SCALE AS NOTED	NAVFAC		FIGURE NO. FIGURE 6-4 REV 0



N

LEGEND

- MACHINE GUN RANGE
- FIRING LINE
- TARGET AREA
- POTENTIOMETER SURFACE
- SURFACE RUNOFF/ INFILTRATION/ GROUNDWATER FLOW
- AQUATIC BIOTA

DRAWN BY ND	DATE 7-26-10	CONCEPTUAL SITE MODEL MACHINE GUN RANGE NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NO. CTO F274
CHECKED BY	DATE		OWNER NO.
REVISED BY	DATE		APPROVED BY DATE
SCALE NOT TO SCALE		NAVFAC	DRAWING NO. FIGURE 6-5 / REV. 0

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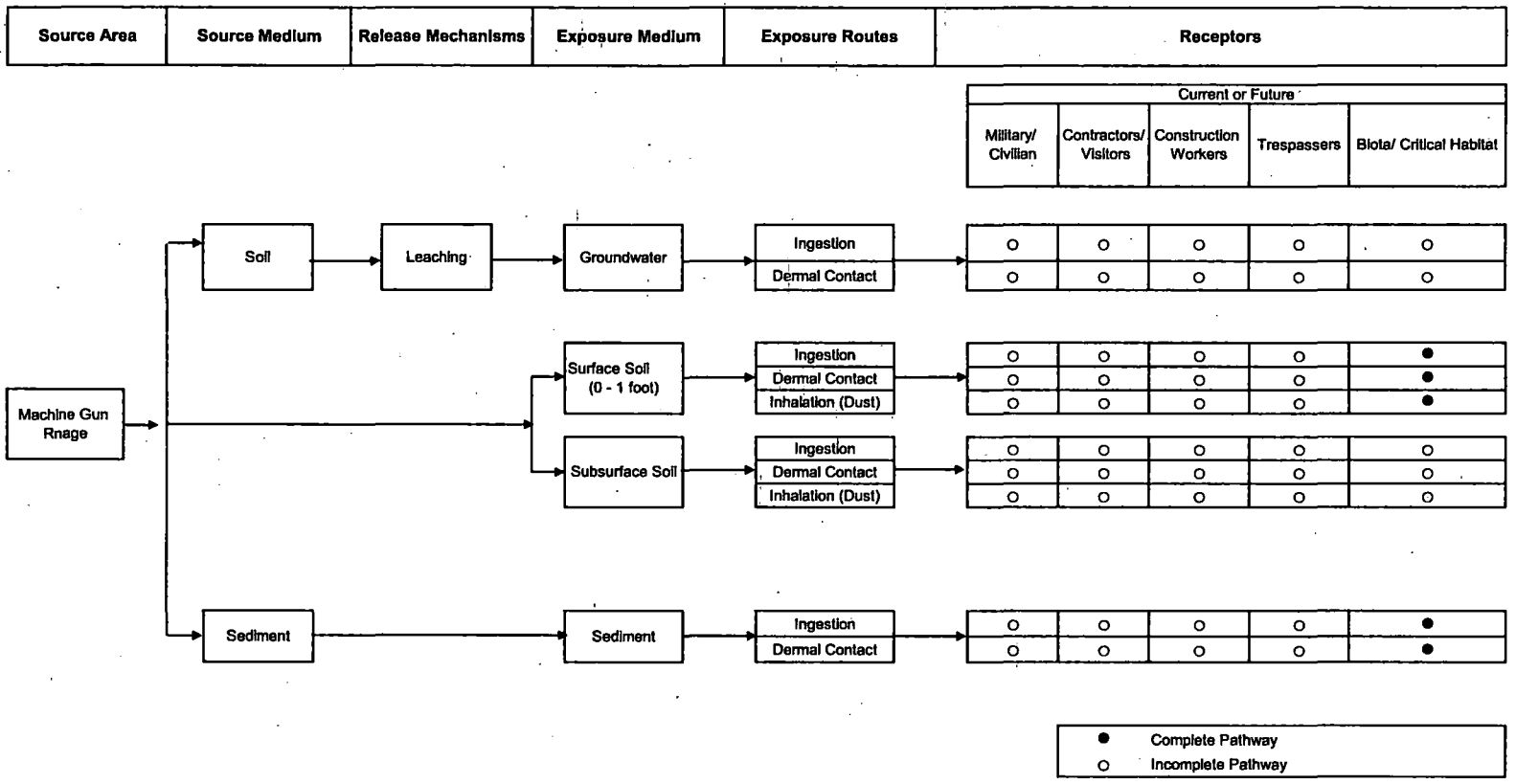
FIGURE 6-6

MC EXPOSURE PATHWAY ANALYSIS
MACHINE GUN RANGE
NS GREAT LAKES, GREAT LAKES, ILLINOIS



7.0 NTC LAKEFRONT

7.1 SITE BACKGROUND

Between 1942 and 1945, personnel stationed at NSGL used the NTC Lakefront for AA artillery training. At that time, 25 gun mounts located on the beachfront were used to fire at targets towed over Lake Michigan. The SI field investigation was conducted on the water portion, which includes the range fan and SDZ over Lake Michigan, which is where a fired munition would have landed. Information regarding NTC Lakefront is limited to the history and site description presented in the Final Water Area Munitions Study NTC Lakefront (Malcolm Pirnie, 2005) and the PA (Malcolm Pirnie, 2008).

The land portion of NTC Lakefront is approximately one acre in size and is located east of the bluff on the beachfront of Lake Michigan. Prior to using the site as an AA range, the shoreline was extended with fill material in order to install the machine gun mounts. The water portion of this site includes a fan area of approximately 4,765 acres that extends out from the shoreline over Lake Michigan.

The NTC Lakefront is bordered by Lake Michigan to the east, a RV park to the north, the bluff to the west, and the Outer Harbor and Boat House to the south. The site is accessible via Ziegemeir Street, which is built over the former gun mount roundels. A magazine, Building 120, is the present lakefront magazine according to a March 17, 2003 listing of known ammunition storage and firing locations at NSGL. Over the years, the buildings associated with the Site, including the Garage and Storage, the Machine Gun Training Building, the Armory, and the Clippings and Empties building, were demolished. Sometime after 1962, a tank farm for fuel storage was constructed in the location of the former Machine Gun Training Building to meet the needs of the power plant. No construction records for the tank farm were available that could provide information regarding potential munitions findings and no visible signs of the demolished buildings exist today. The power plant is adjacent to the tank farm that services it (former location of the NTC Lakefront).

Figure 7-1 depicts NTC Lakefront and associated range features.

7.1.1 Historical Munitions Usage Information

Approximately 1,350 sailors a day were instructed in AA training using 20- and 40-millimeter guns and shot several million shells at cable-drawn targets towed by airplanes over Lake Michigan. Potential MEC and/or MPPEH issues arose from the use of AA ammunition with tracers including:

- 20-mm HE
- HEI
- HET
- HET-DI rounds
- 40-mm blind loaded and plugged (BL&P)
- HET – self destruct (HET-SD)
- high explosive incendiary tracer – self destruct (HEIT-SD) rounds
- 1.1-inch AA artillery
- 3-inch .50 caliber artillery
- DI tracers

Based on the information obtained during the data collection process, no special consideration munitions are known or suspected to have been used at the site. Therefore, NTC Lakefront is not suspected to contain chemical warfare material filled munitions, electrically fuzed munitions, or depleted uranium associated munitions (Malcolm Pirnie, 2005). Additional technical data regarding the munitions used at NTC Lakefront are included in Appendix A-3 of the UFP-SAP.

It is estimated that more than ten million rounds of ammunition were fired between 1942 and 1945. The dud rate is estimated at 5 percent, resulting in potentially several hundred thousand rounds containing explosives, which may be present in the Lake Michigan sediment. Munitions that missed the target could have auto-detonated 3,000 yards from the firing point, which indicates that MEC/MPPEH or MEC debris may be present at this distance from the firing point within Lake Michigan. Munitions that did not detonate at this distance may have traveled a considerable distance before impact, depending on the munition type and typical range. Some of the munitions fired had potential ranges of more than 30,000 feet (5.68 miles).

7.1.2 Munitions Constituents

MC could be present in lake sediment associated with the remaining MEC/MPPEH in the SDZ, primarily in the primary impact zone. However, the concentrations of MC in Lake Michigan surface water resulting from the use of munitions at the range would likely become extremely diluted by the large volume of surface water and the length of time since the placement of the MC occurred. The MC potentially present NTC Lakefront includes:

- Select metals: antimony, arsenic, copper, iron, lead, magnesium, strontium, and zinc; and

- Select explosives: octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), pentaerythritol tetranitrate (PETN), n-methyl-n-2,4,6-tetranitroaniline (tetryl), and trinitrotoluene (TNT).

7.2 SITE FIELDWORK

7.2.1 Site Field Activities

MEC Investigation

Data and information used to make environmental management decisions about Lake Michigan for the MEC investigation include the following:

1. Control Point Data: Site preparation consisted of locating or establishing an adequate number of control points to provide accurate navigational control for the survey work.

2. Bathymetric Survey Data: Technicians used high-resolution multibeam echosounder sonar (MBE) system capable of detecting and identifying features such as potential MEC/MPPEH on the surface of lake sediment. The bathymetric survey was used to map the lake bottom and morphology in addition to identifying obstacles and features that may affect the in-water geophysical survey and any MEC removal activities. The bathymetric survey was conducted in general accordance with SOP 01 of the UFP-SAP; USACE's Hydrographic Surveying Engineering Manual (EM 1110-2-1003 and appendices; USACE, 2002) for an acoustic multi-beam survey as modified by the project-specific technical specifications provided in this work plan.

3. In-Water Geophysical Survey Data: Following the bathymetric survey the study transects were mapped using an underwater marine gradiometer array (MGA) to determine the density and distribution of metallic items that may represent suspect MEC, MPPEH, or scrap metal. All geophysical survey data was recorded electronically and field notes were recorded in field logbooks and/or survey log sheets. Any anomalies detected during the geophysical survey were used to determine whether any suspect MEC/MPPEH may be present on the lake bottom surface or subsurface. These data and their locations were also used to generate MC sampling locations.

4. Real Time Kinematic (RTK) GPS and ultra short acoustic baseline positioning system (USBL): The Leica 1230 RTK GPS/Applanix POS M/V and USBL systems were used to record watercraft and MGA position, dynamics and elevation data.

The horizontal boundary for the MEC SI at the NTC Lakefront is shown as the Lake Michigan SDZ as presented in Figure 7-1. This is the maximum depth covered by the Navy MRP. The vertical boundary (i.e., depth of sediment) of the MEC/MPPEH SI investigation of the lake bottom sediment is limited by the size of the anomalies present and the capabilities of the detection system. Small items (20-mm projectiles) may not be detected unless clustered together. Larger items such as 40-mm projectiles may be detected at depths up to approximately 12 inches in the bottom sediment depending on the technology used.

The data and results of analyses for the MEC/MPPEH geophysical investigation at NTC Lakefront suggest the following conclusions:

- The firing limits for the range (the north and south boundaries of the SDZ) have not been fully defined. The bands of metallic debris detected extend beyond the current estimated north and south boundaries of the historical AA training range.

- The terminus of the SDZ (eastern boundary) appears to be relatively well defined. The survey was completed to the design limits of the area (estimated maximum range of munitions). Even though the survey area ended about 915 feet short of the estimated maximum water depth range boundary based upon the depth limits set for the SI (i.e. water depth < 120 feet), the amount of metallic debris had tapered off significantly indicating that the terminal end of the range was in proximity to the end of the survey area

- Magnetic anomalies, which may represent MEC/MPPEH and/or MD were detected on the lake floor occurred in bands roughly corresponding to the different average ranges of the various known munitions fired at the range.

- The underwater video camera did not prove to be an effective tool for target/anomaly verification, although it did provide data about the lake bottom type and habitat.

Based on these considerations, additional evaluation will be needed to establish the nature and extent of potential MEC/MPPEH/MD contamination of the former AA training range at NSGL. The following activities may be warranted:

Diving operations to evaluate the nature of selected metallic items identified during the MGA survey.

Additional marine survey and geophysical mapping of areas to the north, south and east of the current survey area to bound (if possible) the metallic debris field (and potential UXO) associated with former range operations.

Volume II of the SI Report presents the MEC geophysical investigation report.

MC Investigation

The MC field investigation program for NTC Lakefront included collection of sediment samples from the area of the site within Lake Michigan to identify COPCs (e.g., select metals and select explosives) that may exist as a result of past operations at the range. Photographs associated with the sampling activities at NTC Lakefront are included in Appendix B.

No surface soil samples were collected at the firing line for the AA training area for NTC Lakefront due to the high erosion and deposition rates immediately in front of the firing points at that location. No MC is expected to remain near the firing lines.

Twenty-seven discrete sediment samples were collected from 30 sample locations identified through the NTC Lakefront MEC geophysical investigation with the use of a modified pneumatic Van Veen dredge sampler from the survey vessel, in accordance with SOP-08 of the UFP-SAP. Sediment samples could not be collected from three sample locations (LAK-012, LAK-014, and LAK-022) due to dredge sampler refusal. Sample locations were based on geophysical anomalies identified within the SDZ using a custom-designed MGA to perform the underwater geophysical survey.

All 27 sediment samples collected were submitted to the FBL for analysis of select metals (antimony, arsenic, copper, iron, lead, magnesium, strontium, and zinc) by Method SW-846 6010B and select explosives (HMX, PETN, RDX, tetryl, and TNT) analyses by Method SW-846 8330A. All samples submitted to the laboratory were prepared and analyzed according to the normal laboratory protocol as identified on Worksheet #30 of the UFP-SAP.

Figure 7-2 presents the sediment sample locations within the assumed SDZ area of NTC Lakefront.

7.2.2 Work Plan Deviations

The only deviation from the UFP-SAP (Tetra Tech, 2010) for NTC Lakefront SI was that sediment samples could not be collected from three proposed sample locations (LAK-012, LAK-014, and LAK-022)

due to Van Veen dredge sampler refusal on the rocky lake bottom. Several attempts were made at each sample location, but samples could not be collected due to cobble size glacial sediments.

7.2.3 Field Data Collection

Twenty-seven discrete sediment samples were collected from 27 sample locations identified through the NTC Lakefront MEC geophysical investigation with the use of a modified Van Veen dredge sampler from the survey vessel, in accordance with SOP-08 of the UFP-SAP. Sample locations were based on geophysical anomalies identified within the SDZ by the MGA geophysical instrumentation.

All 27 sediment samples were submitted to the FBL for select metals (antimony, arsenic, copper, iron, lead, magnesium, strontium, and zinc) analyses by Method SW-846 6010B and select explosives (HMX, PETN, RDX, tetryl, and TNT) analyses by Method SW-846 8330A. All samples submitted to the laboratory were prepared and analyzed according to the normal laboratory protocol as identified on Worksheet #30 of the UFP-SAP.

Table 7-1 provides a summary of the samples collected and their respective analysis at NTC Lakefront, and Figure 7-2 shows the sediment sampling and upgradient sediment sampling locations. Sediment sample log sheets are included in Appendix A.

Upgradient Sampling Locations

Three discrete sediment locations (LAK-UPG001 through LAK-UPG003) were collected at sample locations upgradient (north) of the TSA Range and seven discrete sediment samples (LAK-UPG004 through LAK-UPG010) were collected at sample locations upgradient (north) of the SDZ of NTC Lakefront. The sample locations were selected to be upgradient of the locations of magnetic anomalies identified during the MEC investigation and based on the general direction of the sediment transport along the coastal area as well as the suspected northern boundary of the SDZ.

All 10 sediment samples were submitted to the laboratory for select metals (antimony, arsenic, copper, iron, lead, magnesium, strontium, and zinc) analyses by Method SW-846 6010B and three samples (LAK-UPG001 through LAK-UPG003) for PAHs analyses by Method 8270C. All the upgradient sediment samples were collected in accordance with SOP 08 of the UFP-SAP.

7.3 SITE INSPECTION DATA COLLECTION RESULTS

7.3.1 Munitions Constituents Sampling Results

Sediment samples collected at NTC Lakefront were compared to respective Ecological PALs, as listed in Worksheet #15 of the UFP-SAP (Tetra Tech, 2010). The data validation reports are presented in Appendix D.

Table 7-2 presents the select metals (antimony, arsenic, copper, iron, lead, magnesium, strontium, and zinc) and select explosives (HMX, PETN, RDX, tetryl, and TNT) detections in the sediment samples at NTC Lakefront. The data comparison to PALs is discussed in Section 7.5.

Figure 7-3 presents the select metals (arsenic) and select explosives (HMX and RDX) detections in the sediment samples at NTC Lakefront.

7.4 DATA PRESENTATION/DATA USABILITY

7.4.1 Data Quality Review of Samples at NTC Lakefront

This section contains a description of the data review processes used to determine whether analytical laboratory data collected during the sampling field effort for NTC Lakefront were of acceptable quality for use in decision-making. The review began with data validation, which is a comparison of DQIs against the prescribed acceptance criteria. The DQIs are measures used to assess the completeness, sensitivity, accuracy, precision, comparability, and representativeness of the sample collection and sample analysis process. The output of this review was a set of alphabetic flags such as "U," "J", "R," or combinations thereof, assigned to individual results based on the validation effort. These flags were used to infer the general quality of the data and if data quality meets the DQOs of the project. The DQOs presented in the approved UFP-SAP (Tetra Tech, 2010) were maintained through the course of the sampling event. Worksheets #15 and #19 of the UFP-SAP present the analytical methods and compounds analyzed.

7.4.1.1 Data Validation Process

All of the FBL sample results were validated according to several specifications. Assignment of data qualification flags conformed to rules established in USEPA National Functional Guidelines for Organic Data Validation (October 1999), USEPA National Functional Guidelines for Inorganic Data Validation (October 2004), and DoD document entitled QSM for Environmental Laboratories (January 2006 and April 2009) to the greatest extent practicable for non-contract laboratory program data.

Several samples analyzed for various parameters were qualified due to numerous issues. Appendix D contains the data validation reports, which outline the specific qualification reasons for each sample according to the parameter.

7.4.1.2 Data Quality Review

Some of the DQIs are generated from the analysis of field samples (e.g., field duplicates) while others are from the analysis of FBL samples (e.g., laboratory duplicates). Individually, field and FBL DQIs provide measures of the performance of the respective investigative operations (field or laboratory). If individual QC results were unacceptable, there was an assignment of a validation flag indicating the type of QC deficiency impacting the result. Supporting documentation regarding the data presentation and usability for NTC Lakefront is presented in Appendix E.

7.4.1.3 Completeness

The sample collection and analytical completeness for NTC Lakefront was 90 percent. Twenty-seven of the proposed 30 samples were collected, as discussed in Section 7.2. However, the remaining samples were sufficient to meet the project goals.

7.4.1.4 Sensitivity

The PQLGs for each analyte are listed in Worksheet #15 of the UFP-SAP (Tetra Tech, 2010). One-hundred, 85, and 59 percent of TNT, HMX, and RDX sediment data points from NTC Lakefront were reported as non-detected at concentrations greater than corresponding minimum PALs because the contracted laboratory did not achieve method detection limits specified in Worksheet #15 of the UFP-SAP.

It should be noted that a high degree of analytical sensitivity was required for the explosives analyses conducted for this project. Under conditions of high sensitivity, there exists an increased potential for chemical interferences to corrupt the analysis. In addition, the laboratory experienced some apparent contamination problems. A detailed evaluation of the chromatographic data and multiple consultations with the laboratory resulted in some reported detections of explosives compounds being reclassified as non-detects. However, some of the reported detections could not be reclassified and the data suggest that the detections are artifacts of the analysis and do not represent true detections. With the available

data it is impossible to determine with confidence whether these detections are artifacts. Data validation reports explain this situation in more detail (see Appendix D).

The explosives analytical method (liquid chromatography [LC] with ultraviolet detector [UV]) that was used for this project is designed for the sample matrices for this project. Additionally, the analytical laboratory is accredited to conduct the analyses; therefore, the project team could not have anticipated these quality problems. This does not change the fact that reported target analyte detections may be artifacts. Resampling and analysis may be required if the existence of artifacts would change the project decisions. If resampling and analysis is necessary to verify the reported detections or if additional samples are collected as part of the RI process than the LC with a mass spectral detector instead of an UV detector should be utilized because the mass spectral detector has been used successfully for high explosives analyses. The sensitivities achievable are sufficient to detect explosive target analytes at PAL concentrations. Mass spectral detectors provide a greater degree of target analyte identification which helps to avoid incorrectly reporting analytical artifacts as target analyte detections.

7.4.1.5 Field and Laboratory Accuracy

There were no quality control deficiencies noted for field or FBL accuracy for NTC Lakefront.

7.4.1.6 Field and Laboratory Precision

There were no quality control deficiencies noted for the field and FBL precision in NTC Lakefront data. Field duplicate results were acceptable.

7.4.1.7 Comparability

Comparability is defined as the confidence with which one data set can be compared with another (e.g., among sampling points and among sampling events). Comparability was achieved by using standardized sampling and analysis methods, as well as standardized data reporting formats. Comparability of laboratory measurements was achieved primarily through the use and documentation of standard sampling and analytical methods. Results were reported in units that ensured comparability with current state and federal standards and guidelines. Comparability of laboratory measurements was assessed primarily through the use of QC samples and through adherence to the QA plan. The data comparability for NTC Lakefront was deemed acceptable.

7.4.1.8 Representativeness

The UFP-SAP (Tetra Tech, 2010) and the use of standardized sampling, sample handling, sample analysis, and data reporting procedures were designed so that the final data would be accurate representations of actual site conditions. Based upon the field logs indicating the conditions during sample collection and laboratory audits, all reported data are adequately representative of site conditions of NTC Lakefront.

7.5 DATA COMPARISON TO PROJECT ACTION LIMITS

7.5.1 Identification of Chemicals Exceeding Project Action Limits

Twenty-seven sediment samples collected from NTC Lakefront were submitted to the FBL for select metals (antimony, arsenic, copper, iron, lead, magnesium, strontium, and zinc) and select explosives (HMX, PETN, RDX, tetryl, and TNT) analysis.

The laboratory concentrations for the sediment samples were compared to the ecological PAL for screening purposes to determine if further investigation is necessary. In addition, the data was compared to the site-specific background sediment sample concentrations for select metals for evaluation purposes. All of the sediment samples collected from NTC Lakefront were collected 0 to 0.5 feet below the lake bottom.

Table 7-2 summarizes the laboratory analytical detection results as compared to the PALs. If a parameter exceeded its PAL at any sampling point, the parameter was highlighted.

7.5.1.1 Select Metals in Sediment within NTC Lakefront

None of the sediment samples collected from NTC Lakefront and submitted for laboratory analyses exhibited concentrations exceeding their respective ecological PALs for antimony, copper, iron, lead, magnesium, strontium, and zinc.

Arsenic

Arsenic was the only metal, which exhibited concentrations in excess of its respective PAL in the sediment samples collected from NTC Lakefront. Concentrations of arsenic ranged from 2.59 to 14.3 mg/kg. Five of the sediment samples exhibited arsenic concentrations exceeding the ecological PAL of 9.79 mg/kg (Figure 7-3 and Table 7-2). In addition, a statistical comparison of NTC Lakefront sediment

data to the site-specific upgradient/background sediment sample concentrations for arsenic was conducted (Appendix G). The evaluation indicates that the concentrations of arsenic detected in the sediment samples collected from the SDZ of NTC Lakefront are below the site-specific upgradient/background sediment sample concentrations for arsenic (Appendix G).

7.5.1.2 Select Explosives in Sediment within NTC Lakefront

Only HMX and RDX showed detected concentrations above the ecological PALs in sediment collected from NTC Lakefront. As discussed in Section 7.4.1.4, detections of these constituents in the lake sediments are highly suspect because of the laboratory method used to analyze the samples. In addition, the laboratory experienced some apparent contamination problems with the samples analyzed for the explosive constituents, suggesting that the detections are artifacts of the analysis and do not represent true detections. With the available data it is impossible to determine with confidence whether these detections are artifacts, or truly representative of actual environmental conditions.

HMX

HMX concentrations were detected in excess of the PAL in four of the 27 sediment samples collected from NTC Lakefront. Concentrations of HMX ranged from non-detect (<0.1 mg/kg) to 0.152 mg/kg. The four sediment samples exhibited HMX concentrations exceeding the ecological PAL of 0.0047 mg/kg (Figure 7-3 and Table 7-2).

RDX

RDX concentrations were detected in excess of the PAL in 11 of the 27 sediment samples collected from NTC Lakefront. Concentrations of RDX ranged from non-detect (<0.1 mg/kg) to 0.427 mg/kg. The 11 sediment samples exhibited RDX concentrations exceeding the ecological PAL of 0.013 mg/kg (Figure 7-3 and Table 7-2).

None of the sediment samples collected from NTC Lakefront, and submitted for laboratory analyses, exhibited concentrations exceeding their respective ecological PALs for PETN, tetryl, and TNT. However, 100 percent of TNT, 85 percent of HMX, and 59 percent of RDX sediment results were reported as non-detected at concentrations greater than corresponding minimum PALs because the contracted laboratory did not achieve MDLs specified on Worksheet #15 of the UFP-SAP (Tetra Tech, March 2010).

The detection limit for HMX and RDX was 0.1 mg/kg. The ecological PALs for HMX (0.0047 mg/kg) and RDX (0.013 mg/kg) are conservative screening values based on equilibrium partitioning as described in Talmage et al., (1999). Toxicity data from spiked sediment toxicity studies are presented in Sunahara et al., (2009), which presents No Observed Effects Concentrations (NOECs) and Lowest Observed Effects Concentrations (LOECs) for two freshwater aquatic invertebrates (Hyalella azteca and Chironomus tentans) for several explosives in Table 5.2 of the referenced report. NOECs are concentrations where, effects were not observed in the study and LOECs are concentrations where effects were observed. For HMX, the NOECs ranged from 126 mg/kg to 146 mg/kg and for RDX, the NOECs ranged from 102 mg/kg to 711 mg/kg. Therefore, the site concentrations and detection limits are much lower than these NOECs and to impacts and sediment invertebrates from HMX and RDX are not expected.

Although the detection limit for TNT (0.1 mg/kg) was greater than the ecological PAL (0.092 mg/kg), sediment invertebrates are not likely to be impacted by TNT for several reasons. The PAL is just slightly lower than the detection limit, so it is not likely that many samples would have TNT detections between 0.092 mg/kg and 0.1 mg/kg. It is more likely that TNT, if present, is at concentrations less than the PAL. Furthermore, the PAL is a conservative screening value based on equilibrium partitioning (Talmage et al., 1999). Table 5.2 in Sunahara et al., (2009) presents NOECs and LOECs for the same two freshwater aquatic invertebrates listed above. For TNT, the NOECs ranged from <0.1 mg/kg (less than detection) to 4 mg/kg. Therefore, any of the detections would be similar to or lower than the NOECs.

Select Metals in Sediment Upgradient of NTC Lakefront

Arsenic was the only metal, which exhibited concentrations in excess of its respective PAL in the sediment samples collected upgradient of NTC Lakefront. A concentration of 10.7 mg/kg was identified in sample UPG-010, located approximately 1,200 feet northeast of the area of NTC Lakefront. Appendix G presents a statistical evaluation of the upgradient sediment samples to the on-site NTC Lakefront sediment samples using the Wilcox Rank Sum Hypothesis test with a 5% significance level.

7.6 UPDATED CONCEPTUAL SITE MODEL

Table 7-3 contains the tabular CSM, which outlines the current understanding of NTC Lakefront. Figure 7-4 provides a graphical representation of the current understanding of the CSM for NTC Lakefront. Figures 7-5 and 7-6 identify the exposure pathways where site receptors could be exposed to, come in contact with, or be impacted by MEC and MC, respectively. Based on the analytical information obtained during the SI, MC do exist at the site based on a screening against ecological PALs.

MEC/MPPEH was not identified during the SI; however, magnetic anomalies were identified but the full extent of the SDZ may not have been delineated, as discussed in the MEC SI report (Tetra Tech, 2010).

7.7 CONCLUSIONS

Arsenic was the only metal that exhibited concentrations in excess of its ecological PAL in the sediment samples collected from NTC Lakefront. However, the levels of arsenic detected within the SDZ of the site were statistically below the arsenic concentrations detected in the upgradient (background) site-specific sediment samples. Therefore, the arsenic observed within NTC Lakefront can be attributable to naturally occurring arsenic concentrations found within the lake.

Explosive constituents (HMX and RDX) were detected in the sediment samples above the ecological screening criteria within NTC Lakefront. These detections were determined to be non-significant however due to the uncertainties associated with the explosives analysis detailed in Section 7.4.1.4, additional sampling of sediment from NTC Lakefront will be included in association with the MEC RI recommended for this site.

7.8 RECOMMENDATIONS

Based on the results of the SI, further action is recommended for explosives and NFA for select metals for NTC Lakefront. Further action will be necessary to ascertain whether anomalies identified during the underwater geophysical survey are MEC/MPPEH. Anomalies selected for further investigation will be determined during planning of the next phase of investigation and may include some or all of the previously sampled locations. If anomalies are determined to be MEC/MPPEH, then biased MC samples should be collected at these locations for select metals and explosive analytes. In this event, an alternate explosive analytical method should be used. This method should incorporate LC with a mass spectral detector due to its ability to determine the presence of low-level explosive constituents with a higher degree of certainty than the LC method with UV detector.

TABLE 7-1

SUMMARY OF SAMPLES COLLECTED
NTC LAKEFRONT RANGE (WATER PORTION)
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Location	Sample ID	Date Collected	Medium	Depth	Analysis[1]
LAK001	NTC-SD-LAK001-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK002	NTC-SD-LAK002-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK003	NTC-SD-LAK003-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK004	NTC-SD-LAK004-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK005	NTC-SD-LAK005-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK006	NTC-SD-LAK006-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK007	NTC-SD-LAK007-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK008	NTC-SD-LAK008-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK009	NTC-SD-LAK009-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK010	NTC-SD-LAK010-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK011	NTC-SD-LAK011-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK013	NTC-SD-LAK013-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK015	NTC-SD-LAK015-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK016	NTC-SD-LAK016-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK017	NTC-SD-LAK017-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK018	NTC-SD-LAK018-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK019	NTC-SD-LAK019-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK020	NTC-SD-LAK020-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK021	NTC-SD-LAK021-0006	5/22/2020	Sediment	0 - 6	Select Metals and Select Explosives
LAK023	NTC-SD-LAK023-0006	5/20/2010	Sediment	0 - 6	Select Metals and Select Explosives
LAK024	NTC-SD-LAK024-0006	5/20/2010	Sediment	0 - 6	Select Metals and Select Explosives
LAK025	NTC-SD-LAK025-0006	5/20/2010	Sediment	0 - 6	Select Metals and Select Explosives
LAK026	NTC-SD-LAK026-0006	5/20/2010	Sediment	0 - 6	Select Metals and Select Explosives
LAK027	NTC-SD-LAK027-0006	5/20/2010	Sediment	0 - 6	Select Metals and Select Explosives
LAK028	NTC-SD-LAK028-0006	5/20/2010	Sediment	0 - 6	Select Metals and Select Explosives
LAK029	NTC-SD-LAK029-0006	5/20/2010	Sediment	0 - 6	Select Metals and Select Explosives
LAK030	NTC-SD-LAK030-0006	5/20/2010	Sediment	0 - 6	Select Metals and Select Explosives
UPG004	NTC-SD-UPG004-0006	5/20/2010	Sediment	0 - 6	Select Metals
UPG005	NTC-SD-UPG005-0006	5/20/2010	Sediment	0 - 6	Select Metals
UPG006	NTC-SD-UPG006-0006	5/20/2010	Sediment	0 - 6	Select Metals
UPG007	NTC-SD-UPG007-0006	5/20/2010	Sediment	0 - 6	Select Metals
UPG008	NTC-SD-UPG008-0006	5/20/2010	Sediment	0 - 6	Select Metals
UPG009	NTC-SD-UPG009-0006	5/20/2010	Sediment	0 - 6	Select Metals
UPG010	NTC-SD-UPG010-0006	5/20/2010	Sediment	0 - 6	Select Metals

1 Select metals for sediment samples include antimony, arsenic, copper, iron, magnesium, lead, strontium, and zinc.
Select Exploives for sediment samples include HMX, RDX, TNT, PETN, tetryl

TABLE 7-2

SUMMARY OF DETECTED CONCENTRATIONS IN SEDIMENT
NTC LAKEFRONT RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

LOCATION SAMPLE ID SAMPLE DATE DEPTH (ft bss)	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-LAK-001 NTC-SD-LAK-001-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-002 NTC-SD-LAK-002-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-003 NTC-SD-LAK-003-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-004 NTC-SD-LAK-004-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-005 NTC-SD-LAK-005-0006 05/22/2010 0 - 0.5
EXPLOSIVES (mg/kg)						
HMX	0.0047 [2]	0.128 J	0.1 U	0.1 U	0.1 U	0.1 U
RDX	0.013 [2]	0.1 U	0.1 U	0.1 U	0.1 U	0.143 J
METALS (mg/kg)						
Arsenic	9.79	3.62 J	3.41 J	3.15 J	2.95 J	3.11 J
Copper	31.6	3.78	4.06	3	4.03	3.06
Iron	20000	5580	5440	6120	6190	4990
Lead	35.8	9.26	8.19	6.59	6.48	5.31
Magnesium	NC	46500	49500	46900	46100	48500
Strontium	NC	29.5	30.8	29	28.9	31.2
Zinc	121	46.2	45.5	39.7	39	34.4

LOCATION SAMPLE ID SAMPLE DATE DEPTH (ft bss)	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-LAK-006 NTC-SD-LAK-006-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-007 NTC-SD-LAK-007-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-008 NTC-SD-LAK-008-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-009 NTC-SD-LAK-009-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-010 NTC-SD-LAK-010-0006 05/22/2010 0 - 0.5
EXPLOSIVES (mg/kg)						
HMX	0.0047 [2]	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
RDX	0.013 [2]	0.1 U	0.132 J	0.152 J	0.255 J	0.1 U
METALS (mg/kg)						
Arsenic	9.79	3.43 J	2.59 J	8.07 J	**13.4 J**	2.59
Copper	31.6	1.44	2.17	2.75	4.96	3.17
Iron	20000	4040	3790	5600	10200	3090
Lead	35.8	3.33	5.25	5.07	6.06	4.72 J
Magnesium	NC	12700 J	27300 J	18400 J	25400 J	14600 J
Strontium	NC	8.88	18.5	18	21.4	10.5
Zinc	121	14.7	24.2	24.8	29.2	30.6

Footnotes and definitions are summarized on the final page of the table.

TABLE 7-2

SUMMARY OF DETECTED CONCENTRATIONS IN SEDIMENT
NTC LAKEFRONT RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

LOCATION SAMPLE ID SAMPLE DATE DEPTH (ft bss)	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-LAK-011 NTC-SD-LAK-011-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-013 NTC-SD-LAK-013-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-015 NTC-SD-LAK-015-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-016 NTC-SD-LAK-016-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-017 NTC-SD-LAK-017-0006 05/22/2010 0 - 0.5
EXPLOSIVES (mg/kg)						
HMX	0.0047 [2]	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
RDX	0.013 [2]	0.1 U	0.1 U	0.326 J	0.284 J	0.1 U
METALS (mg/kg)						
Arsenic	9.79	8.99 J	3.99	**10.5**	**11.3**	8.26
Copper	31.6	5.04	2.32	8.27	9.76	27.7
Iron	20000	8650	4050	9010	8370	18000
Lead	35.8	6.83	5.57 J	8.22 J	5.2 J	11.2 J
Magnesium	NC	22400 J	20300 J	26500 J	19200 J	39200
Strontium	NC	19.9	15.7	34.1	18.5	58.3
Zinc	121	33.6	30.1	41.7	27.3	55.7

LOCATION SAMPLE ID SAMPLE DATE DEPTH (ft bss)	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-LAK-018 NTC-SD-LAK-018-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-019 NTC-SD-LAK-019-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-020 NTC-SD-LAK-020-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-021 NTC-SD-LAK-021-0006 05/22/2010 0 - 0.5	NTC-SD-LAK-023 NTC-SD-LAK-023-0006 05/20/2010 0 - 0.5
EXPLOSIVES (mg/kg)						
HMX	0.0047 [2]	0.152 J	0.147 J	0.118 J	0.1 U	0.1 U
RDX	0.013 [2]	0.137 J	0.1 U	0.427 J	0.1 U	0.1 U
METALS (mg/kg)						
Arsenic	9.79	5.64	6.05	**14.3**	8.17	2.96 J
Copper	31.6	14.2	14.2	14.4	25.8	1.54
Iron	20000	11100	11600	12000	17900	4340
Lead	35.8	7.68 J	7.86 J	11.3 J	11.1 J	7.75
Magnesium	NC	23200 J	24600 J	31500 J	37300	17500 J
Strontium	NC	37.1	36.3	73.6	58.1	16.2
Zinc	121	53.4	34.2	49.5	48.9	22.6

Footnotes and definitions are summarized on the final page of the table.

TABLE 7-2

SUMMARY OF DETECTED CONCENTRATIONS IN SEDIMENT
NTC LAKEFRONT RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

LOCATION SAMPLE ID SAMPLE DATE DEPTH (ft bss)	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-LAK-024 NTC-SD-LAK-024-0006 05/20/2010 0 - 0.5	NTC-SD-LAK-025 NTC-SD-LAK-025-0006 05/20/2010 0 - 0.5	NTC-SD-LAK-026 NTC-SD-LAK-026-0006 05/20/2010 0 - 0.5	NTC-SD-LAK-027 NTC-SD-LAK-027-0006 05/20/2010 0 - 0.5	NTC-SD-LAK-028 NTC-SD-LAK-028-0006 05/20/2010 0 - 0.5
EXPLOSIVES (mg/kg)						
HMX	0.0047 [2]	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
RDX	0.013 [2]	0.13 J	0.1 U	0.1 U	0.2263 J	0.1 U
METALS (mg/kg)						
Arsenic	9.79	6.04 J	5.17 J	4.54 J	5.05 J	**10.9 J**
Copper	31.6	1.06	11.6	8.65	2.73	13.4
Iron	20000	6480	10500	9450	4770	14700
Lead	35.8	5.99	13.1	12.5	13	15.8
Magnesium	NC	5420 J	33200 J	29100 J	13200 J	31500 J
Strontium	NC	5.33	39.5	35.5	9.78	38.1
Zinc	121	19.1	45.4	39.7	20.2	53.7

LOCATION SAMPLE ID SAMPLE DATE DEPTH (ft bss)	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-LAK-029 NTC-SD-LAK-029-0006 05/20/2010 0 - 0.5	NTC-SD-LAK-030 NTC-SD-LAK-030-0006 05/20/2010 0 - 0.5	NTC-SD-UPG-001 NTC-SD-UPG-001-0006 05/19/2010 0 - 0.5	NTC-SD-UPG-002 NTC-SD-UPG-002-0006 05/19/2010 0 - 0.5	NTC-SD-UPG-003 NTC-SD-UPG-003-0006 05/19/2010 0 - 0.5
EXPLOSIVES (mg/kg)						
HMX	0.0047 [2]	0.1 U	0.1 U	NA	NA	NA
RDX	0.013 [2]	0.1 U	0.219 J	NA	NA	NA
METALS (mg/kg)						
Arsenic	9.79	4.34 J	5.74 J	2.67	3.14	3.17
Copper	31.6	2.62	3.22	3.52	4.53	4.05
Iron	20000	5150	6180	4100	4090	4560
Lead	35.8	11.4	7.99	16.8	16.3	8.98
Magnesium	NC	11900 J	8260 J	31500 J	34900	27800 J
Strontium	NC	9.94	7.95	24.6	27.3	27.7
Zinc	121	17	21.8	36.2	30.4	27.3

Footnotes and definitions are summarized on the final page of the table.

TABLE 7-2

SUMMARY OF DETECTED CONCENTRATIONS IN SEDIMENT
NTC LAKEFRONT RANGES
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

LOCATION	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-UPG-004	NTC-SD-UPG-005	NTC-SD-UPG-006	NTC-SD-UPG-007	NTC-SD-UPG-008
SAMPLE ID		NTC-SD-UPG-004-0006	NTC-SD-UPG-005-0006	NTC-SD-UPG-006-0006	NTC-SD-UPG-007-0006	NTC-SD-UPG-008-0006
SAMPLE DATE		05/20/2010	05/20/2010	05/20/2010	05/20/2010	05/20/2010
DEPTH (ft bss)		0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
EXPLOSIVES (mg/kg)						
HMX	0.0047 [2]	NA	NA	NA	NA	NA
RDX	0.013 [2]	NA	NA	NA	NA	NA
METALS (mg/kg)						
Arsenic	9.79	3.89	9.56	5.22	3.04	4.26
Copper	31.6	2.53	15.2	4.44	5.5	3.53
Iron	20000	3610	14900	5800	4620	4560
Lead	35.8	4.05	9.01	7.31	11.5	11.1
Magnesium	NC	9860 J	36300	22500 J	32000 J	14600 J
Strontium	NC	12.1	40.6	25	25.1	15.5
Zinc	121	15.7	34.8	26.1	27.9	24.3

LOCATION	Federal Ecological Screening Criteria (Region 5 SSLs) [1]	NTC-SD-UPG-009	NTC-SD-UPG-010
SAMPLE ID		NTC-SD-UPG-009-0006	NTC-SD-UPG-010-0006
SAMPLE DATE		05/20/2010	05/20/2010
DEPTH (ft bss)		0 - 0.5	0 - 0.5
EXPLOSIVES (mg/kg)			
HMX	0.0047 [2]	NA	NA
RDX	0.013 [2]	NA	NA
METALS (mg/kg)			
Arsenic	9.79	6.42	**10.7**
Copper	31.6	2.08	6.66
Iron	20000	5260	6630
Lead	35.8	5.05	27.3
Magnesium	NC	15100 J	12700 J
Strontium	NC	11.4	12.4
Zinc	121	14.2 J	44.9

Footnotes and definitions are summarized on the final page of the table.

Bold = exceedance of ecological screening criteria

bss = below sediment surface
ft = feet
J = Indicates that the chemical was detected; however, the associated numerical result is not a precise representation
NA = Not Analyzed
mg/kg = milligram per kilogram
R = Indicates that the chemical was detected; however, the results are rejected because of holding time exceedances.
U = Indicates that the chemical was not detected at the numerical detection limit noted.
µg/kg = microgram per kilogram

Source of Screening Level

1 - USEPA Guidance for Developing Ecological Soil Screening Level. Office of Solid Waste and Emergency and Response. OSWER Directive 92857-55. (February, 2005)
2 - Talmage, S . S., D . M . Opresko, C . J . Maxwell, C . J . E . Welsh, F . M . Cretella, P . H . Reno, and F . B . Daniel. 1999 . Nitroaromatic munition compounds: environmental effects and screening values . Review of Environmental Contamination and Toxicology 161:1-156.

Associated Samples:

NTC-SD-LAK-001-0006
NTC-SD-LAK-002-0006
NTC-SD-LAK-003-0006
NTC-SD-LAK-004-0006
NTC-SD-LAK-005-0006
NTC-SD-LAK-006-0006
NTC-SD-LAK-007-0006
NTC-SD-LAK-008-0006
NTC-SD-LAK-009-0006
NTC-SD-LAK-010-0006
NTC-SD-LAK-011-0006
NTC-SD-LAK-013-0006
NTC-SD-LAK-015-0006
NTC-SD-LAK-016-0006
NTC-SD-LAK-017-0006
NTC-SD-LAK-018-0006
NTC-SD-LAK-019-0006
NTC-SD-LAK-020-0006
NTC-SD-LAK-021-0006
NTC-SD-LAK-023-0006
NTC-SD-LAK-024-0006
NTC-SD-LAK-025-0006
NTC-SD-LAK-026-0006
NTC-SD-LAK-027-0006
NTC-SD-LAK-028-0006
NTC-SD-LAK-029-0006
NTC-SD-LAK-030-0006
NTC-SD-UPG-001-0006
NTC-SD-UPG-002-0006
NTC-SD-UPG-003-0006
NTC-SD-UPG-004-0006
NTC-SD-UPG-005-0006
NTC-SD-UPG-006-0006
NTC-SD-UPG-007-0006
NTC-SD-UPG-008-0006
NTC-SD-UPG-009-0006
NTC-SD-UPG-010-0006

TABLE 7-3

CONCEPTUAL SITE MODEL INFORMATION PROFILE
NTC LAKEFRONT
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Profile Type	Information Needs	Findings
Range/Site Profile	Installation Name	Naval Station Great Lakes (NSGL)
	Installation Location	Great Lakes, Lake County, Illinois
	Range/Site Name	Naval Training Center (NTC) Lakefront
	Range/Site Location	The site is located on the eastern side of NSGL. The site is a lakefront location along the western shore of Lake Michigan, east of the bluff.
	Range/Site History	Used for anti-aircraft (AA) training from 1943 to 1945; used for fuel oil storage for an unknown period of time.
	Range/Site Area and Layout	The site encompasses 3,728 acres. The land portion of the site where the anti-aircraft guns were located is approximately 3.3 acres. The area where fired munitions would have landed consists of 3,725 acres and extends into Lake Michigan.
	Range/Site Structures	The former range consisted of five buildings that served as classroom, storage, and training facilities. Gun mounts were also located here. None of the former range structures remain at the site. Currently, fuel oil storage tanks are located at the site.
	Range/Site Boundaries	See Figures 1-2 and 7-1 N: RV Park (Former TSA Ranges) S: Harbor E: Lake Michigan W: Bluff
	Range/Site Security	The range is located within the installation, which is patrolled by base security; however, there are no access controls specific to the site itself or to the water portion of the site in Lake Michigan. The land portion of the site is located along a roadway with minimal security controls.
Munitions/ Release Profile	Munitions Types	20mm HE, HEI, HET and HET-DI 40mm BL&T, HET-SD and HEIT-SD 1.1-inch AA artillery Dark ignition tracers
	Maximum Probability Penetration Depth	Munitions would not have impacted land portion where the guns were located. The initial penetration depth of fired rounds into sediments would have been limited to the upper 1 foot of sediment. Passage of rounds through the water column would have reduced the velocity of the rounds.
	MEC Density	The presence of MEC is not suspected in the land portion of the site, no evidence of MEC was found during the construction of the tank farm on the site (*i.e.*, no incidents were documented in records). MEC was not identified in lake sediments during the SI activities. However, further action will be necessary to

TABLE 7-3

CONCEPTUAL SITE MODEL INFORMATION PROFILE
NTC LAKEFRONT
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

		ascertain whether anomalies identified during the underwater geophysical survey are MEC/MPPEH.
	Munitions Debris	The presence of munitions debris is not suspected on the land portion of the range. No evidence of munitions debris was documented during the construction of the tank farm. Munitions debris was not identified during the SI. However, further action will be necessary to ascertain whether anomalies identified during the underwater geophysical survey are MEC/MPPEH and/or munitions debris.
	Associated MC	Potential MC for AA munitions include RDX, HMX, TNT, zirconium, lead, antimony, arsenic, copper, tin, zinc, iron, strontium, magnesium, and lead. The only metal that was detected above screening levels in the lake sediment samples was arsenic; however, the concentrations were within background levels. The only explosive constituents, which were detected, were HMX and RDX. However, the low concentrations of these compounds are suspect due to the laboratory method used. All explosive concentrations were below ecological screening levels.
	Migration Routes/Release Mechanisms	Migration mechanisms for both MC and MEC potentially in sediment of Lake Michigan include wave action and lake turnover.
Physical Profile (see Section 2)	Climate	The lakefront is strongly influenced by its proximity to Lake Michigan and by southerly Gulf Stream winds. Average temperatures range from 20.3 °F in January to 71.5 °F in July. The average annual precipitation is 34.1 inches, and the mean seasonal snowfall is 37.9 inches.
	Topography	Bluffs and ravines surround the range.
	Geology	Poorly sorted, unstratified sediments of the Wadsworth formation underlain by Silurian dolomite bedrock.
	Soil	Soil borings collected within NSGL consisted of silt, clay, and sand.
	Hydrogeology	The hydrogeologic framework of the NSGL area consists of an overburden aquifer, with depth to groundwater averaging 2 to 5 feet bgs. Groundwater flow direction is generally to the east toward Lake Michigan. Groundwater is not used as a drinking water source for the installation. Any MC in groundwater discharging into the lake is expected to be very diluted and not to be a concern to the potable water use of the lake.
	Hydrology	There are no surface water bodies on the land portion

TABLE 7-3

CONCEPTUAL SITE MODEL INFORMATION PROFILE
NTC LAKEFRONT
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

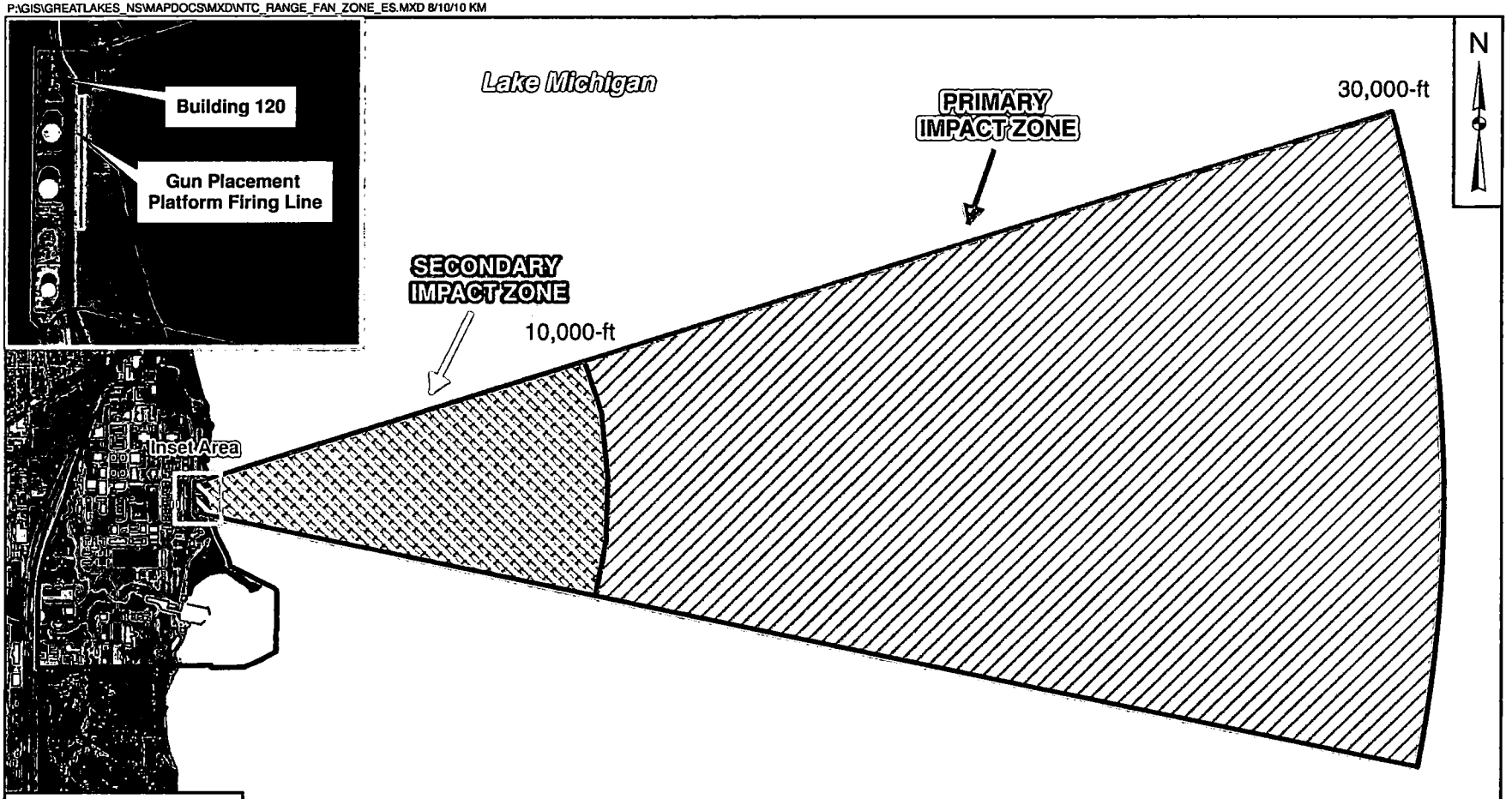
		of Lakefront site. However, the SDZs for the AA range extend into Lake Michigan.
	Vegetation	Predominantly grasses with some woodland species.
Land Use and Exposure Profile	Current Land Use	The land portion of the site is used as a fuel oil tank farm. The water portion of the site is used for transportation, recreation, and as a potable water source.
	Current Human Receptors	Authorized Navy personnel, Navy-escorted contractors and visitors, unauthorized trespassers (land portion of the site), and recreationists and commercial fishermen (water portion of the site).
	Current Activities	Grounds maintenance occurs regularly at the site. Possible additional activities include surveys (e.g., environmental, ecological, cultural) and maintenance of fuel oil storage tanks. The water portion of the site is used regularly for transportation, commercial fishing, and recreation (e.g., diving, swimming, or fishing). Dredging has occurred in Lake Michigan in the past (USACE, 2001).
	Potential Future Land Use	Continued use as storage tank location until tanks are removed, as some tanks have been. There are no plans for use external to the Navy.
	Potential Future Human Receptors	Authorized Navy personnel, Navy-escorted contractors and visitors, unauthorized trespassers (land portion of the site), and recreationists and commercial fishermen (water portion of the site).
	Potential Future Land Use Related Activities	It is expected that construction and maintenance activities will occur on the land portion of the site as storage tanks are placed or removed from the area, and environmental or other types of intrusive investigations may occur at the site. Grounds maintenance will also continue to occur. Use of the water portion of the site is expected to remain the same as current use: for transportation, commercial fishing, and recreation. It is unknown if additional dredging activities are planned.
	Zoning/Land Use Restrictions	A formal land use restriction prohibiting the installation of groundwater wells (with the exception of environmental monitoring wells) and the consumption of groundwater at NSGL was issued in September 2002. Water use restrictions are likely in place for Lake Michigan to protect the potable water supply source.
	Demographics/Zoning	Lake County population density is approximately 1,300 persons per square mile, while NSGL employs approximately 25,000 military and civilian personnel.
	Beneficial Resources	The bluff on the land portion of the site has been identified as a sensitive habitat. Lake Michigan is a

TABLE 7-3

CONCEPTUAL SITE MODEL INFORMATION PROFILE
NTC LAKEFRONT
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

		major fishery with over 22,000 square miles of both commercial and recreational fishing adjacent to NSGL. Lake Michigan is also a municipal potable water source and a recreational resource.
Ecological Profile	Habitat Type	The land portion of the range is fully developed and is not a viable ecological habitat. The beach is transient in nature. Lake Michigan provides aquatic habitat.
	Degree of Disturbance	The land area has been highly disturbed. The land portion of the site is used for the storage of fuel oil, and a roadway runs through the site. Grounds maintenance and maintenance of the tank farm regularly occur at the site. Disturbance of sediments in Lake Michigan is low.
	Ecological Receptors and Species of Special Concern	Grassland and forest species (e.g., vegetation, birds, small mammals, reptiles/amphibians) are expected to utilize the available habitat on the land portion of the site. Aquatic flora and fauna are expected to be present in the water portion of the site (i.e., Lake Michigan). Avian species are expected to be present in the land and water portions of the site.
General Exposure Profile	Relationship of MEC/MC Sources to Habitat and Potential Receptors	The MEC pathway is potentially complete for human and ecological receptors because it is unclear if the magnetic anomalies located during the MEC Investigation are MEC, MPPEH, or cultural debris. The MC Pathway for sediment is incomplete for arsenic because concentrations are below background concentrations and are potentially complete for ecological receptors due to uncertainty regarding explosive constituent (HMX and RDX) concentrations.

P:\GIS\GREATLAKES_NS\MAPDOCS\MXD\NTC_RANGE_FAN_ZONE_ES.MXD 8/10/10 KM



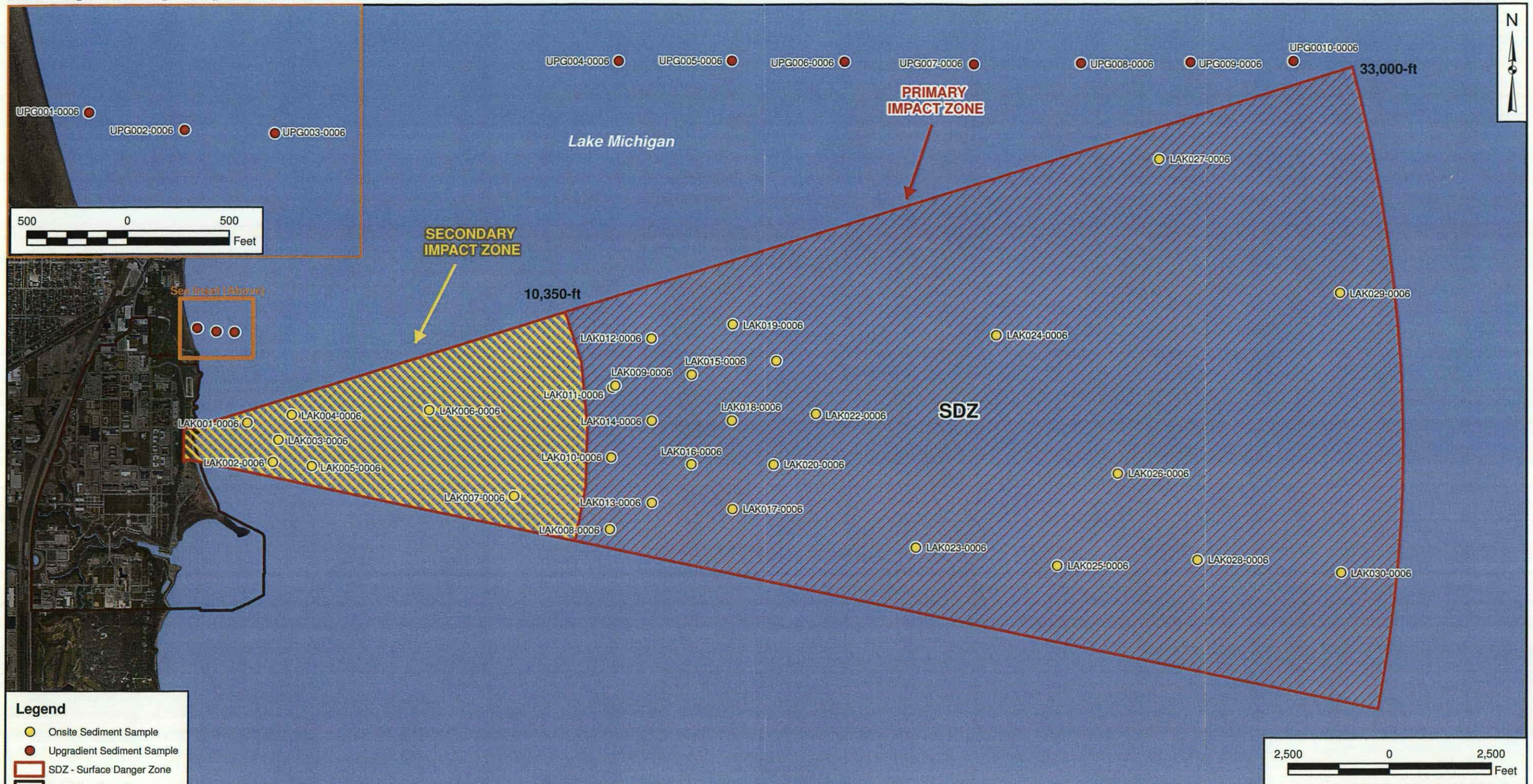
Legend

Installation Boundary

4,000 0 4,000 Feet

DRAWN BY T. WHEATON DATE 10/23/09	NTC LAKEFRONT SURFACE DANGER ZONE (SDZ) NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NUMBER F274
CHECKED BY J. DUCAR DATE 8/10/10		APPROVED BY — DATE —
COST/SCHEDULE AREA		APPROVED BY — DATE —
SCALE AS NOTED	NAVFAC	FIGURE NO. FIGURE 7-1 REV 0

P:\GIS\GREATLAKES_NS\MAPDOCS\MXD\NTC_UPGRADIENT_SAMPLES.MXD 09/30/10 TW



Legend

- Onsite Sediment Sample
- Upgradient Sediment Sample
- SDZ - Surface Danger Zone
- Installation Boundary

Notes:
1.) Investigation boundary is limited by the depth of Lake Michigan and did not extend beyond the point where water depth is 120 ft deep. Water Depth was determined by bathymetry survey.
2.) Actual sediment locations were determined based on anomaly distribution in the SDZ.

DRAWN BY	DATE
K. MOORE	03/24/10
CHECKED BY	DATE
E. LOVE	09/30/10
REVISED BY	DATE
T. WHEATON	09/30/10
SCALE	
AS NOTED	

NAVFAC

NTC LAKEFRONT ONSITE AND
UPGRADIENT SEDIMENT SAMPLE LOCATIONS
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER	
F274	
APPROVED BY	DATE
___	___
APPROVED BY	DATE
___	___
FIGURE NO.	REV
FIGURE 7-2	0

P:\GIS\GREATLAKES_NS\MAPDOCS\MXD\NTC_METALS.MXD 09/30/10 TW

Notes:
1.) Investigation boundary is limited by the depth of Lake Michigan and did not extend beyond the point where water depth is 120 ft deep. Water depth was determined by bathymetry survey.
2.) Actual sediment locations were determined based on anomaly distribution in the SDZ.
3.) Samples LAK012-0006, LAK014-0006, and LAK027-0006 could not be collected due to rocky bottom.

Red indicates exceedances of the Ecological Criteria
J - estimated values

Lake Michigan

PRIMARY IMPACT ZONE

SECONDARY IMPACT ZONE

33,000-ft

10,350-ft

UPG004-0006
UPG005-0006
UPG006-0006
UPG007-0006
UPG008-0006
UPG009-0006

NTC-SD-UPG-010
Inorganics (mg/kg)
ARSENIC 10.7

NTC-SD-LAK-027
Explosives (mg/kg)
RDX 0.2263 J

NTC-SD-LAK-019
Explosives (mg/kg)
HMX 0.147 J

NTC-SD-LAK-015
Explosives (mg/kg)
RDX 0.326 J
Inorganics (mg/kg)
ARSENIC 10.5

NTC-SD-LAK-009
Explosives (mg/kg)
RDX 0.255 J
Inorganics (mg/kg)
ARSENIC 13.4 J

NTC-SD-LAK-024
Explosives (mg/kg)
RDX 0.13 J

NTC-SD-LAK-018
Explosives (mg/kg)
HMX 0.152 J
RDX 0.137 J

NTC-SD-LAK-001
Explosives (mg/kg)
HMX 0.128 J

NTC-SD-LAK-020
Explosives (mg/kg)
HMX 0.118 J
RDX 0.427 J
Inorganics (mg/kg)
ARSENIC 14.3

NTC-SD-LAK-005
Explosives (mg/kg)
RDX 0.143 J

NTC-SD-LAK-028
Inorganics (mg/kg)
ARSENIC 10.9 J

NTC-SD-LAK-007
Explosives (mg/kg)
RDX 0.132 J

NTC-SD-LAK-016
Explosives (mg/kg)
RDX 0.284 J
Inorganics (mg/kg)
ARSENIC 11.3

NTC-SD-LAK-030
Explosives (mg/kg)
RDX 0.219 J

NTC-SD-LAK-008
Explosives (mg/kg)
RDX 0.152 J

LAK029-0006
LAK012-0006
LAK021-0006
LAK011-0006
LAK004-0006
LAK006-0006
LAK014-0006
LAK022-0006
LAK003-0006
LAK010-0006
LAK026-0006
LAK002-0006
LAK013-0006
LAK017-0006
LAK023-0006
LAK025-0006

N

2,500 0 2,500 Feet

Legend

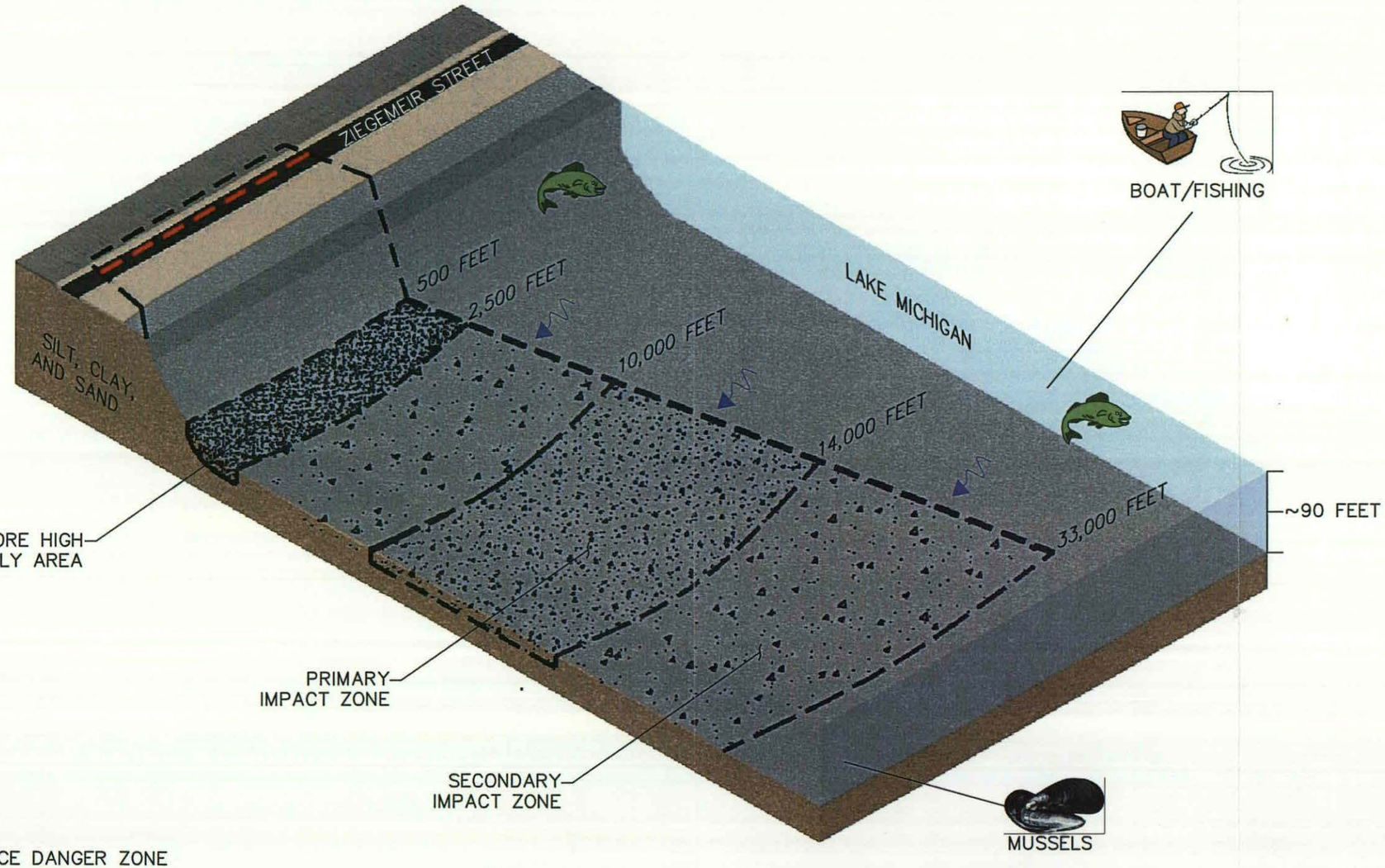
- Sediment Sample with Exceedance of Ecological Screening Criteria
- No Sample Collected - Refusal
- Sediment Sample without Exceedance of Ecological Screening Criteria
- SDZ - Surface Danger Zone
- Installation Boundary

DRAWN BY	DATE
K. MOORE	07/29/10
CHECKED BY	DATE
E. LOVE	09/30/10
REVISED BY	DATE
T. WHEATON	09/30/10
SCALE	
AS NOTED	

NAVFAC

SELECT METALS AND EXPLOSIVES EXCEEDANCES
IN SEDIMENT ONSITE AND UPGRADIENT
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER	
F274	
APPROVED BY	DATE
___	___
APPROVED BY	DATE
___	___
FIGURE NO. FIGURE 7-3	REV 0



LEGEND

- SDZ– SURFACE DANGER ZONE
- FORMER FIRING LINE
- MAGNETIC ANOMALIES
- APPARENT SEDIMENT TRANSPORT DIRECTION
- AQUATIC BIOTA

DRAWN BY ND DATE 7-26-10	NAVFAC	CONCEPTUAL SITE MODEL NTC LAKEFRONT SURFACE DANGER ZONE NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NO. CTO F274
CHECKED BY DATE			OWNER NO.
REVISED BY DATE			APPROVED BY DATE
SCALE NOT TO SCALE			DRAWING NO. FIGURE 7-4 / REV. 0

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FIGURE 7-5

MEC/MPPEH EXPOSURE PATHWAY ANALYSIS
NTC LAKEFRONT RANGE
NS GREAT LAKES, GREAT LAKES, ILLINOIS

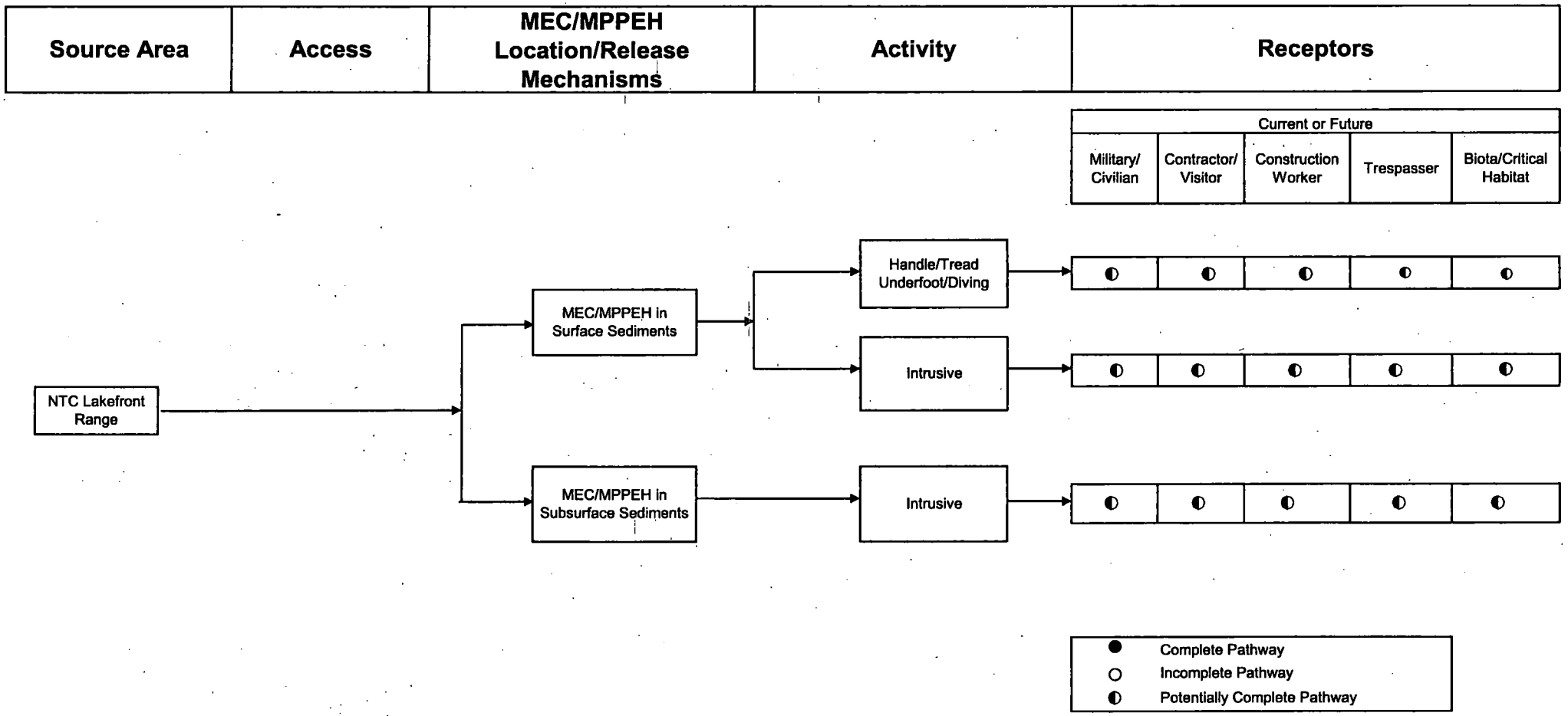
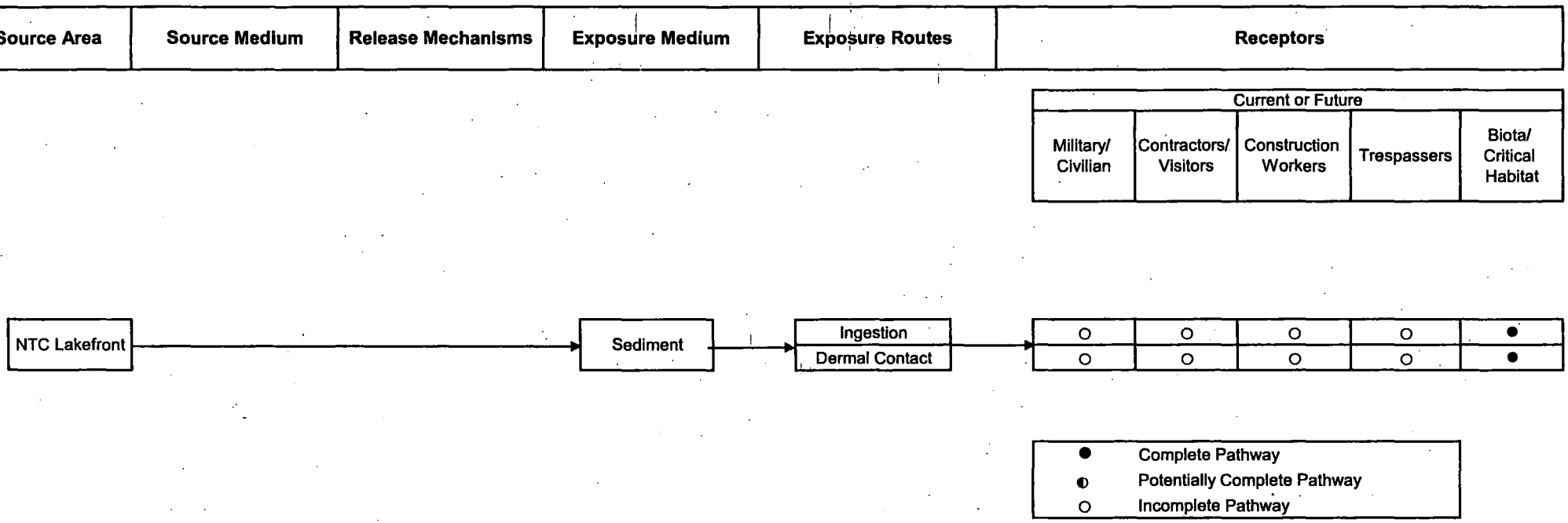


FIGURE 7-6

MC EXPOSURE PATHWAY ANALYSIS
NTC LAKEFRONT RANGE
NS GREAT LAKES, GREAT LAKES, ILLINOIS



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