REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
28-08-2014	Final	April 2011 - December 2012

4. TITLE AND SUBTITLE
Remedial Investigation Report for RVAAP-008-R-01 Load Line #1A MRS, Version 2.0

5a. CONTRACT NUMBER W912DR-09-D-0005

5b. GRANT NUMBER N/A

5c. PROGRAM ELEMENT NUMBER N/A

6. AUTHOR(S)
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5d. PROJECT NUMBER 136147

5e. TASK NUMBER 0700130

5f. WORK UNIT NUMBER N/A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
CB&I Federal Services LLC
150 Royall Street
Canton, MA 02021

8. PERFORMING ORGANIZATION REPORT NUMBER
N/A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Corps of Engineers
North Atlantic Baltimore District
10 S. Howard Street, Room 7000
Baltimore, MD 21201

10. SPONSOR/MONITOR'S ACRONYM(S)
NAB

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
N/A

12. DISTRIBUTION/AVAILABILITY STATEMENT
Reference distribution page.

13. SUPPLEMENTARY NOTES
The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless designated by other documentation.

14. ABSTRACT
This Remedial Investigation (RI) Report presents the findings and conclusions of the RI field activities conducted at RVAAP-008-R-01 Load Line #1A Munitions Response Site (MRS) at the former Ravenna Army Ammunition Plant under the Military Munitions Response Program. The purpose of the RI is to determine whether the Load Line #1A MRS warrants further response action pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and the National Oil and Hazardous Substances Pollution Contingency Plan. More specifically, the RI is intended to determine the nature and extent of munitions and explosives of concern (MEC) and munitions constituents (MC) and subsequently determine the hazards and risks posed to likely human and environmental receptors by MEC and MC. This RI Report also presents additional data to support the identification and evaluation of alternatives in the Feasibility Study (FS), if required. This RI Report was prepared in accordance with the U.S. Army's Final Munitions Response RI/FS guidance dated November 2009.

15. SUBJECT TERMS
Load Line #1, Load Line #1A MRS, Remedial Investigation, Military Munitions Response Program

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			David Crispo
Unclassified	Unclassified	Unclassified	UU	360	19b. TELEPHONE NUMBER *(Include area code)* 781.821.3513

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Prescribed by ANSI Std. Z39.18
Adobe Professional 7.0

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CB&I Federal Services LLC has completed the *Final Remedial Investigation Report for RVAAP-008-R-01 Load Line #1A MRS, Version 2.0,* at the former Ravenna Army Ammunition Plant in Portage and Trumbull Counties, Ravenna, Ohio. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy, principles and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets customer's needs consistent with law and existing United States Army Corps of Engineers policy.

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Final Remedial Investigation Report for
RVAAP-008-R-01 Load Line #1A MRS
Version 2.0

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

Contract No. W912DR-09-D-0005
Delivery Order 0002

Prepared for:

US Army Corps
of Engineers®

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August 28, 2014

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CB&I—CB&I Federal Services LLC
Ohio EPA—Ohio Environmental Protection Agency
RVAAP—Ravenna Army Ammunition Plant
USACE—U.S. Army Corps of Engineers

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Acronyms and Abbreviations

AEDB-R	Army Environmental Data Base Restoration Module
AOC	area of concern
AMEC	AMEC Earth and Environmental, Inc.
amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
ARNG	Army National Guard
ASR	*Final Archives Search Report*
ASTM	American Society of Testing and Materials
BERA	baseline ecological risk assessment
bgs	below ground surface
BSV	background screening value
Camp Ravenna	Camp Ravenna Joint Military Training Center
CB&I	CB&I Federal Services LLC
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	Code of Federal Regulations
COC	chemical of concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CSM	conceptual site model
DERP	Defense Environmental Restoration Program
DoD	U.S. Department of Defense
DQO	data quality objective
e^2M	engineering-environmental Management, Inc.
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
ESA	Endangered Species Act
ESV	ecological screening value
EU	exposure unit
FS	feasibility study
FWCUG	Facility-Wide Cleanup Goal
FWSAP	*Facility-Wide Sampling and Analysis Plan for Environmental Investigations at the RVAAP*
HA	hazard assessment
HHRA	human health risk assessment
HHRAM	*RVAAP Facility-Wide Human Health Risk Assessor Manual*
HQ	hazard quotient
HRR	*Final Historical Records Review*
IDW	investigation derived waste
INRMP	*Integrated Natural Resources Management Plan*
IRP	Installation Restoration Program

Acronyms and Abbreviations (continued)

ISM	incremental sampling methodology
LCS	laboratory control sample
LOD	limit of detection
Pb	lead
MC	munitions constituents
MD	munitions debris
MDL	method detection limit
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
MMRP	Military Munitions Response Program
MPPEH	material potentially presenting an explosive hazard
MRL	method reporting limit
MRS	Munitions Response Site
MRSPP	Munitions Response Site Prioritization Protocol
MS/MSD	matrix spike/matrix spike duplicate sample
NA	not applicable/not available
NCP	*National Oil and Hazardous Substances Pollution Contingency Plan*
NGT	National Guard Trainee
NIST	NIST Chemistry WebBook
NOAEL	no observed adverse effect level
ODNR	Ohio Department of Natural Resources
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
PBT	persistent, bioaccumulative, and toxic
QA	quality assurance
QC	quality control
R(A)	Resident Receptor (Adult)
R(C)	Resident Receptor (Child)
RCRA	*Resource Conservation and Recovery Act*
RI	remedial investigation
RME	reasonable maximum exposure
RPD	relative percent difference
RSL	regional screening level
RVAAP	former Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
Shaw	Shaw Environmental & Infrastructure, Inc.
SI	site inspection
SLERA	screening-level ecological risk assessment
SMDP	scientific management decision point
SOP	standard operating procedure
SRC	site-related chemical

Acronyms and Abbreviations (continued)

TBC	to be considered
TNT	2,4,6-trinitrotoluene
TOC	total organic carbon
TRV	toxicity reference value
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USFWS	U.S. Fish and Wildlife Service
USP&FO	U.S. Property and Fiscal Officer
UXO	unexploded ordnance
VQ	validation qualifier

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EXECUTIVE SUMMARY

This Remedial Investigation (RI) Report documents the findings and conclusions of the RI field activities for the Load Line #1A (RVAAP-008-R-01) Munitions Response Site (MRS) located at the former Ravenna Army Ammunition Plant (RVAAP) in Portage and Trumbull Counties, Ohio. This RI Report was prepared by CB&I Federal Services LLC under Delivery Order 0002 for Military Munitions Response Program (MMRP) environmental services at the facility under the *Multiple Award Military Munitions Services Performance-Based Acquisition Contract* No. W912DR-09-D-0005. The Delivery Order was issued by the United States (U.S.) Army Corps of Engineers (USACE), Baltimore District on May 27, 2009.

The purpose of the RI was to determine whether the Load Line #1A MRS warranted further response action pursuant to the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) of 1980 and the *National Oil and Hazardous Substances Pollution Contingency Plan*. More specifically, the RI was intended to determine the nature and extent of munitions and explosives of concern (MEC) and munitions constituents (MC) and to subsequently determine the potential hazards and risks posed to human health and the environment by MEC and MC.

ES.1 MRS Description

Whenever possible, existing information and data were incorporated into this RI Report. Background information related to the MRS was taken from the *Final Archival Search Report* (USACE, 2004); the *Final Military Munitions Response Program Historical Records Review* (engineering-environmental Management, Inc. [e^2M], 2007) hereafter referred to as the HRR; and the *Final Site Inspection Report* (e^2M, 2008), hereafter referred to as the SI Report. Data collected during previous sampling events at the MRS were also reviewed for applicability for evaluation in the RI. Historical records indicate no samples were collected within the current MRS boundary during past Installation Restoration Program (IRP) sampling events; therefore, evaluation and inclusion of IRP data was not applicable. The surface soil samples collected during the site inspection (SI) field activities were not included for evaluation in the RI since the RI data is considered to be representative of current conditions at the MRS in comparison to samples collected in 2007. The Load Line #1A MRS is a 0.41-acre area and is collocated with the 164-acre IRP Area of Concern Load Line #1 Army Environmental Data Base Restoration Module No. RVAAP-08. The MRS is located at the north end of the Load Line #1.

Prior to the HRR (e^2M, 2007), the MRS was considered as the entire 164-acre Load Line #1. It was determined in the HRR that the potential presence of MEC and/or MC was restricted to the areas associated with former buildings CB-13/CB-13B, the area near the former elevated building foundation slab at CB-14, the former popping furnace, and areas where triple-base propellant have historically been found. It was recommended in the HRR that the MRS be reduced from 164 acres to 4.63 acres at the northern end of Load Line #1 where the propellants were identified.

The principle sources of MEC at the Load Line #1A MRS were reported to be accidental releases during the loading of munitions during World War II and the Korean War. These activities resulted in the potential for MEC and munitions debris (MD), including propellants, to be present in surface soil at the Load Line #1A MRS (e^2M, 2008).

Three pieces of triple-base propellant were found on the ground surface during the SI survey. Lead was detected in surface soil collected using the incremental sampling methodology (ISM) and was considered an MC associated with propellants. Low concentrations of explosives consisting of 2,4,6-trinitrotoluene and nitrobenzene were also detected, but these explosives were not considered to be MC associated with propellants and were not present at concentrations that could result in an explosion. Based on the recommendations in the SI Report (e^2M, 2008), the MRS was reduced to a 0.41-acre area located near the northwest side of the former elevated building CB-14 where the SI field activities identified triple-base propellants on the ground surface and elevated lead concentrations in soil (e^2M, 2008).

Current activities at the Load Line #1A MRS include maintenance, remediation, and natural resource management activities. The Ohio Army National Guard (OHARNG) future land use at the MRS is military training.

ES.2 Summary of Remedial Investigation Activities

The preliminary MEC and MC conceptual site models (CSMs) were developed during the SI (e^2M, 2008) phase of the CERCLA process and were used to identify the data needs and the data quality objectives (DQOs) as outlined in the *Final Work Plan for Military Munitions Response Program Remedial Investigation Environmental Services* (Shaw Environmental & Infrastructure, Inc. [Shaw], 2011), hereafter referred to as the Work Plan. The data needs DQOs were determined at the planning stage and included characterization for MEC and/or MC associated with the former activities at the MRS. The DQOs were developed to ensure the reliability of field sampling, chemical analyses, and physical analyses; the collection of sufficient data; the acceptable quality of data generated for its intended use; and the inference of valid assumptions from the data. The DQOs for the Load Line #1A MRS identified the following decision rules that were implemented in evaluating the MRS:

- Perform a visual survey investigation to identify if a MEC source (triple-base propellant) was present on the ground surface.

- Collect ISM samples at two sampling units over the entire MRS to evaluate for MC.
- Collect additional discrete samples (surface and subsurface) in areas with concentrated MEC/MD, if any are identified during the field work, in order to evaluate for MC.
- Process the information to evaluate whether there were unacceptable risks to human health and the environment associated with MEC and/or MC and make a determination if further investigation is required under the CERCLA process.

Separate full coverage instrument-assisted nonintrusive visual surveys were conducted in April and May 2011, respectively, to identify potential surface MEC and/or MD at the Load Line #1A MRS. No MEC or MD was found on the ground or shallow surface soils during either survey.

Environmental samples for MC were collected at the Load Line #1A MRS following completion of the visual surveys. Two ISM surface soil samples, each comprising one half of the MRS acreage (0.2 acres), were collected at depths between 0 and 0.5 feet. Together, the two ISM sampling units represent 100 percent coverage of the MRS that is the decision unit and is considered the exposure unit area where human and ecological receptors potentially are exposed to the site-related chemicals (SRCs).

The DQOs stated that discrete samples (surface and subsurface soil) would be collected in areas with concentrated MEC or MD. Since no MEC or MD was identified at the Load Line #1A MRS during the RI field activities, additional sampling for MC was not performed.

ES.3 MEC Hazard Assessment

The *Interim Munitions and Explosives of Concern Hazard Assessment (MEC HA) Methodology* (U.S. Environmental Protection Agency [EPA], 2008) addresses human health and safety concerns associated with potential exposure to MEC at a MRS under a variety of site conditions, including various cleanup scenarios and land use assumptions. If an explosive hazard is identified for this RI, the MEC hazard assessment (HA) evaluation will include the information available for the MRS up to and including the RI field activities and provide a scoring summary for the current and future land use activities. If no explosive hazard is found at the MRS, then there is no need to calculate a MEC HA score since there are no human health safety concerns. No MEC or MD items were identified at the MRS during RI field activities, which indicates that no MEC source or explosive safety hazard is present at the MRS. Therefore, calculation of a MEC HA score was not warranted for the Load Line #1A MRS.

ES.4 MC Risk Assessment Summary

SRCs for the Load Line #1A MRS were determined for the surface soil samples collected during the RI field activities through the facility data screening process as presented in the *Final Facility-Wide Human Health Cleanup Goals for the RVAAP* (Science Applications International Corporation [SAIC], 2010). The SRCs identified in the environmental media samples collected during the RI were lead and nitroguanidine. The identified SRCs were then carried through the human health and ecological risk assessments process to evaluate for potential receptors. The risk assessments resulted in the following conclusions.

Human Health Risk Assessment

A human health risk assessment (HHRA) was conducted for surface soil samples collected at the Load Line #1A MRS to determine if the identified SRCs were chemicals of potential concern (COPCs) and/or chemicals of concern (COCs) that may pose a risk to future human receptors. The future land use for the Load Line #1A MRS is military training, and the Representative Receptor is the National Guard Trainee. The Representative Receptor for military training, in conjunction with the evaluation of the Resident Receptor (Adult and Child) for Unrestricted Land Use, was the basis for identifying COCs in the RI. Evaluation for Unrestricted (Residential) Land Use is performed to assess baseline conditions and the no action alternative under CERCLA, and as outlined in the *RVAAP Facility-Wide Human Health Risk Assessor Manual* (HHRAM) (USACE, 2005). Since the RI was initiated before the finalization of the U.S. Army's *Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the Ravenna Army Ammunition Plant Installation Restoration Program* (Army National Guard, 2014), the Commercial Industrial Land Use using the Industrial Receptor was not included.

The facility has defined exposure scenarios for the identified receptors (USACE, 2005). Surface soil for the Resident Receptor (Adult and Child) is defined as 0 to 1 foot below ground surface (bgs). Because the National Guard Trainee is exposed more often to the upper 4 feet of soil during training activities, surface soil is defined as 0 to 4 feet bgs for this receptor. Sampling for MC under the MMRP is selective in general to evaluate identified munitions-related source areas and the potential that MC may have been released from the source areas. The data used in the HHRA are used to evaluate for the receptors at the depths that the samples were collected; however, the data are not intended to evaluate for predefined exposure depth scenarios, as is typically performed under the IRP. The presence of munitions-related source areas at an MRS is the primary driver for determining future actions under the MMRP; however, the HHRA is valuable in identifying potential releases of MC from the source areas and if the MC poses risks to likely human receptors.

The media of concern that was evaluated in the HHRA consists solely of surface soil that was biased by collecting samples across the entire MRS at a sample depth of 0 to 0.5 feet bgs. The 0.5-foot sample depth across the MRS is the focus of this HHRA since it is the maximum depth that MC associated with the propellants would be expected to vertically migrate in the soil column and is the deepest that MC has been detected at the MRS during the SI field activities (e^2M, 2008). This sampling methodology is consistent with the sample depth intervals recommended in the *Military Munitions Response Program Munitions Response Remedial Investigation/Feasibility Study Guidance* (U.S. Army, 2009). Therefore, for the RI, surface soil for the Resident Receptor (Adult and Child) and the National Guard Trainee is evaluated as 0 to 0.5 feet bgs, the depth at which the ISM surface soil samples were collected.

The two SRCs that consisted of lead or nitroguanidine were not identified as COPCs in the first screening step. Therefore, these SRCs were not further evaluated as COCs and are not likely to pose risks to human receptors. Since no COCs were identified for the Resident Receptor (Adult and Child), Unrestricted Land Use was achieved for MC.

Ecological Risk Assessment

Both of the SRCs, lead and nitroguanidine, were identified as chemicals of potential ecological concern (COPECs) in the soil samples collected at 0 to 0.5 feet for the RI at the Load Line #1A MRS. COPECs are determined in the ecological risk assessment and may differ from COPCs. Given the conservativeness of the ecological risk assessment and the low overall concentrations detected, the potential that exposure to the COPECs identified to adversely impact populations of ecological receptors at the Load Line #1A MRS is considered to be very low and not pose a concern to ecological receptors. Therefore, no further investigation or action is considered necessary at the Load Line #1A MRS for ecological purposes.

ES.5 Conceptual Site Model

The information collected during the RI field activities was used to update the MEC and MC CSMs for the Load Line #1A MRS as presented in the SI Report (e^2M, 2008). The purpose of the CSMs is to identify all complete, potentially complete, or incomplete source-receptor interactions for future land use activities at the MRS. An exposure pathway is the course a MEC item or MC takes from a source to a receptor. Each pathway includes a source, activity, access, and receptor.

Taking into consideration the historical activities that occurred at the MRS, it is expected that triple-base propellants that may be present at the MRS would be found primarily on the ground surface. Two nonintrusive visual surveys were performed over 100 percent of the

Load Line #1A MRS during the RI field activities. No MEC or MD items were observed on the ground surface of the MRS during the visual survey; therefore, the MEC exposure pathway for surface soil is considered incomplete for all receptors.

Since a MEC source was not found on the ground surface, a subsurface investigation was not warranted. Given the lack of a MEC source, the MEC exposure pathway for subsurface soil is considered incomplete for all receptors.

Sampling was performed at the Load Line #1A MRS to further characterize the nature and extent of contamination associated with previous activities at the MRS. The SRCs detected at the MRS consisted of the lead and nitroguanidine in surface soil. Although a MEC source was not found, the identified SRCs may have resulted from degradation due to exposure to the elements of the propellants previously encountered at the MRS. None of the SRC concentrations were determined to pose risks to human health or the environment. The MC CSM has been updated to reflect a lack of source and incomplete pathways for all the receptors at the MRS.

ES.6 Conclusions and Recommendations

The RI was prepared in accordance with the project DQOs and included evaluations for explosives hazards and potential sources of MC that may pose threats to likely receptors. The following statements can be made for the Load Line #1A MRS based on the results of the RI field activities:

- Instrument-assisted nonintrusive visual survey coverage was performed over the entire Load Line #1A MRS during the RI and no subsurface anomalies were detected.
- No physical evidence of MEC or MD was found on the ground surface during the RI and no explosive hazard is anticipated to be present at the MRS.
- Although no MEC source was found during the RI, ISM surface soil samples were analyzed for MC and represent 100 percent coverage of the MRS.
- Detected concentrations of SRCs in surface soil (0 to 0.5 feet) do not pose potential risks to human or ecological receptors; therefore, no further action is required for MC at this MRS.

Based on these conclusions, it is determined that the Load Line #1A MRS has been adequately characterized and that the DQOs presented in the Work Plan (Shaw, 2011) have been satisfied. Therefore, No Further Action is recommended for the Load Line #1A MRS under the MMRP, and the next course of action will be to proceed to a No Further Action Proposed Plan.

1.0 INTRODUCTION

This Remedial Investigation (RI) Report documents the findings and conclusions of the RI field activities for the Load Line #1A (RVAAP-008-R-01) Munitions Response Site (MRS) located at the former Ravenna Army Ammunition Plant (RVAAP) in Portage and Trumbull Counties, Ohio. This RI Report was prepared by CB&I Federal Services LLC (CB&I) under Delivery Order 0002 for Military Munitions Response Program (MMRP) environmental services at the facility under the *Multiple Award Military Munitions Services Performance-Based Acquisition* Contract No. W912DR-09-D-0005. The Delivery Order was issued by the United States (U.S.) Army Corps of Engineers (USACE), Baltimore District on May 27, 2009.

This RI Report presents the results of the RI field activities that were conducted at the Load Line #1A MRS between April and May 2011. This report was developed in accordance with the *Final Work Plan Addendum for Military Munitions Response Program Remedial Investigation Environmental Services* (Shaw Environmental & Infrastructure, Inc. [Shaw], 2011) at the facility, hereafter referred to as the Work Plan, and the *Military Munitions Response Program Munitions Response Remedial Investigation/Feasibility Study Guidance* (U.S. Army, 2009).

1.1 Purpose

Environmental cleanup decision-making under the MMRP follows the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) of 1980 prescribed sequence of RI, Feasibility Study (FS), Proposed Plan, and Record of Decision. The RI serves as the mechanism for collecting data to characterize MRS conditions, determining the nature and extent of the contamination, and assessing potential risks to human health and the environment from this contamination. While not all munitions and explosives of concern (MEC) or munitions constituents (MC) under the MMRP constitute CERCLA hazardous substances, pollutants or contaminants, the Defense Environmental Restoration Program (DERP) statute provides the U.S. Department of Defense (DoD) the authority to respond to releases of MEC/MC, and DoD policy states that such responses shall be conducted in accordance with CERCLA and the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP).

The purpose of the RI was to determine whether the Load Line #1A MRS warrants further response action pursuant to CERCLA and the NCP. More specifically, the RI was intended to determine the nature and extent of MEC and MC and to subsequently identify the potential hazards and risks posed to likely human and ecological receptors by MEC and MC.

Additional data are also presented in this RI Report to support the identification and evaluation of alternatives in a FS, if required.

1.2 Problem Identification

The principle sources of MEC at the Load Line #1A MRS were reported to be accidental releases during the loading of munitions during World War II and the Korean War. These activities resulted in the potential for MEC and munitions debris (MD), including propellants, to be present in surface soil at the Load Line #1A MRS (engineering-environmental Management, Inc. [e^2M], 2008). The MRS consists of a 0.41-acre area located near the northwest side of the former elevated building CB-14 where triple-base propellants were observed on the ground surface and MC results for elevated lead concentrations and low detects for explosives were detected in surface soil during the 2007 site inspection (SI) activities.

It was concluded in the *Final Site Inspection Report* (e^2M, 2008), hereafter referred to as the SI Report, that there was a potential for surface MEC (triple-base propellant nodules) and MC in concentrations in surface soil posing a risk to human and ecological receptors at the MRS. It was recommended in the SI Report that further characterization for MEC and MC be performed at the MRS under the MMRP.

1.3 Physical Setting

This section presents the physical characteristics of the facility, the Load Line #1A MRS and the surrounding environment that are factors in understanding fate and transport, receptors, and exposure scenarios for potential human health and ecological risks. The physiographic setting, hydrology, climate, and ecological characteristics of the facility were compiled primarily from information originally presented in the SI Report (e^2M, 2008), which included the Load Line #1A MRS, and the *Integrated Natural Resources Management Plan for the Ravenna Training and Logistics Sites* (INRMP) that was prepared for the Ohio Army National Guard (OHARNG) by AMEC Earth and Environmental, Inc. (AMEC) in 2008.

1.3.1 Location

The former RVAAP (Federal Facility ID No. OH213820736), now known as the Camp Ravenna Joint Military Training Center (Camp Ravenna), is located in northeastern Ohio within Portage and Trumbull Counties and is approximately 3 miles east-northeast of the city of Ravenna. The facility is approximately 11 miles long and 3.5 miles wide. The facility is bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad to the south; Garret, McCormick, and Berry Roads to the west; the Norfolk Southern Railroad to the north; and State Route 534 to the east. In addition, the facility is surrounded by the communities of Windham, Garrettsville, Newton Falls, Charlestown, and Wayland (**Figure 1-1**).

The Load Line #1A MRS is a 0.41-acre parcel located in the eastern portion of the facility within Portage County (**Figure 1-2**). The MRS is collocated with an Installation Restoration Program (IRP) Area of Concern (AOC) identified as Army Environmental Database-Restoration Module (AEDB-R) number RVAAP-08.

Administrative control of the 21,683-acre facility has been transferred to the U.S. Property and Fiscal Officer for Ohio and subsequently licensed to the OHARNG for use as a training site, Camp Ravenna. The restoration program involves cleanup of former production areas across the facility related to former operations under the former RVAAP.

The MRS is located on federal property that is managed by the Army National Guard (ARNG) and the OHARNG. **Table 1-1** summarizes the administrative description for the Load Line #1A MRS. The table includes the facility AEDB-R numerical designation for the MRS, the current MRS acreage, and the agencies responsible for the MRS.

Table 1-1
Administrative Description Summary of the Load Line #1A MRS

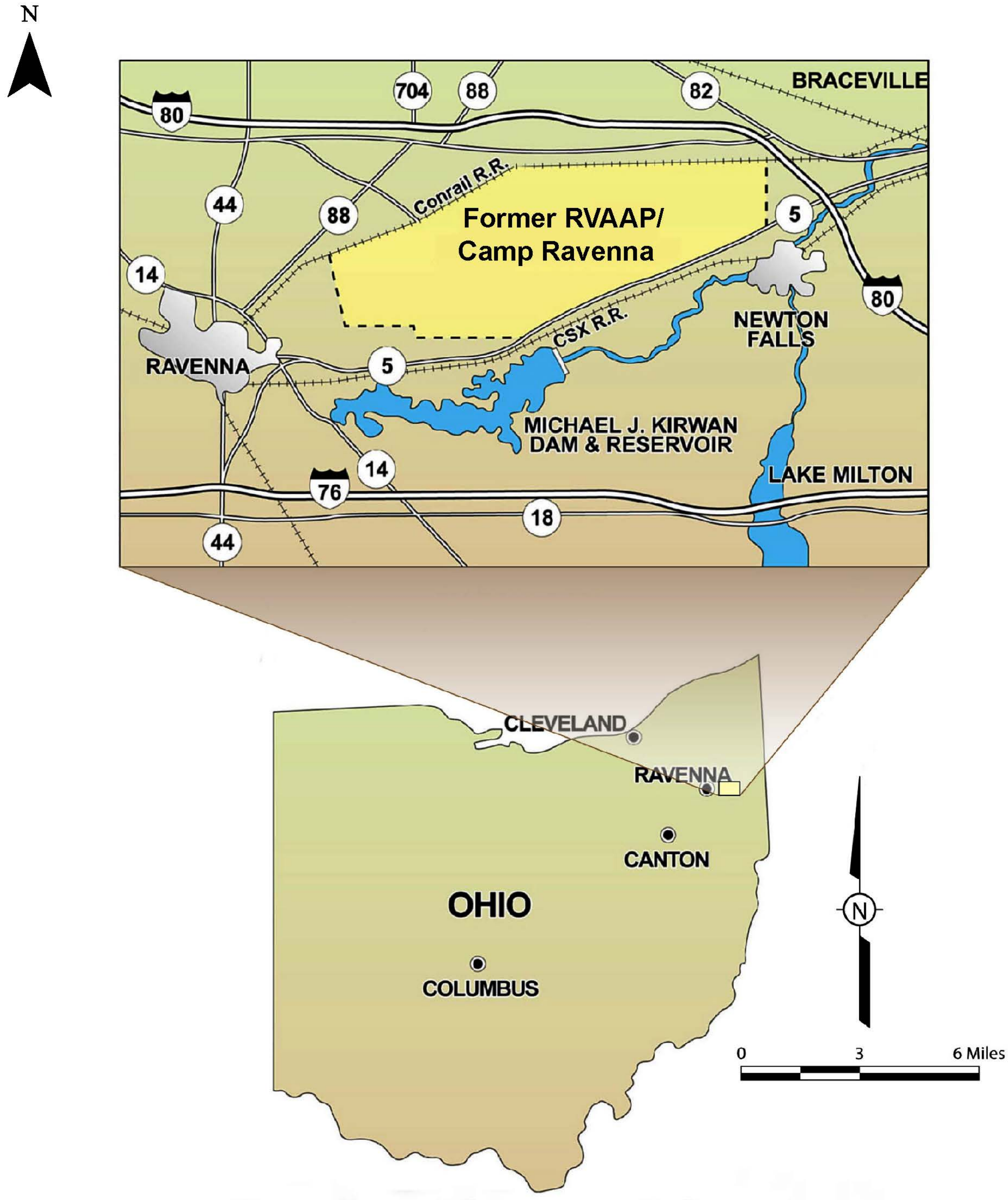
MRS Name	AEDB-R MRS Number	MRS Acreage (acres)	Property Owner	MRS Management Responsibility
Load Line #1A	RVAAP-008-R-01	0.41	USP&FO	ARNG/OHARNG

AEDB-R denotes Army Environmental Database Restoration.
ARNG denotes Army National Guard.
MRS denotes Munitions Response Site.
OHARNG denotes Ohio Army National Guard.
USP&FO denotes United States Property and Fiscal Officer.

1.3.2 Current and Projected Land Use

This section presents the current and future land use for the Load Line #1A MRS. The future land use description for the MRS is based on information provided in the *RVAAP Facility-Wide Human Health Risk Assessor Manual* (HHRAM) (USACE, 2005) and information provided by the OHARNG during preparation of the Work Plan (Shaw, 2011).

Current activities at the Load Line #1A MRS include maintenance, remediation, and natural resource management activities. Possible users associated with the current activities at the MRS include facility personnel, contractors, and potential trespassers.



Note:
The Scale is for the Upper Map Only
Showing the Former RVAAP/Camp Ravenna Location

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MILITARY MUNITIONS RESPONSE PROGRAM

FORMER RVAAP/CAMP RAVENNA
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Canton, MA 02021

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FIGURE 1-1 INSTALLATION LOCATION MAP

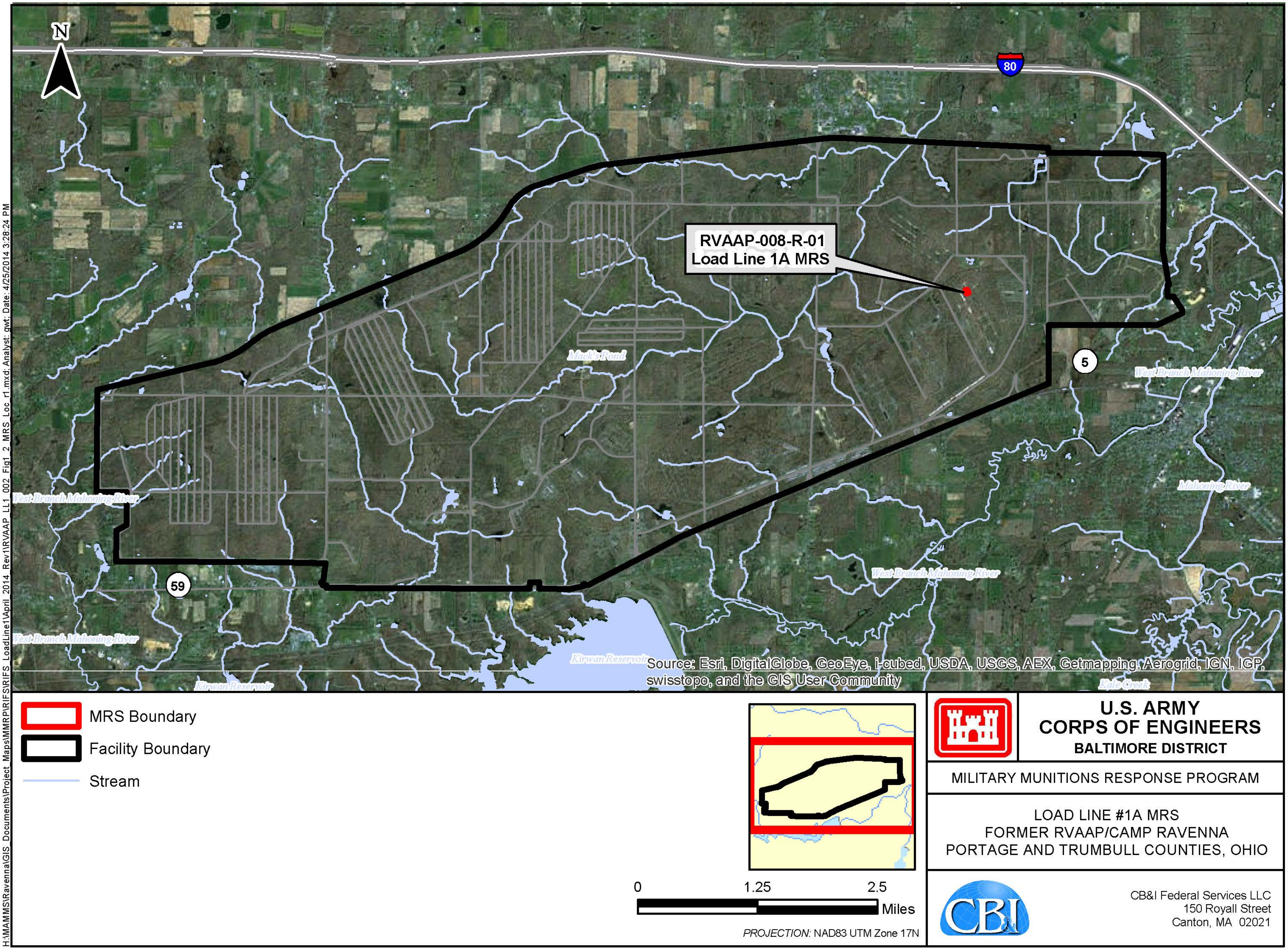


FIGURE 1-2 MRS LOCATION MAP

The OHARNG future use at the MRS is military training. The potential user for the future land use is the National Guard Trainee (USACE, 2005). Since the RI was completed prior to finalization of the U.S. Army's *Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the Ravenna Army Ammunition Plant Installation Restoration Program* (ARNG, 2014) and Unrestricted Land Use was demonstrated, the Commercial Industrial Land Use was not evaluated in the RI.

1.3.3 Climate

The climate at the facility is classified as humid continental, and the region is characterized by warm, humid summers and cold winters. The National Weather Service identified the average annual precipitation for Ravenna, Ohio as 40.23 inches, with February as the driest month and July as the wettest month. **Table 1-2** reflects the annual climate and weather normally encountered at nearby Youngstown Municipal Airport.

Table 1-2
Climatic Information, Youngstown Municipal Airport, Ohio

Temperature Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Max Temperature (°F)	32.4	36.0	46.3	58.2	69.0	77.1	81.0	79.3	72.1	60.7	48.4	37.3
Normal Min Temperature (°F)	17.4	19.3	27.1	36.5	46.2	54.6	58.7	57.5	50.9	40.9	33.0	23.4
Mean Precipitation (inches)	2.34	2.03	3.05	3.33	3.45	3.91	4.10	3.43	3.89	2.46	3.07	2.96
Mean Snowfall (inches)	13.1	9.6	10.4	2.2	0	0	0	0	Trace	0.6	4.5	12.3

Source: National Oceanic and Atmospheric Administration Climatography of the United States No. 81 1971–2000.
°F denotes degrees Fahrenheit.

1.3.4 Topography

The RVAAP is located within the Southern New York section of the Appalachian Plateaus physiographic province. Rolling topography containing incised streams and dendritic drainage patterns are prevalent in the province. Rounded ridges, filled major valleys, and areas covered with glacially derived unconsolidated deposits were the product of glaciation in the Southern New York section. In addition, bogs, kettle lakes, and kames are evidence of past glacial activity in the province; however, none are located at the MRS. Old stream drainage patterns were disturbed and wetlands were created within the province as a result of past glacial activity (e^2M, 2008).

Load Line #1A MRS Topography

Topography across the Load Line #1A MRS is relatively flat with little change in elevation. The MRS is in a slight depression related to its immediate surroundings. Based on topographical maps, local surface drainage is to the east. There are no natural streams or ponds located within the MRS and the MRS is not located within a flood plain. The ground surface elevation at the MRS is approximately 990 feet above mean sea level (amsl). The topography for the Load Line #1A MRS and its immediate vicinity is presented in **Figure 1-3**.

1.3.5 Hydrology and Hydrogeology

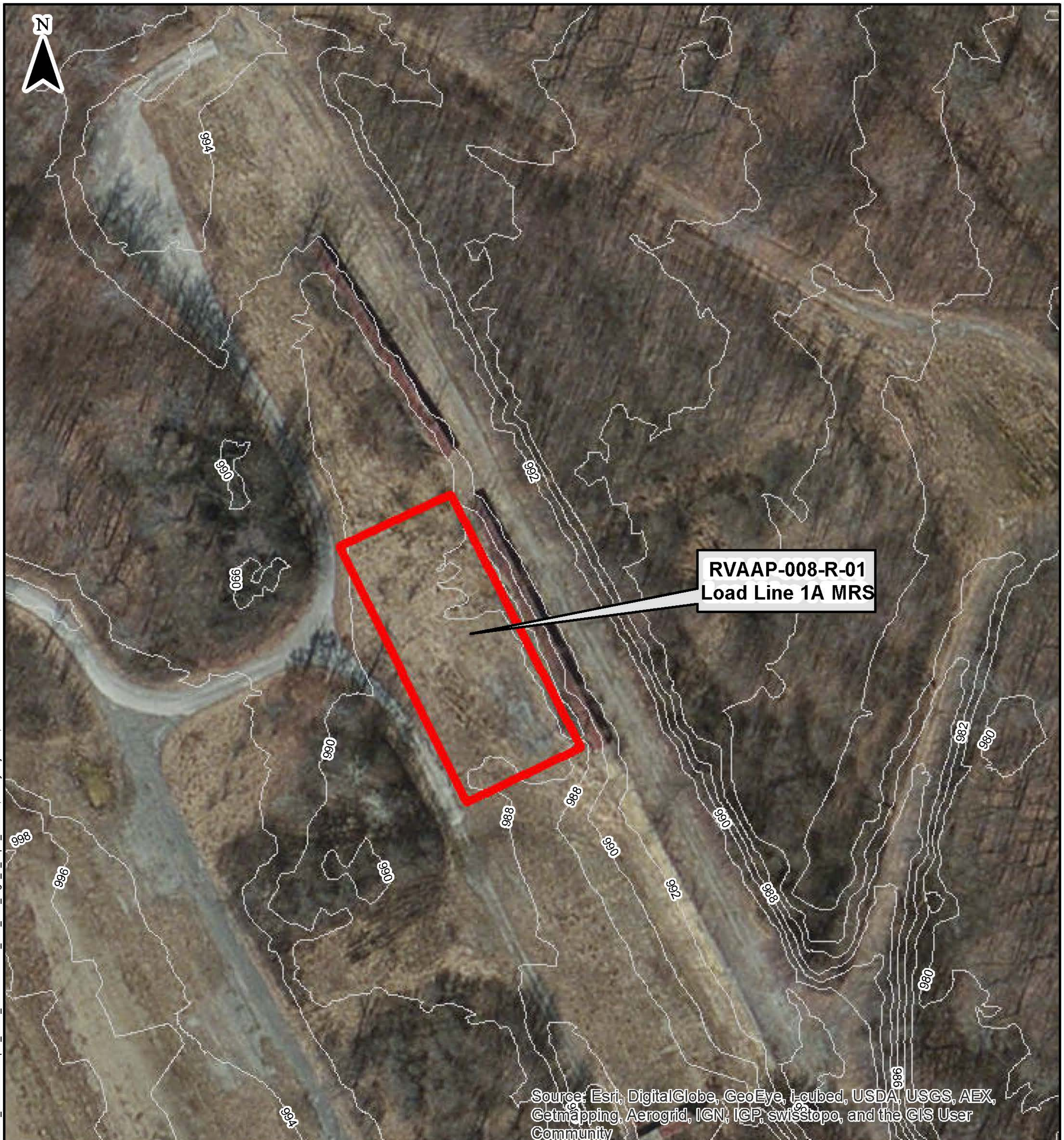
The facility is located within the Ohio River Basin. The major surface stream at the facility is the west branch of the Mahoning River, which flows adjacent to the western end of the facility, generally from north to south, before flowing into the Michael J. Kirwan Reservoir. After leaving the reservoir, the west branch joins the Mahoning River east of the facility.

Surface water features within the facility include a variety of streams, lakes, ponds, floodplains, and wetlands. Numerous streams drain the facility, including approximately 19 miles of perennial streams. The combined stream length at the facility is 212 linear miles (AMEC, 2008).

Three primary watercourses drain the facility: (1) the south fork of Eagle Creek, (2) Sand Creek, and (3) Hinkley Creek. Eagle Creek and its tributaries, including Sand Creek, are designated as State Resource Waters. With this designation, the stream and its tributaries fall under the state's antidegradation policy. These waters are protected from any action that would degrade the existing water quality.

Approximately 153 acres of ponds are found on the facility. Most of the ponds were created by beaver activity or small man-made dams and embankments. Some were constructed within natural drainage ways to function as settling ponds for effluent or runoff. No ponds are located at the Load Line #1A MRS (AMEC, 2008).

A planning-level survey (i.e., desktop review of wetlands data and resources [National Wetlands Inventory maps, aerials, etc.]) for wetlands was conducted for the entire facility, including the MRS. Wetlands located within the facility include seasonally saturated wetlands, wet fields, and forested wetlands. Sand and gravel aquifers are present within the buried-valley and outwash deposits in Portage County. In general, the aquifer is too thin and localized to provide large quantities of water; however, yields are sufficient for residential water supplies. Wells located on the facility were primarily located within the sandstone facies of the Sharon Member (MKM Engineers, Inc., 2007).



MRS Boundary

Elevation Contour (2 Foot Intervals)

0 100 200 Feet

Projection : NAD_1983_UTM_Zone_17N

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LOAD LINE #1A MRS
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PORTAGE AND TRUMBULL COUNTIES, OHIO

CB&I Federal Services LLC
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Canton, MA 02021

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FIGURE 1-3 TOPOGRAPHY

Although groundwater recharge and discharge areas have not been delineated at the facility, it is assumed that the extensive uplands areas at the facility, primarily located at the western portion of the former RVAAP, are regional recharge zones. Sand Creek, Hinkley Creek, and Eagle Creek are presumed to be major groundwater discharge areas (e^2M, 2008). The Load Line #1A MRS is located at the eastern lowland portion of the facility that is not situated in the upland areas that are considered to be regional recharge zones.

Load Line #1A MRS Hydrology and Hydrogeology

No surface water features, wetlands, bogs, kettle lakes, or kames are located at the Load Line #1A MRS. The MRS is not located in a floodplain. The nearest surface water drainage is an unnamed drainage outlet at the northeast corner of Load Line #1 and is considered an intermittent surface water drainage channel.

Groundwater is present at the MRS at approximately 32 feet below ground surface (bgs) in unconsolidated sediments (MKM Engineers, Inc., 2007; Environmental Quality Management, Inc., 2012). Groundwater flow is generally to the northeast (Science Applications International Corporation [SAIC], 2003).

1.3.6 Geology and Soils

Based on regional geology, the facility consists of Mississippian- and Pennsylvanian-age bedrock strata, which dip to the south at approximately 5 to 10 feet per mile. The bedrock is overlain by unconsolidated glacial deposits of varying thickness.

Bedrock is overlain by deposits of Wisconsin-age Lavery Till and Hiram Till in the western and eastern portions of the facility, respectively. The thickness of the glacial deposits varies throughout the facility, ranging from ground surface in parts of the eastern portion of the facility to an estimated 150 feet in the south-central portion of the facility.

Bedrock is present near the ground surface in many locations at the facility, including Load Line #1 at the east end of the facility. Where glacial deposits are still present, their distribution and character are indicative of ground moraine origin. Laterally discontinuous groupings of yellow-brown, brown, and gray silty clays to clayey silts, with sand and rock fragments are present. Glacial-age standing-water-body deposits may be present at the facility, in the form of uniform light gray silt deposits over 50 feet thick.

At approximately 200 feet bgs, the Mississippian Cuyahoga Group is present throughout most of the facility. In the northeastern corner of the facility, the Meadville Shale Member of the Cuyahoga Group is present close to the surface. The Meadville Shale Member of the Cuyahoga Group is blue-gray silty shale characterized by alternating thin beds of sandstone and siltstone.

The Sharon Member of the Pennsylvanian Pottsville Formation unconformably overlies the Meadville Shale Member of the Mississippian Cuyahoga Group. A relief of as much as 200 feet exists in Portage County, which can be seen in the Sharon Member thickness variations. The Sharon Member is made up of shale and a conglomerate.

The Sharon Member conglomerate unit is identified as highly porous, permeable, cross-bedded, frequently fractured, and weathered quartzite sandstone, which is locally conglomeratic and has an average thickness of 100 feet. A thickness of as much as 250 feet exists in the Sharon Conglomerate where it was deposited in a broad channel cut into Mississippian rocks. In marginal areas of the channel, the conglomerate unit may thin out to approximately 20 feet; in some places, it may be missing owing to nondeposition on the uplands of the early Pennsylvanian erosional surface. Thin shale lenses occur intermittently within the upper part of the conglomerate unit.

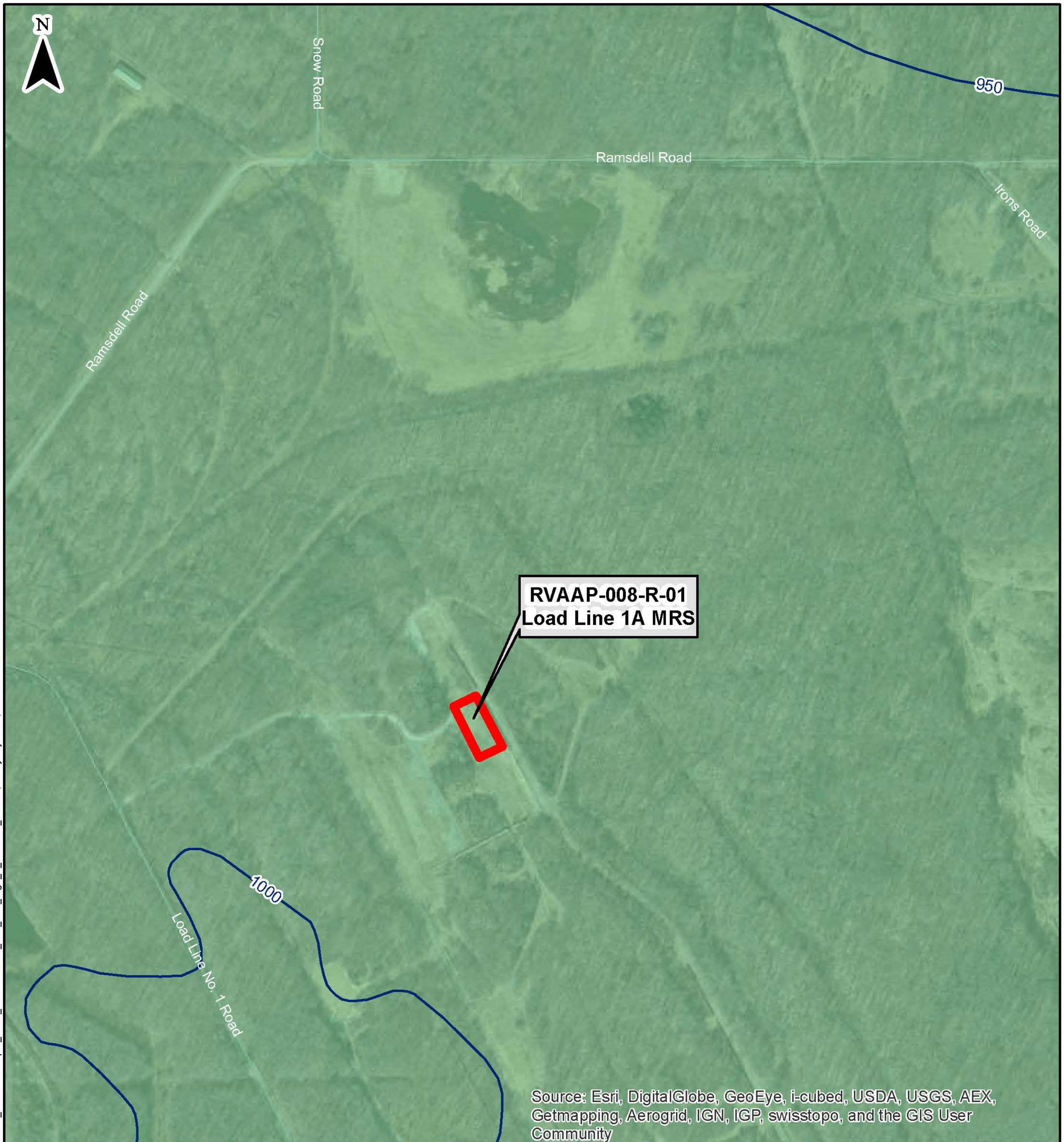
The Sharon Member shale unit is identified as a light- to dark-gray fissile shale, which overlies the conglomerate in some locations; however, it has been eroded throughout the majority of the facility. The Sharon Member outcrops in many locations in the eastern half of the facility.

The remaining members of the Pottsville Formation overlie the Sharon Member in the western portion of the facility. Due to erosion and because the land surface was above the level of deposition, the Pottsville Formation is not found in the eastern half of the facility.

The Connoquenessing Sandstone Member, which is a sporadic, relatively thin channel of sandstone comprised of gray to white coarse-grained quartz with a higher percentage of feldspar and clay than the Sharon Conglomerate, unconformably overlies the Sharon Member. The Mercer Member, which is found above the Connoquenessing Sandstone Member, consists of silty to carbonaceous shale with many thin and discontinuous lenses of sandstone in its upper part. The Homewood Sandstone Member unconformably overlies the Mercer Member and consists of the uppermost unit of the Pottsville Formation. The Homewood Sandstone Member ranges from well-sorted, coarse-grained, white quartz sandstone to a tan, poorly sorted, clay-bonded, micaceous, medium- to fine-grained sandstone. The Homewood Sandstone Member occurs as a caprock on bedrock highs in the subsurface (e^2M, 2008).

Geology and Soils at the Load Line #1A MRS

The Load Line #1A MRS is located over the Sharon Sandstone formation and the depth to bedrock is less than 3.5 feet bgs (U.S. Department of Agriculture [USDA], 1978). The approximate elevation of bedrock at the MRS is 987 feet amsl (AMEC, 2008). **Figure 1-4** illustrates the bedrock formation beneath the MRS.



MRS Boundary

Geologic Formation

Sharon Sandstone - Conglomerate Unit

Bedrock Elevation Contour

0 500 1,000 Feet

Projection: NAD_1983_UTM_Zone_17N

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LOAD LINE #1A MRS
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FIGURE 1-4 BEDROCK MAP

The soils identified at the facility are generally derived from the Wisconsin-age silty clay glacial till. The major soil types found at the facility are silt or clay loams, ranging in permeability from 6.0×10^{-7} to 1.4×10^{-3} centimeters per second (USDA, 1978). The native soil type at the Load Line #1A MRS is the Mitiwanga silt loam with 0- to 2-percent slopes (AMEC, 2008). This is a nearly level soil type in wide flat areas such as the MRS. Permeability is very slow in the subsoil and underlying glacial till with an average rate of 1.04×10^{-7} centimeters per second. Runoff is slow and ponding is common after heavy rains or seasonally wet weather. **Figure 1-5** illustrates the soil types at and in the vicinity of the Load Line #1A MRS.

1.3.7 Vegetation

The facility has a diverse range of vegetation and habitat resources. Habitats present within the facility include large tracts of closed-canopy hardwood forest, scrub/shrub open areas, grasslands, wetlands, and open-water ponds and lakes. Vegetation at the facility can be grouped into three categories: (1) herb dominated, (2) shrub dominated, and (3) tree dominated. Tree-dominated areas are most abundant, covering approximately 13,000 acres of the facility. Shrub vegetation covers approximately 4,200 acres. A plant species survey identified 18 vegetation communities on the facility. The facility has seven forest formations, four shrub formations, eight herbaceous formations, and one nonvegetated formation (AMEC, 2008).

Vegetation at the Load Line #1A MRS

The vegetation community present at the Load Line #1A MRS is categorized as the "Dry Midsuccessional Cold-Deciduous Shrubland Alliance." This shrubland alliance is associated with relatively open areas characterized by shrub species covering more than 50 percent of the area, with relatively few large trees. This alliance often is found within previously disturbed areas, and is dominated by gray dogwood, northern arrowwood, blackberry, hawthorn, and multiflora rose (AMEC, 2008).

1.3.8 Endangered, Threatened, and Other Rare Species

Federal status as a threatened or endangered species is derived from the Endangered Species Act (ESA) (16 United States Code [USC] 1538, et seq.) and is administered by the U.S. Fish and Wildlife Service (USFWS). While there are species under federal review for listing, there are currently no federally listed species or critical habitats at the facility. State-listed plant and animal species are determined by the Ohio Department of Natural Resources (ODNR). Although biological inventories have not occurred within the MRS boundary and no confirmed sightings of state-listed species have been reported, there is the potential for state-listed or rare species to be within the MRS boundary. Information regarding endangered, threatened, and candidate species at the facility was obtained from the Camp

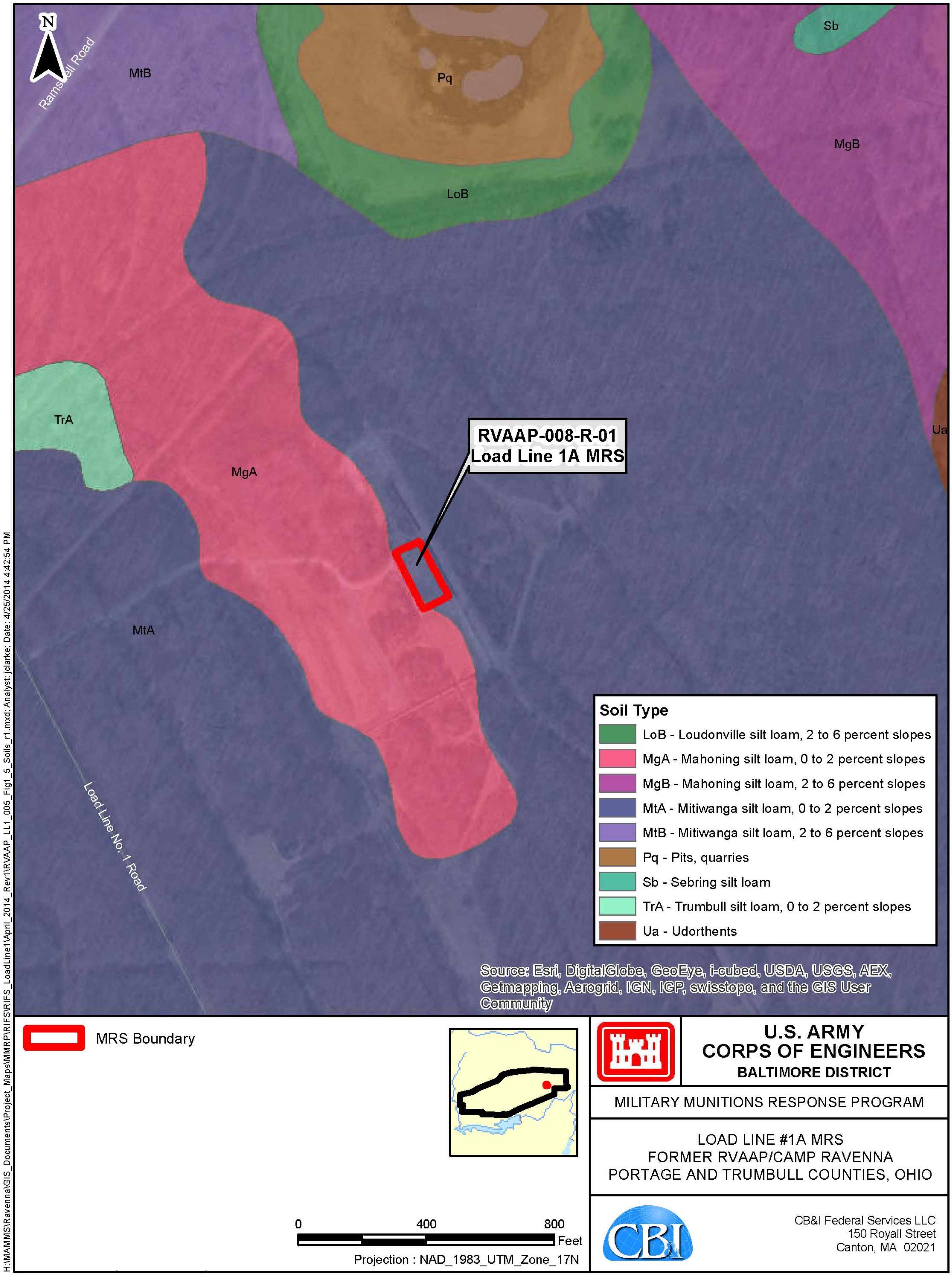

FIGURE 1-5 SOILS MAP

Ravenna Rare Species List (2010). **Table 1-3** presents state-listed species that have been identified to be on the facility by biological inventories and confirmed sightings.

Table 1-3
Camp Ravenna Rare Species List

Common Name	Scientific Name
State Endangered	
American bittern	*Botaurus lentiginosus*
Northern harrier	*Circus cyaneus*
Yellow-bellied sapsucker	*Sphyrapicus varius*
Golden-winged warbler	*Vermivora chrysoptera*
Osprey	*Pandion haliaetus*
Trumpeter swan	*Cygnus buccinators*
Mountain brook lamprey	*Ichthyomyzon greeleyi*
Graceful underwing	*Catocala gracilis*
Bobcat	*Felis rufus*
Narrow-necked Pohl's moss	*Pohlia elongate var. Elongata*
Sandhill crane (probable nester)	*Grus canadensis*
Bald eagle (nesting pair)	*Haliaetus leucocephalus*
State Threatened	
Barn owl	*Tyto alba*
Dark-eyed junco (migrant)	*Junco hyemalis*
Hermit thrush (migrant)	*Catharus guttatus*
Least bittern	*Ixobrychus exilis*
Least flycatcher	*Empidonax minimus*
Caddisfly	*Psilotreta indecisa*
Simple willow-herb	*Epilobium strictum*
Woodland horsetail	*Equisetum sylvaticum*
Lurking leskea	*Plagiiothecium latebricola*
Pale sedge	*Carex pallescens*
State Potentially Threatened Plants	
Gray birch	*Betula populifolia*
Butternut	*Juglans cinerea*

Table 1-3 (continued)
Camp Ravenna Rare Species List

Common Name	Scientific Name
Northern rose azalea	*Rhododendron nudiflorum var. Roseum*
Hobblebush	*Viburnum alnifolium*
Long beech fern	*Phegopteris connectilis*
Straw sedge	*Carex straminea*
Tall St. John's wort	*Hypercium majus*
Water avens	*Geum rivale*
Shining ladies-tresses	*Spiranthes lucida*
Swamp oats	*Sphenopholis pensylvanica*
Arbor vitae	*Thuja occidentalis*
American chestnut	*Castanea dentate*
Tufted moisture-loving moss	*Philonotis fontana var. Caespitosa*
State Species of Concern	
Pygmy shrew	*Sorex hovi*
Woodland jumping mouse	*Napaeozapus insignis*
Star-nosed mole	*Condylura cristata*
Sharp-shinned hawk	*Accipiter striatus*
Marsh wren	*Cistothorus palustris*
Henslow's sparrow	*Ammodramus henslowii*
Cerulean warbler	*Dendroica cerulean*
Prothonotary warbler	*Protonotaria citrea*
Bobolink	*Dolichonyx oryzivorus*
Northern bobwhite	*Colinus virginianus*
Common moorhen	*Gallinula chlorpus*
Great egret (migrant)	*Ardea alba*
Sora	*Porzana carolina*
Virginia rail	*Rallus limicola*
Creek heelsplitter	*Lasmigona compressa*
Eastern box turtle	*Terrapene carolina*
Four-toed salamander	*Hemidactylium scutatum*
Mayfly	*Stenonema ithica*

Table 1-3 (continued)
Camp Ravenna Rare Species List

Common Name	Scientific Name
Coastal plain apamea	*Apamea mixta*
Willow peasant	*Brachylomia algens*
Sedge wren	*Cistothorus platensis*
State Special Interest	
Canada warbler	*Wilsonia Canadensis*
Little blue heron	*Egretta caerula*
Magnolia warbler	*Dendroica magnolia*
Northern waterthrush	*Seiurus noveboracensis*
Winter wren	*Troglodytes troglodytes*
Back-throated blue warbler	*Dendroica caerulescens*
Brown creeper	*Certhia americana*
Mourning warbler	*Oporornis philadelphia*
Pine siskin	*Carduelis pinus*
Purple finch	*Carpodacus purpureus*
Red-breasted nuthatch	*Sitta canadensis*
Golden-crowned kinglet	*Regulus satrapa*
Blackburnian warbler	*Dendroica fusca*
Blue grosbeak	*Guiraca caerulea*
Common snipe	*Gallinago gallinago*
American wigeon	*Anas americana*
Gadwall	*Anas strepera*
Green-winged teal	*Anas crecca*
Northern shoveler	*Anas clypeata*
Redhead duck	*Aythya americana*
Ruddy duck	*Oxyura jamaicensis*

Source: Camp Ravenna Rare Species List, April 27, 2010.

1.3.9 Cultural and Archeological Resources

A number of archeological surveys have been conducted at the facility. Cultural and archeological resources have been identified at the facility during past surveys. The Load Line #1A MRS has not been previously surveyed for cultural and archeological resources

(AMEC, 2008). However, due to the disturbed nature of the area from former operations and remediation activities, it is unlikely that cultural and/or archeological resources are present at the MRS.

1.4 Facility History and Background

During operations as an ammunition plant, the former RVAAP was a government-owned and contractor-operated industrial facility. Industrial operations at the facility consisted of 12 munitions assembly facilities, referred to as “load lines.” Load Lines 1 through 4 were used to melt and load 2,4,6-trinitrotoluene (TNT) and Composition B into large-caliber shells and bombs. The operations on the load lines produced explosive dust, spills, and vapors that collected on the floors and walls of each building. Periodically, the floors and walls were cleaned with water and steam. Following cleaning, the “pink water” waste water, which contained TNT and Composition B, was collected in concrete holding tanks, filtered, and pumped into unlined ditches for transport to earthen settling ponds. Load Lines 5 through 11 were used to manufacture fuzes, primers, and boosters. Potential contaminants in these load lines include lead compounds, mercury compounds, and explosives. From 1946 to 1949, Load Line 12 was used to produce ammonium nitrate for explosives and fertilizers prior to use as a weapons demilitarization facility.

In 1950, the facility was placed in standby status and operations were limited to renovation, demilitarization, and normal maintenance of equipment, along with storage of munitions. Production activities were resumed from July 1954 to October 1957 and again from May 1968 to August 1972. In addition to production missions, various demilitarization activities were conducted at facilities constructed at Load Lines 1, 2, 3, and 12. Demilitarization activities included disassembly of munitions and explosives melt-out and recovery operations using hot water and steam processes. Periodic demilitarization of various munitions continued through 1992.

In addition to production and demilitarization activities at the load lines, other facilities at the former RVAAP include MRSs that were used for the burning, demolition, and testing of munitions. These burning and demolition grounds consist of large parcels of open space or abandoned quarries. Potential contaminants at these MRSs include explosives, propellants, metals, and waste oils. Other AOCs present at the facility include landfills, an aircraft fuel tank testing facility, and various general industrial support and maintenance facilities (SAIC, 2011).

Load Line #1A MRS History and Background

Load Line #1 is approximately 164 acres in area. It was used to melt and load TNT and Composition B explosives into large-caliber shells during World War II and the Korean War.

Explosive dust, spills, and vapors collected on the floors and walls of several buildings as a result of operations at the load line. The walls were periodically washed with water and steam. In 1971, the load line's freestanding equipment was removed.

Investigation and remediation activities under the IRP have been ongoing at the Load Line #1 AOC, in which the MRS is collocated, since 1996. From 1996 through 1998, salvage operations continued, with the removal of the overhead steam lines, major rail spurs and all telephone lines. The majority of the buildings were demolished and removed by 2000. The remainder of the floor slabs were demolished and removed in 2009.

The Load Line #1A MRS was originally a 4.63-acre area composed of several buildings associated with packing and shipping (CB-13/CB-13B), the location of the former popping furnace located adjacent to the former building CB-13B, and the area around the former propellant charge building (CB-14). Based on the recommendations in the SI Report (e^2M, 2008), the MRS was reduced to a 0.41-acre area located near the northwest side of the former propellant charge building (CB-14) where triple-base propellants were observed on the ground surface and elevated lead concentrations and low concentrations of explosives were detected in surface soil during the SI activities. The MRS is located at the north end of the load line. **Figure 1-6** presents the current MRS boundaries and associated features investigated for the RI.

The principle sources of MEC at the Load Line #1A MRS were reported to be accidental releases during the loading of munitions during World War II and the Korean War. These activities resulted in the potential for MEC/MD, including propellants, to be present in surface soil at the Load Line #1A MRS (e^2M, 2008).

1.5 Previous Investigations and Actions

This section briefly summarizes the investigations and actions as they pertain to the Load Line #1A MRS. This information was obtained primarily from the *Final Historical Records Review* (e^2M, 200), hereafter referred to as the HRR, and the SI Report (e^2M, 2008). It is noted that the MRS was originally referred to as "Load Line #1 MRS" during the previous investigations and activities that occurred at the MRS under the MMRP and prior to the RI field work. In coordination with the Ohio Environmental Protection Agency (Ohio EPA) and the U.S. Army, the designation for the current MRS area was revised to "Load Line #1A MRS" following the RI field work due to propellants that have since been observed outside the current MRS boundary. The purpose for the MRS name revision is to differentiate it from other areas at Load Line #1 that may require further actions under the MMRP. For the purposes of the previous investigations and actions discussion herein, the MRS will be referred to as the Load Line #1 MRS as it was originally called out in the historical documents.

MRS Boundary

0 50 100 Feet

Projection : NAD_1983_UTM_Zone_17N

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MILITARY MUNITIONS RESPONSE PROGRAM

LOAD LINE #1A MRS
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FIGURE 1-6 SITE FEATURES MAP

1.5.1 2004 USACE Archives Search Report

The USACE conducted an archives search in 2004 under the DERP as a historical records search and SI for the presence of MEC at the facility. The *Final Archives Search Report* (ASR) was prepared by the USACE in 2004 and identified 12 AOCs as well as 4 additional locations with the potential for MEC. Based on the ASR, Ramsdell Quarry Landfill, Erie Burning Grounds, Open Demolition Area #1, Load Line 12 and Dilution/Settling Pond, Building 1200 and Dilution/Settling Pond, Quarry Landfill/Former Fuze and Booster Burning Pits, 40 mm Firing Range, Building 1037—Laundry Waste Water Sump, Anchor Test Area, Atlas Scrap Yard, Block D Igloo, and Tracer Burning Furnace were identified as potential MRSs containing MEC. Confirmed MEC was identified at Open Demolition Area #2, Landfill North of Winklepeck, Load Line #1 and Dilution/Settling Pond, and Load Line #3 and Dilution/Settling Pond (USACE, 2004).

1.5.2 2007 e^{2}M Historical Records Review

The HRR was completed by e^{2}M in January 2007. The primary objective of the HRR was to perform a limited-scope records search to document historical and other known information on MRSs identified at the facility, to supplement the U.S. Army Closed, Transferring, and Transferred Range/Site Inventory, and to support the technical project planning process designed to facilitate decisions on those areas where more information was needed to determine the next step(s) in the CERCLA process.

Of the 19 MMRP-eligible MRSs identified during the U.S. Army Closed, Transferring, and Transferred Range/Site Inventory, the HRR identified 18 MRSs that qualified for the MMRP due to the demolition and/or disposal activities that occurred. These activities may have resulted in the presence of MEC and/or MC at the MRSs where the releases occurred prior to September 2002 (e^{2}M, 2008). These 18 MRSs identified during the HRR included the following:

- Ramsdell Quarry Landfill (RVAAP-001-R-01)
- Erie Burning Grounds (RVAAP-002-R-01)
- Open Demolition Area #2 (RVAAP-004-R-01)
- Load Line #1 (RVAAP-008-R-01)
- Load Line 12 (RVAAP-012-R-01)
- Fuze and Booster Quarry (RVAAP-016-R-01)
- Landfill North of Winklepeck (RVAAP-019-R-01)
- 40 mm Firing Range (RVAAP-32-R-01)

- Firestone Test Facility (RVAAP-033-R-01)
- Sand Creek Dump (RVAAP-034-R-01)
- Building #F-15 and F-16 (RVAAP-046-R-01)
- Anchor Test Area (RVAAP-048-R-01)
- Atlas Scrap Yard (RVAAP-050-R-01)
- Block D Igloo (RVAAP-060-R-01)
- Block D Igloo TD (RVAAP-061-R-01)
- Water Works #4 Dump (RVAAP-062-R-01)
- Area Between Buildings 846 and 849 (RVAAP-063-R-01) (now identified as "Group 8")
- Field at the Northeast Corner of the Intersection (RVAAP-064-R-01)

Following the HRR, the Field at the Northeast Corner of the Intersection (RVAAP-064-R-01), otherwise known as the Old Hayfield MRS, was classified as an operational range. This MRS was removed from eligibility under the MMRP, reducing the number of active MRSs at the facility to 17.

Prior to the HRR, the U.S. Army Closed, Transferring, and Transferred Range/Site Inventory considered the MRS as the entire 164-acre Load Line #1. During 1996 Phase I RI field activities, residual propellant pellets were found on the ground beside Buildings CB-13, CB-13B, and CB-14, as well as in the area of the former popping furnace. It was recommended in the HHR that the MRS acreage be reduced from 164 acres to 4.63 acres at the northern end of the load line where the propellants were identified. The resulting MRS boundaries following the recommendations in the HRR are presented in **Figure 1-7**.

1.5.3 2008 e^{2}M MMRP Site Inspection Report

In 2007, e^{2}M conducted a SI at each of the 17 MRSs under the MMRP. The primary objectives of the SI activities were to collect the appropriate amount of information to support recommendations of "no further action, immediate response, or further characterization" concerning the presence of MEC and/or MC at each of the MRSs. The SI also included a review of the HRR for each of the applicable MRSs. Out of the 17 MRSs evaluated during the SI phase, 14 were recommended for additional characterization under the MMRP, which included the Load Line #1 MRS (RVAAP-008-R-01). A summary of the SI Report (e^{2}M, 2008) recommendations for the Load Line #1 MRS is presented in **Table 1-4** and discussed below.

Table 1-4
Site Inspection Report Recommendations

MRS	MRSPP Priority	Recommendation	Basis for Recommendation	
			MEC	**MC**
Load Line #1 MRS (RVAAP-008-R-01)	5	Further characterization of MEC and MC at reduced MRS footprint	MEC present	MC detected above screening criteria

MC denotes munitions constituent.
MEC denotes munitions and explosives of concern.
MRS denotes Munitions Response Site.
MRSPP denotes Munitions Response Site Prioritization Protocol.
RVAAP denotes former Ravenna Army Ammunitions Plant.

The Load Line #1 MRS was assigned a Munitions Response Site Prioritization Protocol (MRSPP) priority of 5. The MRSPP is a funding mechanism typically performed during the Preliminary Assessment/SI stage to prioritize funding for MRSs on a priority scale of 1 to 8 with a Priority 1 being the highest relative priority. Based on the MRSPP identified for the MRS in the SI Report (e^2M, 2008), the Load Line #1 MRS was selected for inclusion for "further characterization." The following paragraphs summarize the investigation activities performed at the Load Line #1 MRS during the 2007 SI and the conclusions and recommendations for the MRS as identified in the SI Report (e^2M, 2008).

The Load Line #1 MRS at the time of the SI was the 4.63 acres recommended in the HRR (e^2M, 2007) and the field activities consisted of a meandering path survey. Three pieces of triple-base propellant (1 inch by ¼ inch each) were found on the ground surface during the survey and were classified as MEC. One nodule was found on the northwestern side of the former elevated building CB-14 slab. The other two nodules were located along the rail bed adjacent to the northeast side of the building CB-14 slab. The areas investigated during the SI field activities are presented in **Figure 1-7**.

One surface soil sample (MC1) was collected using the incremental sampling methodology (ISM) during the SI field activities. The sample was collected at the northwest side of the former elevated building CB-14 slab where one of the pieces of triple-base propellants was found. Lead is considered an MC associated with propellants and was detected in the ISM sample. Low concentrations of explosives that consisted of TNT and nitrobenzene were also detected; however, neither of these explosives is considered to be MC associated with propellants. Additionally, the concentrations of TNT and nitrobenzene were found to be too low to pose an explosives hazard. The location of the ISM sample collected at the MRS during the SI field activities is presented in **Figure 1-7**.

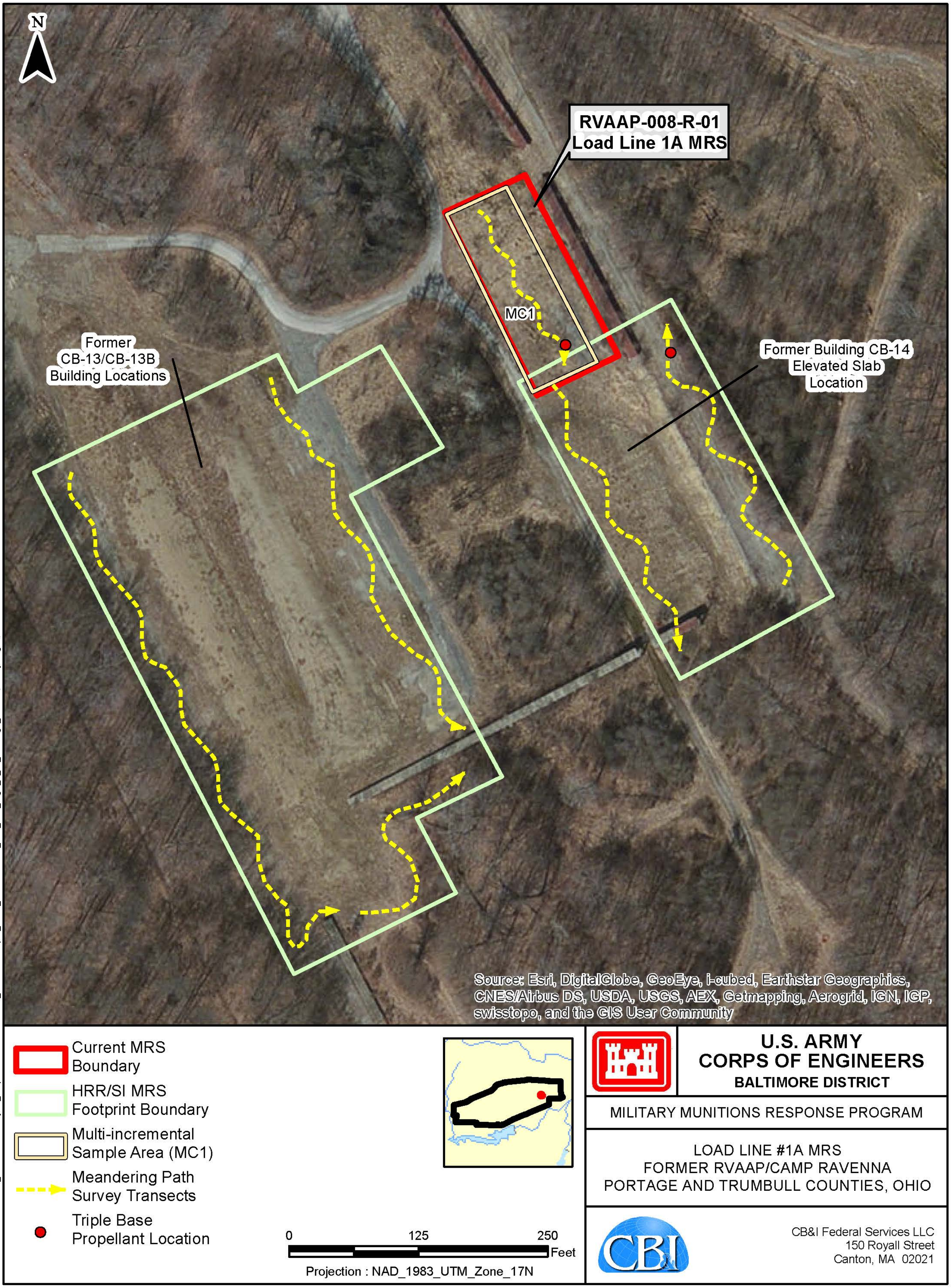

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FIGURE 1-7 SI FIELD WORK AND FINDINGS

Based on the unexploded ordnance (UXO) survey and MC results for lead and low detects for explosives, the SI recommended further characterization to address MEC and MC concerns at the Load Line #1 MRS as the density of propellants at the MRS was not fully understood. The SI Report (e^2M, 2008) also recommended that the MRS footprint be reduced from the original 4.63 acres to the current 0.41 acres where the ISM sample with detected elevated lead concentrations was collected. The area adjacent to the northeast of the former elevated building CB-14 slab where the two propellants were found during the SI survey activities was not recommended for further characterization, since soil remediation activities were planned at the location by another contractor (Shaw) in late 2007.

1.6 Remedial Investigation Report Organization

The contents and order of presentation of this RI Report are based on the requirements of the *Military Munitions Response Program Munitions Response Remedial Investigation/Feasibility Study Guidance* (U.S. Army, 2009). Specifically, this RI Report includes the following sections:

- **Section 1.0—**Introduction
- **Section 2.0—**Project Objectives
- **Section 3.0—**Characterization of MEC and MC
- **Section 4.0—**Remedial Investigation Results
- **Section 5.0—**Fate and Transport
- **Section 6.0—**MEC Hazard Assessment
- **Section 7.0—**Human Health Risk Assessment
- **Section 8.0—**Ecological Risk Assessment
- **Section 9.0—**Revised Conceptual Site Model
- **Section 10.0—**Summary and Conclusions
- **Section 11.0—**References

Appendices included at the end of this RI Report are as follows:

- **Appendix A—**Field Documentation
- **Appendix B—**Data Validation Report
- **Appendix C—**Summary of Laboratory Analytical Results
- **Appendix D—**Investigation Derived Waste

- **Appendix E—**Photograph Documentation Log
- **Appendix F—**Ecological Risk Assessment Tables
- **Appendix G—**Munitions Response Site Prioritization Protocol Data Tables
- **Appendix H—**Ohio EPA Correspondence
- **Appendix I—**Responses to Ohio EPA Comments
- **Appendix J—**Ohio EPA Approval Letter

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2.0 PROJECT OBJECTIVES

This section presents the preliminary conceptual site models (CSMs) for MEC and MC for the Load Line #1A MRS based on historical information and identified data gaps associated with the preliminary CSMs and the data quality objectives (DQOs) necessary to achieve the project objectives.

A CSM for a MRS provides an analysis of potential exposures associated with MEC and/or MC and an evaluation of the potential transport pathways MEC and/or MC take from a source to a receptor. Each pathway includes a source, activity, access, and receptor component, with complete, potentially complete, or incomplete exposure pathways identified for each receptor. Each component of the CSM analysis is discussed below.

- **Sources—**Sources are those areas where MEC or MC have entered (or may enter) the physical system. A MEC source is the location where material potentially presenting an explosive hazard (MPPEH) or ordnance is situated or are expected to be found. A MC source is a location where MC has entered the environment.
- **Activity—**The hazard from MEC and/or MC arises from direct contact as a result of some human or ecological activity. Interactions associated with activities describe ways that receptors are exposed to a source. For MEC, movement is not typically significant, and interaction will occur only at the source area as described above, limited by access and activity. However, there can be some movement of MEC through natural processes such as frost heave, erosion, and stream conveyance. For MC, this can include physical transportation of the contaminant and transfer from one medium to another through various processes such that media other than the source area can become contaminated. Interactions also include exposure routes (ingestion, inhalation, and dermal contact) for each receptor. Ecological exposure can include coming into contact with MEC or MC lying on the ground surface or through disturbing buried MEC/MC while digging or performing other activities such as burrowing.
- **Access—**Access is the ease with which a receptor can be exposed to a source. The presence of access controls help determine whether an exposure pathway to a receptor is complete, as fences or natural barriers can limit human access to a source area. Furthermore, the depth of MEC items in subsurface soils and associated MC may also limit access by a receptor. Ease of entry for adjacent populations (i.e., lack of fencing) can facilitate trespassing at the MRS, either intentional or accidental.

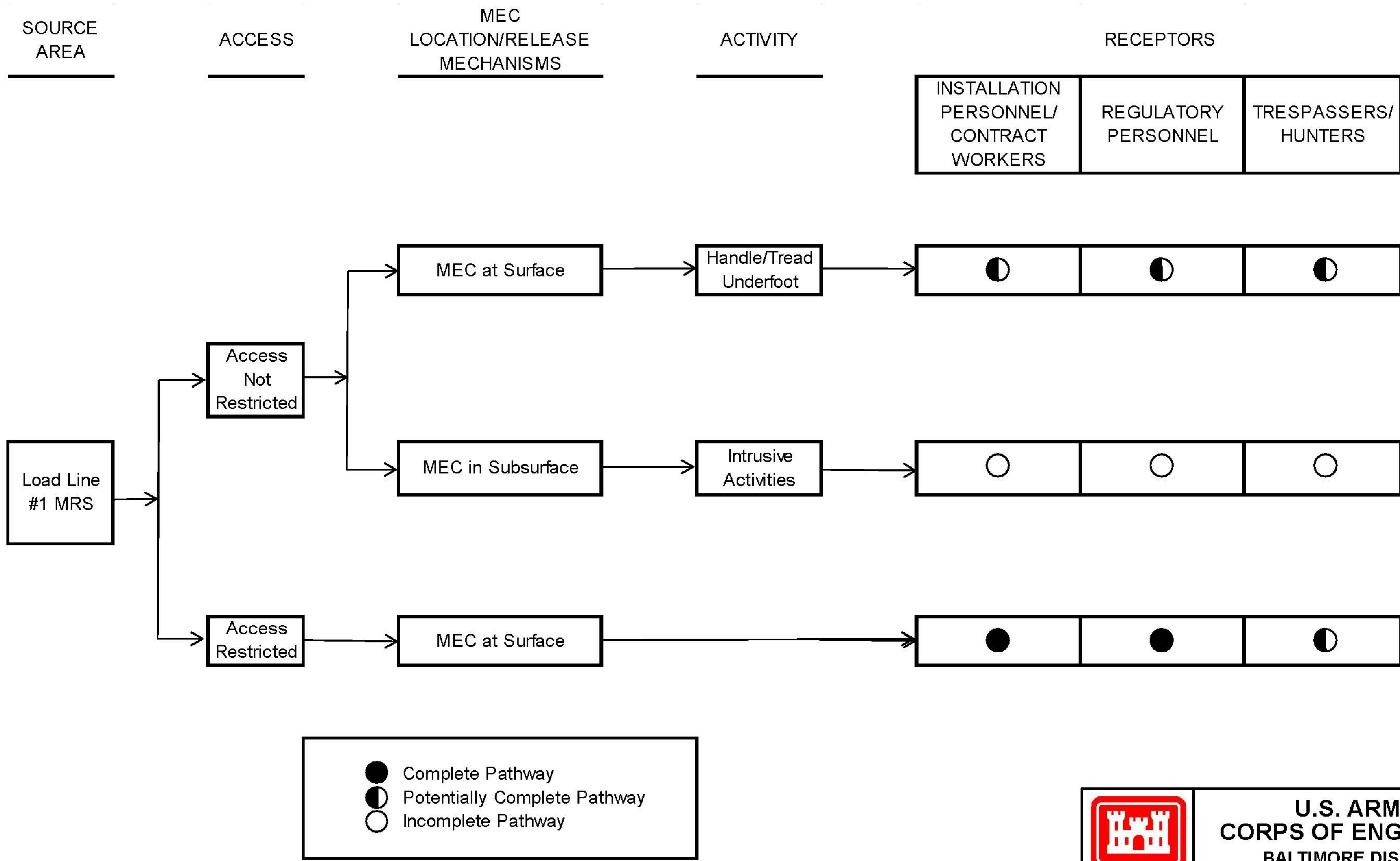
- **Receptors—**A receptor is an organism (human or ecological) that contacts a chemical or physical agent. The pathway evaluation must consider both current and reasonably anticipated future land use and activities, as receptors are determined on that basis. If present, MEC and/or MC on the ground surface and near the surface can be accessed by facility personnel, contractors, trespassers, and biota.

In general, the CSMs for each MRS are intended to assist in planning, interpreting data, and communicating MRS-specific information. The CSMs are used as a planning tool to integrate information from a variety of resources, to evaluate the information with respect to project objectives and data needs, and to evolve through an iterative process of further data collection or action. A discussion of the preliminary CSMs identified for the Load Line #1A MRS, as presented in the SI Report (e^2M, 2008), is presented in the following section. The data collected during the RI are incorporated into this model and is discussed in Section 4.0, "Remedial Investigation Results."

2.1 Preliminary CSMs and Project Approach

The preliminary CSMs for MEC and MC for the Load Line #1A MRS are based on MRS-specific data and general historical information including literature reviews, maps, training manuals, technical manuals, and field observations. The preliminary CSMs, which were originally developed during the SI process, are based on guidance from the USACE Engineer Manual 1110-1-1200, *Conceptual Site Models for Ordnance and Explosives and Hazardous, Toxic, and Radioactive Waste Projects* (USACE, 2003a). The preliminary MEC CSM and MC CSM are represented by the diagrams provided as **Figures 2-1** and **2-2**, respectively. A summary of each of the factors evaluated for the preliminary CSMs are discussed below.

- **Sources—**The potential presence of triple-base propellants on the ground surface was considered as the primary source of the potentially explosive MEC at the Load Line #1A MRS. Based on review of the archival records and available documentation, the principle sources of MEC at the Load Line #1A MRS were accidental releases during the loading of munitions during World War II and the Korean War. These activities resulted in the potential for MEC/MD to be present in surface soil at the Load Line #1A MRS. Given the MRS history, the presence of MEC in the subsurface was not anticipated, as no burial activities were known to occur. The source of MC at the MRS also includes the potential residual contamination in soils as a result of the propellants on the ground surface.



Source: Final Site Inspection Report, Ravenna Army Ammunition Plant, Ohio (e²M, 2008)

U.S. ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT

MILITARY MUNITIONS RESPONSE PROGRAM

LOAD LINE #1A MRS
FORMER RVAAP/CAMP RAVENNA
PORTAGE AND TRUMBULL COUNTIES, OHIO

CB&I Federal Services LLC
150 Royall Street
Canton, MA 02021

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FIGURE 2-1 PRELIMINARY MEC CONCEPTUAL SITE MODEL

SOURCE AREA	SOURCE MEDIA	RELEASE MECHANISMS	EXPOSURE MEDIA	EXPOSURE ROUTES	INSTALLATION PERSONNEL/ CONTRACT WORKERS	REGULATORY PERSONNEL	TRESPASSERS/ HUNTER	BIOTA
Load Line #1 MRS	Soil		Plant/Game/ Fish/Prey	Ingestion	○	○	○	○
		Runoff	Surface Water/Sediment	Ingestion	○	○	○	○
				Dermal Contact	○	○	○	○
		Leaching	Ground Water	Ingestion	○	○	○	○
				Dermal Contact	○	○	○	○
				Inhalation (Vapor)	○	○	○	○
			Subsurface Soil (>2 Feet)	Ingestion	◐	◐	◐	○
				Dermal Contact	◐	◐	◐	○
				Inhalation (Dust)	◐	◐	◐	○
			Surface Soil (0-2 Feet)	Ingestion	●	●	●	○
				Dermal Contact	●	●	●	○
				Inhalation (Dust)	●	●	●	○

● Complete Pathway
◐ Potentially Complete Pathway
○ Incomplete Pathway

Source: Final Site Inspection Report, Ravenna Army Ammunition Plant, Ohio (e^{2}M, 2008)

U.S. ARMY
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BALTIMORE DISTRICT

MILITARY MUNITIONS RESPONSE PROGRAM

LOAD LINE #1A MRS
FORMER RVAAP/CAMP RAVENNA
PORTAGE AND TRUMBULL COUNTIES, OHIO

CB&I Federal Services LLC
150 Royall Street
Canton, MA 02021

FIGURE 2-2 PRELIMINARY MC CONCEPTUAL SITE MODEL

- **Activity—**Human activities considered for the preliminary CSM included maintenance of the grounds, environmental sampling under the IRP, natural resource management activities, and infrequent security checks.
- **Access—**Access to Load Line #1 at the time of the SI was controlled by a fenced perimeter; however, a section of fence was missing behind the former guard building. Once inside Load Line #1, the MRS is not physically restricted and is accessible. The SI Report (e^2M, 2008) identified future plans for the MRS as military training once the load line was remediated.
- **Receptors—**At the time of the SI, current and reasonably anticipated receptors included installation personnel, soldiers, contractors (including maintenance personnel), and possibly trespassers and hunters. The SI Report (e^2M, 2008) considered biota to be state-listed species identified as being present at the facility.

The SI Report concluded that the MEC source at the MRS was triple-base propellants lying on the ground surface. Considering this, the human receptor pathway was considered as contact with MEC in surface soils by handling or treading underfoot (e^2M, 2008). **Figure 2-1** presents the preliminary CSM for MEC at the Load Line #1A MRS as presented in the SI Report.

The SI field activities showed the presence of lead in surface soil on the northwestern side of the elevated building slab at CB-14. Complete pathways for MC were considered present for surface soil and potential pathways were considered present for subsurface soil. Exposures to MC were analyzed to include dermal contact and ingestion of contaminated soil. Transport of MC via groundwater, surface water, and sediments was also considered to be possible (e^2M, 2008). **Figure 2-2** presents the preliminary CSM for MC at the Load Line #1A MRS as presented in the SI Report.

2.2 Applicable or Relevant and Appropriate Requirements and TBC Information

Applicable or relevant and appropriate requirements (ARARs) and “to be considered” (TBC) guidance for future anticipated and reasonable remedial actions at the facility under the MMRP are currently under development. Once ARARs and/or TBC materials have been identified, preliminary remediation goals and remedial action objectives will also be developed. The ARARs, TBCs, and other developed guidance and objectives will be included in the follow-on documents for this MRS as required under the CERCLA process.

2.3 Data Quality Objectives and Data Needs

The DQOs and data needs were determined at the planning stage and are outlined in the Work Plan (Shaw, 2011). The data needs included characterization for MEC and/or MC associated with the former activities at the MRS. The DQOs were developed to ensure the reliability of field sampling, chemical analyses, and physical analyses; the collection of sufficient data; the acceptable quality of data generated for its intended use; and valid assumptions could be inferred from the data.

2.3.1 Data Quality Objectives

The DQOs were developed for MEC in accordance with data needs, the *Facility-Wide Sampling and Analysis Plan for Environmental Investigations at the RVAAP* (SAIC, 2011); hereafter referred to as the FWSAP, and the U.S. Environmental Protection Agency (EPA) *Data Quality Objectives Process for Hazardous Waste Site Investigations, EPA QA/G-4HW* (2000). **Table 2-1** identifies the DQO process at the Load Line #1A MRS as presented in the Work Plan (Shaw, 2011).

Table 2-1
Data Quality Objectives Process at the Load Line #1A MRS

Step	Data Quality Objective
1. State the problem.	The MRS consists of a 0.41-acre area located near the northwest side of the former elevated building CB-14 where triple-base propellants were observed on the ground surface and MC results for elevated lead concentrations and low detects for explosives were detected in surface soil during the SI field activities. The principle sources of MEC at the Load Line #1A MRS were reported to be accidental releases during the loading of munitions during World War II and the Korean War. These activities resulted in the potential for MEC and MD, including propellants, to be present in surface soil at the Load Line #1A MRS (e^2M, 2008). Based on the findings and conclusions presented in the SI Report (e^2M, 2008), there is a potential for MEC on the ground surface and a potential for environmental impacts from MC at the MRS.
2. Identify the decision.	The goal of the investigation at the Load Line #1A MRS is to identify the areas impacted with MEC. In addition, MC sampling will be predetermined in order to further characterize the nature and extent of contamination associated with previous activities at the MRS. The information obtained during the RI will be used to assess the potential risk and hazards posed to human health and the environment.
3. Identify inputs to the decision.	• Historical information • Instrument-assisted visual survey • Incremental environmental media sampling
4. Define the study boundaries.	The RI investigation will be performed in the Load Line #1A MRS boundaries as defined at the conclusion of the SI Report (e^2M, 2008).

Table 2-1 (continued)
Data Quality Objectives Process at the Load Line #1A MRS

Step	Data Quality Objective
5. Develop a decision rule.	In order to define the amount of MEC (triple-base propellant) at the Load Line #1A MRS, CB&I will perform a visual survey of the entire MRS. First, the visual survey will investigate the surface area. Then, the team will perform a visual survey with the slag removed. Two ISM surface soil samples are proposed at the MRS in the Work Plan stage. In addition, discrete samples (surface and subsurface) will be collected in areas where concentrated MEC/MD is identified. The final location and number of discrete samples, if any, would be proposed at the conclusion of the MEC investigation.
6. Specify limit of decision errors.	QC procedures are in place so that all field work was performed in accordance with all applicable standards. Further details on the QC process implemented during the RI are located in Section 4 of the Work Plan (Shaw, 2011).
7. Optimize the design for obtaining data.	The information gathered as part of the field investigation at the Load Line #1A MRS will be used to determine what risks, hazards, if any, were present at the MRS. CB&I will perform a MEC HA to identify potential MEC hazards. In addition, MRS-specific HHRA and ERA will be performed on the analytical results. If unacceptable risks or hazards to human health and the environment are determined to exist at the MRS at the conclusion of the investigation, then the MRS will be identified for further evaluation under the CERCLA process.

CERCLA denotes Comprehensive, Environmental Response, Compensation, and Liability Act of 1980.

ERA denotes ecological risk assessment.

HA denotes hazard assessment.

HHRA denotes human health risk assessment.

ISM denotes incremental sampling methodology.

MC denotes munitions constituents.

MD denotes munitions debris.

MEC denotes munitions and explosives of concern.

MRS denotes Munitions Response Site.

QC denotes quality control.

RI denotes remedial investigation.

SI denotes site inspection.

2.3.2 Data Needs

For MEC, data needs include determining the types, locations, condition, and quantity of MEC items present at the MRS so that the potential hazard to likely human and ecological receptors can be assessed and remedial decisions can be made. The DQOs were developed in accordance with the FWSAP (SAIC, 2011), the DQO Guidance (EPA, 2000), and experience with MRSs containing MEC. These data needs for MEC were evaluated using the most applicable methods and technologies that are discussed in following sections.

For MC, data needs include sufficient information to determine the nature and extent of MC, determine the fate and transport of MC, and characterize the risk of MC to potential receptors by performing a human health risk assessment (HHRA) and an ecological risk assessment (ERA). More specifically, the data needed are concentrations of MC associated with the MRS in surface soil that pose a potential unacceptable risk to human and ecological receptors. Data quality was assessed through the evaluation of sampling activities and field measurements associated with the chemical data in order to verify the reliability of the chemical analyses and the precision, accuracy, completeness, and sensitivity of information acquired from the laboratory. Representativeness and comparability were also evaluated with regard to the proper design of the sampling program and quality of the data set respectively. The reporting limits (a.k.a., method detection limits [MDLs] or method reporting limits [MRLs]) should be equal to or less than the screening criteria to support the HHRA and ERA in this RI Report whenever possible.

2.3.3 Data Incorporated into the RI

Whenever possible, existing data are incorporated into this RI Report. The following summarizes existing data and how that data were used:

- **Historical Records Review—**The HRR (e^2M, 2007) provides historical documentation regarding the MRS and identifies the types of activities previously conducted, the types of munitions used, and historical finds and incidents. These data were used to identify the expected baseline conditions and other hazards that may be present.
- **Installation Restoration Program Data—**Data collected under the IRP at various AOCs collocated with MRSs include analytes considered to be MC associated with previous activities at the MRS, although it should be noted that not all analytes are considered as MC. The IRP data set may be incorporated with sampling data collected during the RI on a MRS-specific basis in order to close data gaps. For the Load Line #1A MRS, the IRP data were reviewed and it was determined that incorporation of the data was not warranted, as no previous IRP samples were taken from within the current 0.41-acre MRS boundaries.
- **Site Inspection Data—**MC sampling was performed at the Load Line #1A MRS during the 2007 SI field activities. One ISM surface soil sample and a duplicate were collected at depths of 0 to 6 inches bgs from a sampling unit that consisted of the entire 0.41-acre MRS. The purpose of the predetermined ISM surface soil samples for the RI field activities were to further characterize the nature and extent of contamination associated with previous activities at the MRS. In addition, any samples collected during the RI field work would be considered more representative

of current conditions at the MRS in comparison to samples collected in 2007. This is applicable due to the demolition activities of the adjacent CB-14 building slab and remediation activities at locations near the MRS that may have resulted in vehicle and heavy equipment traffic and the disturbance of surface soils. Therefore, the ISM sample result from the SI field activities was not used for the purposes of this RI Report.

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3.0 CHARACTERIZATION OF MEC AND MC

This section documents the approaches used to investigate MEC and MC at the Load Line #1A MRS in accordance with the DQOs presented in Section 2.0, “Project Objectives.” The MEC and MC characterization activities were conducted in accordance with Section 3.0, “Field Investigation Plan” of the Work Plan (Shaw, 2011).

3.1 MEC Characterization

Based on observations of triple-base propellant nodules at the MRS during the 2007 SI field activities, it was determined that there is a potential for MEC on the ground surface. In order to fully characterize the amount of MEC, CB&I performed visual surveys at the Load Line #1A MRS on two separate occasions. The following section summarizes the processes used to implement the visual surveys that were performed at the Load Line #1A MRS. The results of the visual surveys are discussed in Section 4.0.

3.1.1 Visual Survey Activities

Nonintrusive visual surveys were performed at the Load Line #1A MRS on two occasions during the RI field activities. The first step of the RI field work at the Load Line #1A MRS was to perform an instrument-assisted visual survey over 100 percent of the MRS. The instrument-assisted visual survey, which occurred on April 29, 2011, was performed to investigate the ground surface for the presence of MEC. While performing the visual survey, any anomalies identified by the Schonstedt magnetometer were documented. Although subsurface MEC was not anticipated at the Load Line #1A MRS, the Schonstedt magnetometer was used to verify that ferrous items (i.e., potential MEC) were not present at the MRS.

Following the completion of the initial visual survey, the Work Plan (Shaw, 2011) specified that slag from the ground surface be removed and a second visual survey be performed. The goal of the second visual survey was to look solely for triple-base propellant nodules (approximately 1 by ¼ inch in size). Since the triple-base propellant nodules do not contain ferrous material, a magnetometer was not used for this survey. During the RI field activities, minimal slag was present at the MRS and removal of this material was not required. The second visual survey was conducted on May 20, 2011, and was performed over 100 percent of the MRS.

The surveys were performed by UXO-qualified personnel. The equipment used for the instrument-assisted survey consisted of a Schonstedt Model 52CX flux-gate magnetometer, which was used to locate ferrous items. All investigation activities were conducted in accordance with the Work Plan's Section 3.2.3, "Load Line #1 (RVAAP-008-R-01)" (Shaw, 2011).

3.1.2 Field Instrument Quality Control

Prior to the instrument-assisted visual survey operations at the Load Line #1A MRS, a brief test program was performed at the instrument verification strip established at Load Line #7 at the facility for field instrument quality control (QC) measures. The objectives of the test program were to validate the Schonstedt magnetometer handheld sensor meets the project objectives, ensure the instrument settings and survey parameters were optimized and the sensor was functioning properly on a daily basis, and certify the sweep personnel performing the magnetometer and dig and detector-aided visual survey tasks. This ensured that consistent data of known quality was being collected.

Prior to performing the visual surveys at the Load Line #1A MRS, inert seed items consisting of industry standard objects were buried at the depth and orientation indicated and separated along the analog test strip at intervals of approximately 5 to 10 feet. The industry standard objects consisted of 1- by 4-inch (small), 2- by 8-inch (medium), and 4- by 12-inch (large) pipe nipples made from Schedule 40 black carbon steel from McMaster Carr Hardware (or equivalent). After burial of the inert seed items, the UXOQC Specialist conducted a test program using experienced operators, whereby the handheld detector settings were optimized and documented for the soil conditions and reliable detection of the seed items. The results of the instrument verification strip indicate that the instrument functional test program would ensure the instruments used were of sufficient quantity and quality to meet the project objectives for the visual survey investigation.

3.2 MC Characterization

This section summarizes the MC characterization activities and decision making process at the Load Line #1A MRS. Sampling for MC was predetermined during the DQO decision-making process to further characterize the nature and extent of contamination associated with previous activities at the MRS. In accordance with the Work Plan (Shaw, 2011), ISM soil samples were proposed at two sampling units at the MRS. The determination as to whether additional MC characterization was required at the MRS was made based on historical evidence and the results of the MEC investigations. Additional discrete samples were proposed in areas identified with concentrated MEC/MD. The final location, type, and quantity for any additional samples required approval from the USACE and the Ohio EPA following the MEC investigation. All MC samples were collected in accordance with the *Final Sampling and Analysis Plan and Quality Assurance Project Plan* included in Appendix D of the Work Plan (Shaw, 2011); hereafter, referred to as the SAP. The results of the MC sampling activities are presented in Section 4.3, "Nature and Extent of SRCs."

3.2.1 Sampling Approach

The decision to collect ISM surface soil samples at predetermined sampling units was made during development of the DQOs in the Work Plan (Shaw, 2011) that stated that additional ISM and/or discrete samples may be required if locations at the MRS with concentrated areas of MEC/MD areas are identified during the RI field surveys. No MEC or MD was identified at the Load Line #1A MRS during the investigation activities; therefore, only the predetermined ISM samples were collected and additional sampling for MC was not warranted. The rationale for not collecting additional samples at the MRS is presented in the *Visual Survey Results and Proposed Munitions Constituents Sampling Locations for the Load Line #1 MRS (RVAAP-008-R-01)* technical memorandum included in **Appendix A**.

3.2.1.1 Surface Soil Sample Collection

The ISM surface soil samples were collected during the RI field activities in August 2011 to further characterize the nature and extent of contamination associated with previous activities at the MRS. There were no deviations from the Work Plan (Shaw, 2011) during the RI field activities. The combined proposed sampling units cover the entire MRS that is considered the decision unit. The sample depth was determined to be 0.5 feet bgs, which is the maximum depth that contamination from triple-base propellant on the ground surface would be expected to vertically migrate in the soil column. This sample interval is in accordance with the recommended sampling approach that is presented in the *Military Munitions Response Program Munitions Response Remedial Investigation/Feasibility Study Guidance* (U.S. Army, 2009). **Table 3-1** summarizes the media samples for the RI and the rationale for the sample strategy.

Table 3-1
Summary and Rationale for Surface Soil Sampling at the Load Line #1A MRS

Sample Medium	Sample Type	Sample Depth (feet bgs)	No. of Samples[1]	Sampling Rationale
Surface Soil	ISM	0–0.5	2	To further characterize the nature and extent of contamination associated with previous activities at the MRS.

[1] Number of samples does not include duplicate or other quality control samples.
bgs denotes below ground surface.
ISM denotes incremental sampling methodology.
MRS denotes Munitions Response Site.

Detailed presentation of the procedures used to collect ISM samples are presented in the SAP (Shaw, 2011) and are based upon the procedures presented in the *Interim Guidance 09-02, Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program* (USACE, 2009). The methods used for the collection of the ISM surface soil samples during the RI are summarized below.

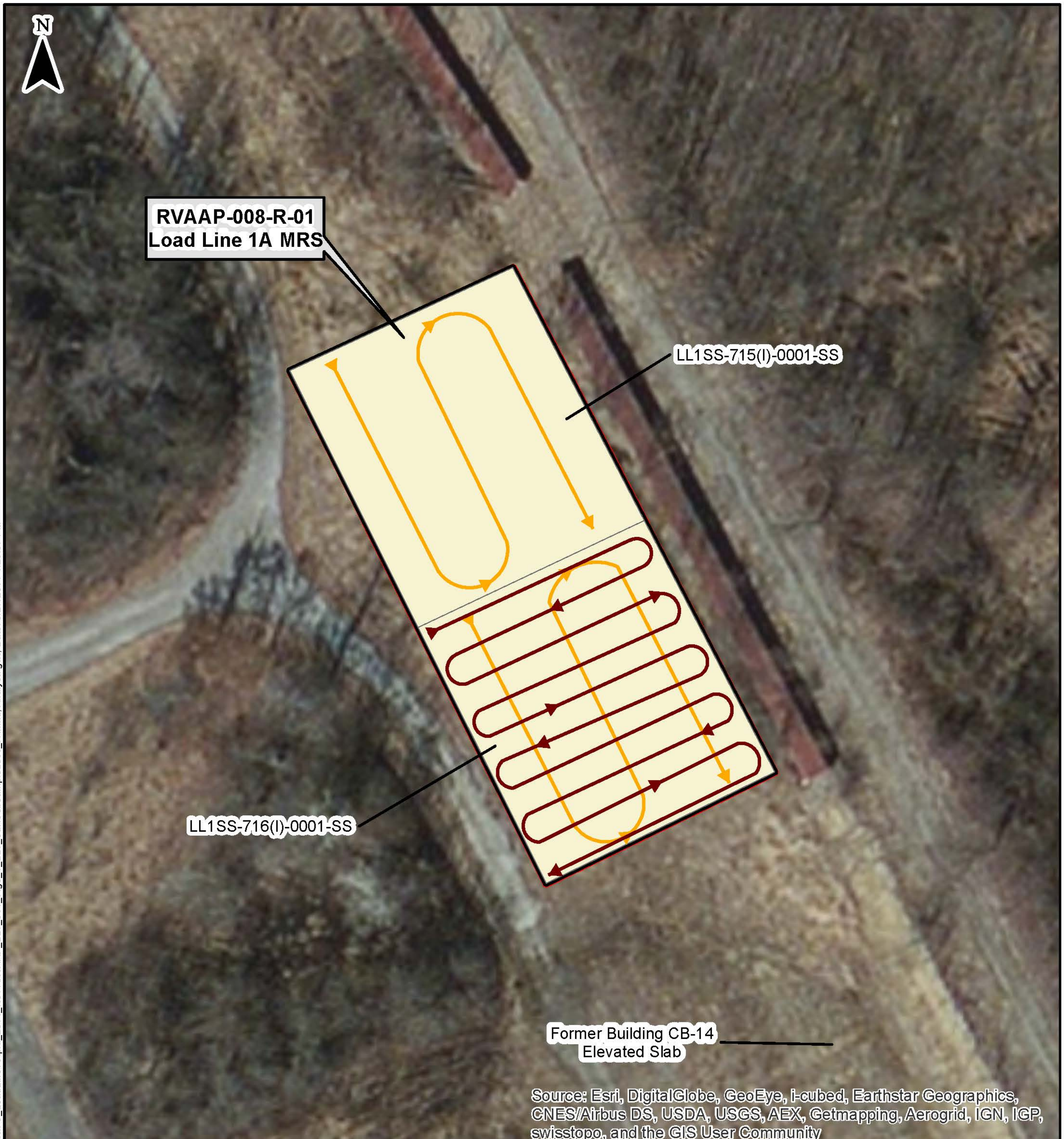
Each ISM surface soil sample consisted of 30 increments collected from locations selected in a systematic random pattern throughout the designated grid area (i.e., sampling unit). The 0.41-acre MRS is considered the ISM decision unit and was split into two predetermined sampling units (approximately 0.2 acres each) that are equally considered areas of anticipated use by potential receptors. Splitting the decision unit into multiple sampling units resulted in more frequent increments than collected during the SI Report (e^2M, 2008) that were used to further evaluate the nature and extent of contamination associated with previous activities at the MRS (**Figure 3-1**). The three key steps for collection of a systematic increment were: (1) subdivide the sampling unit into a uniform grid (i.e., pace out the area and divide into at least 30 grids for a 30-increment sample), (2) randomly select a single increment location in the first grid, and (3) collect increments from the same relative location within each of the other grids.

The sampling units were established by placing pin flags at the corners of each unit. The ISM samples were collected from the predetermined number of increment sample locations using a $^{7}/_{8}$-inch-diameter stainless steel step probe sample collection device. The increments of soil were placed into a plastic lined bucket and combined to make a single sample weighing between 1 to 2 kilograms.

The QC samples included a field duplicate sample, which was also designated as the matrix spike/matrix spike duplicate sample (MS/MSD). The collection of the QC samples required similar increments of soil as the original sample. Therefore, at the ISM sampling unit where a QC sample was required, an additional ISM sample was collected from within the same sampling unit consisting of at least 30 increments of soil. The field duplicate was labeled with a different sample number and submitted to the laboratory for processing as a blind field duplicate. All data and observations at each sample location were recorded in the sampling field logs included in **Appendix A**.

3.2.2 Sample Analysis

Analytical services for chemical samples were provided by the DoD Environmental Laboratory Accreditation Program (ELAP) and the National Environmental Laboratory Accreditation Conference accredited laboratory CT Laboratories, Inc. of Baraboo, Wisconsin. The EPA publication SW846 entitled, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Analytical Protocols* (EPA, 2007) provides test procedures and guidance that are recommended for use in conducting the evaluations and measurements needed to comply with the *Resource Conservation and Recovery Act* (RCRA). These methods are accepted by the EPA for obtaining data to satisfy the requirements of 40 Code of Federal Regulations (CFR), Parts 122 through 270, promulgated under RCRA, as amended, and are commonly used on CERCLA sites for contamination evaluation. Test methods are

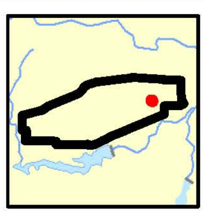


MRS Boundary

ISM Soil Sample Unit

Original Sample Path

Duplicate Sample Path



0 50 100 Feet

Projection : NAD_1983_UTM_Zone_17N

U.S. ARMY
CORPS OF ENGINEERS
BALTIMORE DISTRICT

MILITARY MUNITIONS RESPONSE PROGRAM

LOAD LINE #1A MRS
FORMER RVAAP/CAMP RAVENNA
PORTAGE AND TRUMBULL COUNTIES, OHIO

CB&I Federal Services LLC
150 Royall Street
Canton, MA 02021

H:\MAMMS\Ravenna\GIS_Documents\Project_Maps\MMRP\RIFS\RIFS_LoadLine1\April_2014_Rev1\RVAAP_LL1_014_Fig3_1_LL1_SurfSoilSampleLocs_r1.mxd; Analyst: gwt; Date: 8/27/2014 4:25:37 PM

FIGURE 3-1 SURFACE SOIL SAMPLING UNIT LOCATIONS

approved procedures for measuring the presence and concentration of physical and chemical pollutants, evaluating properties such as toxic properties of chemical substances, or measuring the effects of substances under various conditions. The selection of chemical analyses for the Load Line #1A MRS was based on the types of munitions historically identified at the MRS and the potential MC associated with those munitions. The only munitions identified for the Load Line #1A MRS were bulk triple-base propellants. Based on this information, the proposed analytical suites and methods were presented in the *MC Sampling Rationale* included in the SAP (Shaw, 2011) and included the following:

- Lead, EPA Method SW846 6010B
- Explosives, EPA Method SW846 8330B
- Nitrocellulose, EPA Method SW846 9056
- Total organic carbon (TOC), Lloyd Kahn Method
- pH, EPA Method SW846 9045D

In addition to the above analyses, the surface soils samples were also analyzed for geochemical parameters via EPA Method 6010B in order to potentially evaluate naturally high inorganic concentrations and distinguish them from potential contamination. The geochemical parameters analyzed for the Load Line #1A MRS include aluminum, calcium, magnesium, and manganese.

Each 1- to 2-kilogram sample was submitted to the contracted laboratory for processing and analysis. Processing consisted of drying out the sample and sieving the sample through a #10 sieve. Any material larger than the #10 sieve was discarded. The remaining air-dried, sieved material was then ground using a puck mill to reduce the particle size as sampling splitting and particle size reduction is necessary to reduce fundamental error. The final reduced portions of the ISM field samples were analyzed for lead, explosives, and nitrocellulose. The ISM field samples were analyzed for TOC and pH following processing of the sample and prior to grinding. The surface soil sampling units at the MRS are presented in **Figure 3-1**. A summary of the number and types of samples collected is presented in **Table 3-2**.

Table 3-2
Summary of Field Samples Collected and Required Analytical Parameters

Sample Name	Sample Type	Depth (ft bgs)	Analytical Parameters	No. of Samples	Field Duplicate
LL1SS-715(I)-0001-SS	ISM	0–0.5	• Lead • Geochemical Parameters[1]	1	

Sample Name	Sample Type	Depth (ft bgs)	Analytical Parameters	No. of Samples	Field Duplicate
LL1SS-716(I)-0001-SS			• Explosives • Nitrocellulose • TOC • pH	1	1

[1] *Geochemical metals include analyses for aluminum, calcium, magnesium, and manganese.*

ft bgs denotes feet below ground surface.

ISM denotes incremental sampling methodology.

TOC denotes total organic carbon.

The collected samples were properly packaged for shipment and dispatched to the contracted analytical laboratory, CT Laboratories in accordance with the SAP (Shaw, 2011). A separate signed custody record with sample numbers and locations listed was enclosed with each shipment. When transferring the possession of samples, the individuals relinquishing and receiving signed, dated, and noted the time on the record. All shipments complied with applicable U.S. Department of Transportation regulations for environmental samples.

3.2.3 Laboratory Analyses

The surface soil samples were collected and analyzed according to the FWSAP (SAIC, 2011) and the SAP (Shaw, 2011). The FWSAP and associated addenda were prepared in accordance with USACE and EPA guidance, and outline the organization, objectives, intended data uses, and quality assurance (QA)/QC activities to achieve the desired DQOs and to maintain the defensibility of the data. Project DQOs were established in accordance with EPA DQO Guidance (2000). Requirements for sample collection, handling, analysis criteria, target analytes, laboratory criteria, and data validation criteria for the RI are consistent with EPA requirements for National Priorities List sites. The DQOs for this project included analytical precision, accuracy, representativeness, completeness, comparability, and sensitivity for the measurement data.

Strict adherence to the requirements set forth in the FWSAP (SAIC, 2011) and the SAP (Shaw, 2011) was required of the analytical laboratory so that conditions adverse to quality would not arise. The laboratory was required to perform all analyses in compliance with EPA SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Analytical Protocols* (EPA, 2007). SW-846 chemical analytical procedures were followed for the analyses of metals, explosives, and nitrocellulose. The contracted laboratory was required to comply with all methods as written; recommendations were considered requirements.

The QA/QC samples for this project included field blanks, laboratory method blanks, laboratory control samples (LCSs), laboratory duplicates, and MS/MSDs. An equipment rinsate sample was submitted for analysis, along with a field duplicate sample, to provide a means to assess the quality of the data resulting from the field sampling program. **Table 3-3** presents a summary of QA/QC samples utilized during the RI field activities for the Load Line #1A MRS.

Table 3-3
Summary of Quality Assurance/Quality Control Samples

Sample Type	Rationale
Field Duplicate	Analyzed to determine sample heterogeneity and sampling methodology reproducibility
Equipment Rinsate	Analyzed to assess the adequacy of the equipment decontamination processes for soil
Laboratory Method Blanks	Analyzed to determine the accuracy and precision of the analytical method as implemented by the laboratory
Laboratory Duplicate Samples	Analyzed to assist in determining the analytical reproducibility and precision of the analysis for the samples of interest and provide information about the effect of the sample matrix on the measurement methodology
Matrix Spike/Matrix Spike Duplicate	Analyzed to assist in determining the analytical reproducibility and precision of the analysis for the samples of interest and provide information about the effect of the sample matrix on the measurement methodology

CB&I is the custodian of the project file and will maintain the contents of the files for this investigation, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports, correspondence, and chain-of-custody forms. These files will remain in a secure area under the custody of CB&I until they are transferred to the USACE, Baltimore District and the ARNG. CT Laboratories retain all original raw data in a secure area under the custody of the laboratory project manager.

CT Laboratories performed in-house analytical data reduction under the direction of the laboratory project manager and QA officer. These individuals were responsible for assessing data quality and informing CB&I of any data that are considered “unacceptable” or required caution on the part of the data user in terms of its reliability. Data were reduced, reviewed, and reported as described in the laboratory QA manual and the laboratory standard operation procedures in the SAP (Shaw, 2011). Data reduction, review, and reporting by the laboratory were conducted as follows:

- Raw data produced by the analyst were turned over to the respective area supervisor.
- The area supervisor reviewed the data for attainment of QC criteria, as outlined in the established methods and for overall reasonableness.
- Upon acceptance of the raw data by the area supervisor, a report was generated and sent to the laboratory project manager.

- The laboratory project manager completed a thorough review of all reports.
- Final reports were generated by the laboratory project manager.

Data were then delivered to CB&I for data validation. CT Laboratories prepared and retained full analytical and QC documentation for the project in electronic storage media (i.e., compact disc), as directed by the analytical methods employed. CT Laboratories provided the following information to CB&I in each analytical data package submitted:

- Cover sheets listing the samples included in the report and narrative comments describing problems encountered in analysis.
- Tabulated results of inorganic and organic compounds identified and quantified.
- Analytical results for QC sample spikes, sample duplicates, and initial and continuing calibration verifications of standards and blanks, method blanks, and LCS information.

3.2.4 Data Validation

Following receipt of the analytical data packages, CB&I performed data validation on all three surface soil ISM samples collected from the Load Line #1A MRS (including field duplicate and QC samples) to ensure that the precision and accuracy of the analytical data were adequate for their intended use. The review constituted comprehensive validation of 100 percent of the primary dataset and a comparison of primary sample and field duplicate sample. This validation also attempted to minimize the potential of using false-positive or false-negative results in the decision-making process (i.e., to ensure accurate identification of detected versus nondetected compounds). This approach was consistent with the DQOs for the project and with the analytical methods, and was appropriate for determining chemicals of concern and calculating risk.

Analytical results were reported by the laboratory in electronic format and were issued to CB&I on compact disc. Data validation was performed to ensure all requested data were received and complete. Data use qualifiers were assigned to each result based on laboratory QA review and verification criteria. Results were qualified as follows:

- “U”**—**Analyte was not detected or reported less than the level of detection.
- “J”**—**The reported result is an estimated value.

In addition to assigning qualifiers, the validation process also selected the appropriate result to use when reanalysis or dilutions were performed. Where laboratory surrogate recovery data or laboratory QC samples were outside of analytical method specifications, the validation chemist determined whether laboratory reanalysis should be used in place of an original reported result. If the laboratory results were reported for both diluted and undiluted samples, diluted sample results were used for those analytes that exceeded the calibration range of the undiluted sample. A complete presentation of the validation process and results for the RI data is contained in the *Data Validation Report* in **Appendix B**.

3.2.5 Data Review and Quality Assessment

This section provides discussion of data review and the results of the data validation process and evaluates usability of data collected for this sampling event in accordance with the project QA program. Quality assurance is defined as the overall system for assuring the reliability of data produced. The system integrates the quality planning, assessment, and improvement efforts of various groups in the organization to provide the independent QA program necessary to establish and maintain an effective system for collection and analysis of environmental samples and related activities. The program also encompasses the generation of useable and complete data, as well as its review and documentation.

The QA program was designed to achieve the DQOs for the RI. The program was developed in accordance with the project specifications and the data were produced, reviewed, and reported by the laboratory in accordance with specifications outlined in the SAP (Shaw, 2011), FWSAP (SAIC, 2011), the *Quality Systems Manual, Version 4.2* (DoD, 2010) and the laboratory's QA manual. Laboratory reports included documentation verifying analytical holding time compliance. The DQOs were developed concurrently with the Work Plan (Shaw, 2011) to ensure the following:

- The reliability of field sampling, chemical analyses, and physical analyses
- The sufficiency of collected data
- The applicability of data for intended use
- The validity of assumptions inferred from the data

Attainment of the DQOs was assessed throughout the evaluation of all data collected using data quality indicators that are discussed in detail in this section. For this RI Report, a full data validation effort was performed to assess laboratory performance, including a review of the following:

- Completeness
- Chain-of-custody records
- Sample holding times

- QC results reported on summary forms as applicable to the analysis performed (i.e., initial and continuing calibrations; method, calibration, equipment, and trip blanks; LCS/MS/MSD; performance and interference check samples and instrument tunes; surrogates; internal standards; and serial dilutions)
- Detection and reporting limits
- Other contractual items

Criteria for QC results were compared to laboratory established criteria in accordance with the method and work plan requirements. Further details and discussion are provided in the *Data Validation Report* in **Appendix B**.

Data were qualified during the validation process from predetermined criteria for QC nonconformances. The quality of data collected in support of the RI sampling activities as noted in data tables is considered acceptable with qualifications, unless qualified as rejected (and denoted with "R" qualifier) during the validation process. Results were assessed for accuracy and precision of laboratory analyses to identify the limitations and quality of data. A QA review of the data was performed and the following data quality indicators were measured:

- **General Review—**The EPA Guidance, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part A, Interim Final* (EPA, 1989), states that the data qualified during the validation process as estimated "J" or "UJ" may be included in quantitative assessments indicating the associated numerical value is an estimated quantity, i.e., the guidance states to "use J-qualified concentrations the same way as positive data that do not have this qualifier." In review of analytical information, the sample results qualified as "J" (i.e., estimated or nondetect estimated values) during the validation process are considered usable data points (EPA, 1989), and are included in the data summary tables of this report. The majority of the "J" qualified samples were the result of analytical column confirmation or accuracy recoveries outside criteria. There were no data rejections (i.e., R-flagged results) resulting from the data validation reviews.
- **Precision—**Laboratory duplicate pairs and/or laboratory spiked duplicate pairs were analyzed as per method requirements for each parameter and/or compound on a batch and matrix specific basis. Field duplicates were collected on the basis of 10-percent frequency per matrix to identify the cumulative precision of the sampling and analytical process and were sent on a blind basis to the laboratory. Field duplicates are evaluated at less than or equal to a 50-percent relative percent difference (RPD) for organic parameters and less than or equal to a 25-percent

RPD for inorganic parameters. Field duplicate pairs, laboratory duplicate pairs, and/or laboratory MSDs were evaluated for the surface soil samples.

The MS/MSD pair was outside RPD criteria for target compound 1,3,5-trinitrobenzene for the spiked sample LL1SS-715(I)-0001-SS; therefore, the spiked sample was qualified estimated "J" based upon this outlier. All laboratories duplicates and other MSD pairs were within RPD criteria limits; therefore, did not warrant further qualification. A blind field duplicate sample pair LL1SS-716(I)-0001-SS/LL1SS-017(I)-0001-SS was collected for all parameter groups. For the field duplicate pair, explosive compound nitroguanidine was detected at low levels in the parent sample and nondetect in the associated duplicate pair. The nitroguanidine detection did not pass method confirmation criteria; therefore, it was qualified estimated "J" based upon this outlier. For all other parameter groups, all criteria were met for the field duplicate. Although these results have been qualified as estimated due to the outliers noted, the data are still considered useable (EPA, 1989). Further discussion is provided in the *Data Validation Report* in **Appendix B**.

- **Accuracy—**Accuracy was evaluated for each matrix by reviewing the recovery results of the LCS, MS/MSD, and surrogate, as applicable, for each analytical method performed. The LCS, MS/MSD, and surrogate QC samples were analyzed as per method requirements for each parameter and/or compound on a batch and matrix specific basis.

The MS/MSD recoveries for spiked sample LL1SS-715(I)-0001-SS exceeded recovery limits for lead, magnesium, and manganese. The associated serial dilution and/or post-digestion spike recoveries were within acceptable limits for these metals as well as the high sample concentrations related to the amount spiked; therefore, their results were reported without qualification in the parent sample. MS/MSD recoveries for sample LL1SS-715(I)-0001-SS were below the recovery limits for nitrocellulose; therefore, the parent sample result was qualified estimated nondetect with a "UJ" flag based upon this outlier. All other MS/MSD recoveries were within criteria.

The rinsate blank sample LL1-718-RB had a surrogate recovery that was more than double the spiked surrogate amount. The method and laboratory blanks, as well as the LCS, had acceptable surrogate recoveries. The sample was reanalyzed on the confirmation column and the surrogate recovery was within the acceptable range. All other surrogates were within criteria for the surface soil samples.

All LCS recoveries were within criteria limits for all parameter groups; therefore, did not warrant qualification. As a result, no further actions were required.

Although some data results have been qualified as estimated due to the outliers noted, the data are still considered useable (EPA, 1989). Further discussion is presented in the *Data Validation Report* in **Appendix B**.

- **QC Blanks—**Method blanks, calibration blanks, and rinsate blanks were evaluated to identify potential non-site-related contamination from sample collection through laboratory analyses. Analytical results found within the "5 times" and "10 times" rules were qualified "B" and considered nondetect at the limit of detection (LOD) or level of contamination, whichever was greater. From EPA Guidance (1989), the definitions of the "5 times" and "10 times" rules are as follows:

> "If the blank contains detectable levels of one or more organic or inorganic chemicals, then consider site sample results as positive only if the concentration of the chemical in the site sample exceeds five times the maximum amount detected in any blank for compounds that are not considered by EPA to be common laboratory contaminants. Consider ten times the maximum amount for common laboratory contaminants acetone, 2-butanone (methyl ethyl ketone), methylene chloride, toluene, and the phthalate esters. Treat samples containing less than five times (ten times for common laboratory contaminants) the amount in any blank as nondetects and consider the blank-related chemical concentration to be the quantitation limit for the chemical in that sample."

All laboratory calibration blanks and rinsate blank (LL1-718-RB) were nondetect (less than or equal to the limit of detection) for all target analytes, and therefore, did not warrant qualification. Trace amounts of calcium, magnesium, and manganese were detected in the laboratory method blank (less than or equal to LOD); however, these concentrations were well below detected sample concentrations and did not warrant qualification. As a result, no further actions were required. Further discussion is provided in the *Data Validation Report* in **Appendix B**.

- **Representativeness—**Representativeness is a measure of the degree to which the measured results accurately reflect the medium being sampled. It is a qualitative parameter that is addressed through the proper design of the sampling program in terms of sample location, number of samples, and actual material collected as a "sample" of the whole. Representativeness applies to both sampling and analytical evaluations and should be 100 percent. Analytical representativeness is inferred from associated documentation (i.e., data validation reports, field records, etc.) for holding times, QC blanks, accuracy, and precision, as well as from the completeness evaluations. Sampling protocols were developed to assure that samples collected are representative of the media. Field handling protocols (i.e., storage, handling in the field, and shipping) were designed to protect the representativeness of the collected samples.

A QC field inspection was conducted for field sampling activities at the facility in accordance with the Work Plan (Shaw, 2011). The inspection was activity-based and covered ISM surface soil sample collection conducted at the Group 8 MRS in February 2012. Although, the inspection was not conducted at the Load Line #1A MRS, it is considered applicable to the representatives of the ISM surface soil samples collected at the MRS. The *Quality Surveillance Summary Report* conducted at the Group 8 MRS is presented along with the field documentation in **Appendix A**.

Several nonconformances were observed during the QA field inspection by the UXOQC Specialist. The noncomformances included not having the sampling standard operating procedures (SOPs) on-site during the beginning of field sampling activities and the potential for cross-contaminating equipment with used sampling gloves. These noncomformances were remedied in the field and the corrective action included retrieving the sampling SOPs from the field office and ensuring that new sampling gloves were donned after handling used equipment. The primary nonconformance that had the potential to affect the data was the handling of decontaminated equipment with used gloves. This incident was observed by the UXOQC Specialist prior to actual sampling activities and during the removal of the sampling equipment and materials from the vehicle. There was no contact with used gloves on the end of the step probe used to collect the ISM samples and the handle and stem of the step probe was recleaned prior to sample collection. Results of the rinsate blank (GR8-RB-01) for the sampling equipment step probes provide supporting evidence that equipment was properly decontaminated during field activities.

An additional nonconformance was identified by the UXOQC Specialist and was considered to be more of a recommendation. The recommendation was to ensure the separation of the step probes from other equipment in the vehicle. The step probes were properly protected at the time of the observance as noted in the audit and did not affect the data.

- **Completeness—**Completeness is a measure of the amount of information that must be collected during the field investigation to allow for successful achievement of the objectives of the program and valid conclusions. Completeness is defined as the percentage of measurements that are judged to be usable. The percent completeness criterion is 90. In this data validation review, three categories of completeness quotients are calculated: (1) the overall sampling completeness, (2) the overall analytical completeness, and (3) the analytical completeness by parameter group.

The sampling percent completeness is determined by taking the number of planned samples (including QC samples) and dividing that number by the number of samples actually collected during the current round of sampling. Three surface soil samples (including one field duplicate sample) and one rinsate blank were collected and sent to the laboratory for analysis. Three surface soil samples (including one field duplicate sample) and one rinsate blank were proposed in the Work Plan (Shaw, 2011) for this sampling event. Excluding rinsate blanks, the overall sampling completeness was 100 percent (or three surface soil samples collected divided by three planned surface soil samples).

The overall analytical percent completeness is calculated from the number of usable data inputs divided by the number of analyzed data inputs. The evaluation of completeness for the surface soil samples resulted in 72 useable data points of possible 72 data points, resulting in an overall analytical completeness quotient of 100 percent for all parameter groups. The completeness statistics were computed as follows:

- 72 represents the number of accepted analytes as usable data points (no analytes were rejected)
- 72 represents the number of analyzed inputs, which is equal to the number of analytes for all field samples

There were no rejected data points for any of the parameters explosives, metals, or nitrocellulose for this event; therefore, their analytical completeness quotients were each 100 percent. All of the overall and parameter-specific analytical completeness and soil sampling completeness quotients were above the predefined completeness goal of 90 percent. Further discussion is presented in the *Data Validation Report* in **Appendix B**.

- **Comparability—**Comparability is the confidence with which one data set can be compared to another. Comparability was controlled using SOPs that have been developed to standardize the collection of measurements, samples, and approved analytical techniques with defined QC criteria. The laboratory chemical analyses were performed by an ELAP-accredited laboratory in accordance with the approved SAP (Shaw, 2011) using cited EPA methodology. Where applicable, the

EPA-approved methods and DoD *Quality Systems Manual* provided the QC criteria guidelines for the analytical methods and the ELAP accrediting body provided the QA oversight (DoD, 2010). The laboratory adapted its processes accordingly into an applicable working SOP specific to their laboratory capabilities (i.e., instrumentation, prep method, sample volumes, etc.) in applying the EPA methods. The SOPs were followed throughout the process by the laboratory, as reviewed by the ELAP accrediting body. Furthermore, laboratory data were validated in accordance with established SOPs, and the validation qualifiers were applied when QC nonconformances were identified (as applicable). The consistent use of the laboratory SOPs provides confidence with which one data set could be compared to another previous data set.

Established field SOPs that were preapproved in the SAP (Shaw, 2011) for the RI program were applied to on-site work during this surface soil sampling round. The field SOPs were followed, as established in the SAP (Shaw, 2011) to ensure that protocols meet project DQOs. The recorded field documentation provided verification that proper field procedures were followed. The consistent application of field SOPs over the course of the RI program from sampling event to sampling event lends confidence in the comparison of field data sets.

- **Sensitivity—**The sensitivities are dependent on the analytical method, the sample volumes, and percent moistures (solid matrix) used in laboratory determinative analysis. For each analyte, the method sensitivities (i.e., MDLs, MRLs, LODs, etc.) and analyte detections presented in the analytical data were compared to the screening criteria for the each of the samples collected. The analytical laboratory updated their sensitivity reporting convention from MDLs/MRLs to MDLs/LODs/MRLs during the sampling and analysis phase for this RI. Upon comparing the soil sample results to the minimum project screening criteria, the method sensitivity requirements were met. All MDLs, LODs, or MRLs were less than the project screening criteria presented in Attachment F, *Table 12 Proposed Human Health and Ecological Screening Level for Ravenna AAP MRSs* of the Work Plan (Shaw, 2011). A summary of the laboratory data results for the samples collected at the Load Line #1A MRS during the RI field activities is presented in **Appendix C**.

The Load Line #1 MRS data were determined to be of sufficient quality to make informed decisions for the surface soil samples collected. Further discussions of data qualifications are provided in the *Data Validation Report* in **Appendix B**.

3.3 Decontamination Procedures

Decontamination of dedicated sampling equipment was performed in accordance with the procedures presented in the SAP (Shaw, 2011) with the exception that the hydrochloric acid step was eliminated due to previous observations of surface corrosion on the sampling equipment when applied. The sampling equipment consisted of individual $^{7}/_{8}$-inch-diameter stainless steel step probes used to collect each of the ISM and the field duplicate surface soil samples. The step probes were decontaminated following the collection of an ISM sample at each sampling unit. All sampling decontamination procedures were performed at Building 1036, the facility contractors' building. In summary, the decontamination procedures consisted of the following:

- Wet the equipment with an American Society of Testing and Materials (ASTM) Type 1 water and phosphate free detergent (Liquinox) solution to remove residual particulate matter and surface film from the equipment.
- Rinse the equipment with ASTM Type 1 water.
- Rinse the equipment with methanol.
- Rinse with ASTM Type 1 water.
- Allow equipment to air dry.

Once dry, the sampling equipment was wrapped in aluminum foil to prevent cross contamination while in storage or transport to an MRS for sampling. In order to minimize waste, the liquids used in the decontamination process were applied using hand-held spray bottles.

Following the equipment decontamination process, an equipment rinsate sample was collected by running distilled water through the sampling equipment for the identical analytical parameters as the environmental samples. The purpose of the equipment rinsate sample was to assess the adequacy of the equipment decontamination process.

The results of the equipment blank analysis did not identify any interference or anomalies in the laboratory data and supports the adequacy of the equipment decontamination process. Evaluation of the equipment rinsate sample analytical data to assess the adequacy of the equipment decontamination process is further discussed in Section 3.2.5, "Data Review and Quality Assessment." A summary of the laboratory data results for the equipment rinsate sample is presented in **Appendix C**.

3.4 Investigation Derived Waste

The investigation derived waste (IDW) generated during the field activities at the Load Line #1A MRS consisted of solid waste that included personal protective equipment and equipment decontamination materials. Due to the minimal number of sampling equipment used and an effort to minimize waste generation, the decontamination liquids were applied using hand-held spray bottles and the spray and excess liquid was collected on absorbent pads. No free liquid wastes were generated.

The disposal of IDW was performed in accordance with the procedures presented in the Work Plan (Shaw, 2011). The IDW generated was containerized separately along with similar materials generated from other MRSs and were staged at Building 1036 in accordance with the FWSAP (SAIC, 2011). IDW management, which describes the waste characterization analyses performed, waste characterization screening, and IDW transport and disposal, is presented in **Appendix D**.

4.0 REMEDIAL INVESTIGATION RESULTS

This section presents a discussion of the results of the RI data that were collected for MEC and MC at the Load Line #1A MRS in accordance with the procedures discussed in Section 3.0, "Characterization of MEC and MC." These results will be used to determine the nature and extent of MEC and associated MC, and subsequently determine the potential hazards and risks posed to likely human and environmental receptors. Once the risks are determined, they will then be integrated into the preliminary CSMs developed during the SI (e^2M, 2008) that were presented in Section 2.0. Photographs of the RI activities performed at the MRS are presented in **Appendix E**.

4.1 MEC Investigation Results

The following sections present the results of the RI field efforts that were performed to achieve the DQOs defined in Section 2.3.1, "Data Quality Objectives," and define the nature and extent of MEC at the Load Line #1A MRS. These efforts included visual surveys of the ground surface for triple-base propellant that was performed in accordance with the Work Plan (Shaw, 2011).

4.1.1 Visual Survey Results

A full coverage nonintrusive visual survey was performed at the Load Line #1A MRS on two separate occasions. No MEC or MD was found on the ground or shallow surface soils during the visual surveys.

4.2 MC Data Evaluation

This section presents the results of the RI data screening process for MC that may be indicative of impacts from triple-base propellants previously observed on the ground surface at the Load Line #1A MRS and to evaluate the occurrence and distribution of the site-related chemicals (SRCs) in surface soil. The data evaluated for the Load Line #1A MRS are inclusive of the results of the RI sampling event only. Analytical data from a previous sample collected during the 2007 SI field activities were not included in this evaluation since the data collected for the RI are considered more representative of current conditions at the MRS as summarized in Section 2.3.3, "Data Incorporated into the RI."

The data reduction and screening process presented herein describes the statistical methods and facility-wide background screening criteria used to distinguish constituents present at ambient concentrations from those present at concentrations that indicate potential impacts related to historical operations within the MRS. The nature and extent of identified SRCs within the sampled environmental media (surface soil) established for this RI Report are also presented below. A summary of the laboratory results for the RI data is presented in **Appendix C**.

4.2.1 Data Evaluation Methods

Data evaluation methods for the Load Line #1A MRS are consistent with those established in the *Final Facility-Wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant* (SAIC, 2010); hereafter, referred to as the FWCUG Report. These methods consist of three general steps: (1) define data aggregate; (2) data verification, reduction, and screening; and (3) data presentation.

4.2.1.1 Definition of Aggregate

The data aggregate at the Load Line #1A MRS consists of surface soils collected over the lateral extent of the MRS using ISM. The 0- to 0.5-foot sample depth is the maximum anticipated depth that MC would be found within the likely area of release. The surface soil aggregate consists of sampling units of similar sizes and depth over the likely area of release and are considered comparable for screening for the evaluation of the nature and extent of SRCs associated with previous activities at the MRS.

For consideration of the MC exposure analysis, the surface soil aggregate encompasses only areas of equally probable anticipated use by receptors and the decision unit, which is the entire extent of the MRS, is the defined exposure unit (EU) for surface soil to a depth of 0.5 feet. The surface soil aggregate will be used to define human health and ecological exposure in the risk assessments as discussed in Section 7.0, “Human Health Risk Assessment” and Section 8.0, “Ecological Risk Assessment.”

4.2.1.2 Data Validation

Data validation was performed on all three surface soil ISMs collected from the Load Line #1A MRS (including field duplicates and QC samples) during the RI field activities to ensure that the precision and accuracy of the analytical data were adequate for their intended use. The review constituted comprehensive validation of 100 percent of the primary dataset as discussed in Section 3.2.4, “Data Validation,” of this report.

4.2.1.3 Data Reduction and Screening

The data reduction process implemented to identify SRCs involves identifying frequency of detection summary statistics, comparison to facility-wide background screening values (BSVs) for inorganics only, and evaluation of essential nutrients. QC and field duplicates were excluded from the screening data sets. All analytes having at least one detected value were included in the data reduction process. Summary statistics calculated for each data aggregate included the minimum, maximum, and average (mean) detected values and the proportion of detected results to the number of samples collected. For calculation of mean detected values, nondetected results were included by using one half of the reported detection limit as a surrogate value during calculation of the mean result for each compound. Following data reduction, the data was screened to identify SRCs using the processes outlined in the following sections. **Figure 4-1** shows the facility data screening process to identify chemicals as SRCs and perform selection for chemicals of potential concern (COPCs) and chemicals of concern (COCs) as necessary. The determination of COPCs and COCs is for human health evaluation only.

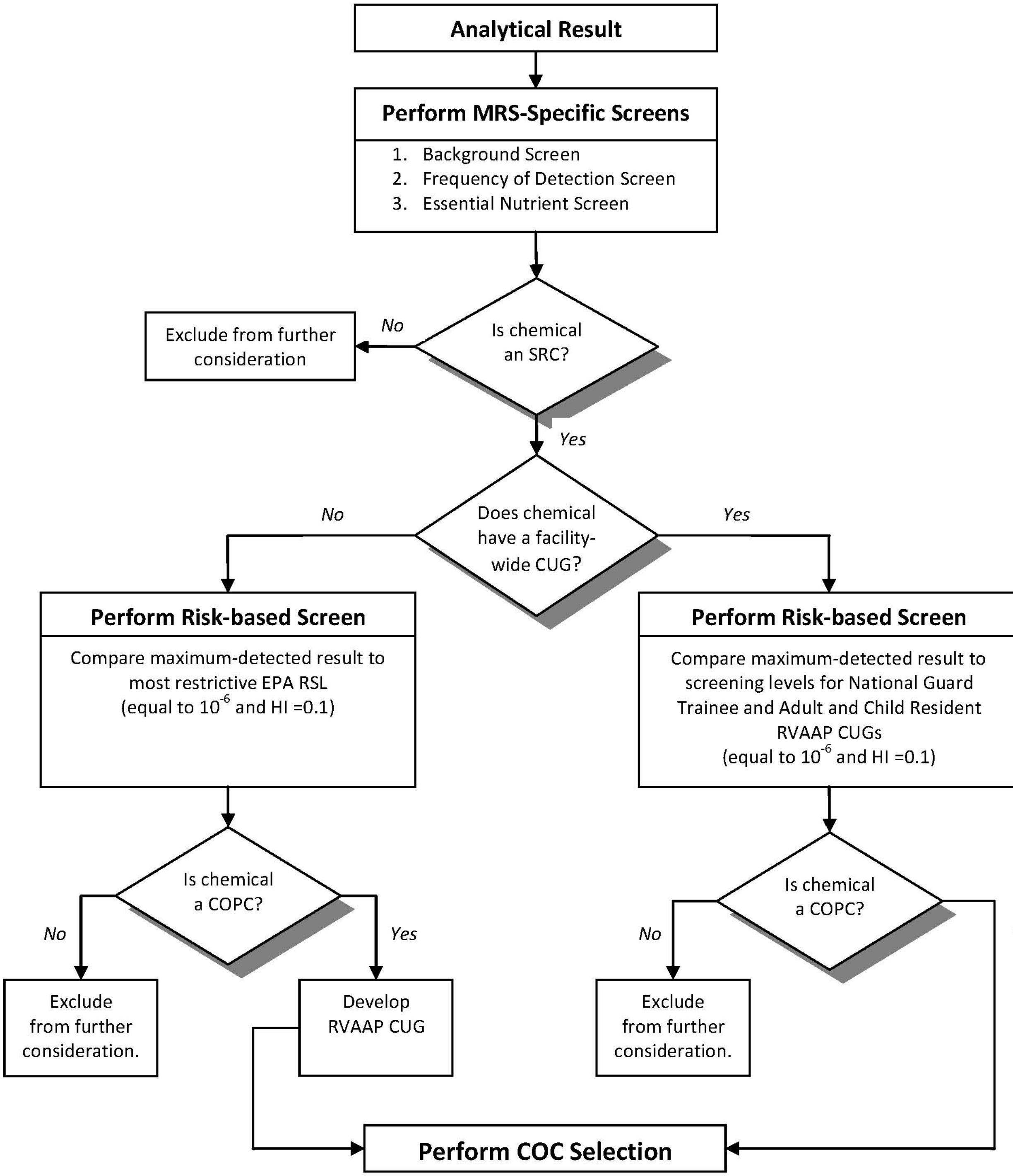
Frequency of Detection

Chemicals that are detected infrequently, except explosives and propellants, may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to the MRS activities or disposal practices. For sample aggregations, except for explosives and propellants, with at least 20 samples and frequency of detection of less than 5 percent, a weight of evidence approach may be used to determine if the chemical is MRS-related. Since surface soil samples were collected at only two locations (two ISM sampling units), frequency of detection was not utilized to support a weight of evidence approach for the Load Line #1A MRS data set.

Facility-Wide Background Screen

For inorganic constituents, if the maximum detected concentration exceeded its respective BSV, it was considered to be an SRC. It should be noted that not all inorganic compounds analyzed as part of the RI sampling event have established screening levels or BSVs. Therefore, in the event an inorganic constituent was not detected in the background data set, the BSV was set to zero, and any detected result for that constituent was considered above background. This conservative process ensures that detected constituents are not eliminated as SRCs simply because they are not detected in the background data set. All detected organic compounds were considered to be above background because these classes of compounds do not occur naturally.

For the RI field efforts across the facility, MRSs being investigated under the MMRP, analyses were conducted for calcium, magnesium, and manganese to be potentially used for geochemical analysis. Aluminum was also analyzed for geochemical purposes at the Load Line #1A MRS where it is not considered an MC related to triple-base propellant. Geochemical analysis is typically used when metals are found to be only slightly elevated above background levels and risk assessment identifies potential risk to receptors due to metals. A geochemical analysis is then used to determine if MEC metals are background related or actually elevated due to site history. Use of the geochemical evaluation in this manner requires approval from the USACE and Ohio EPA prior to implementing geochemical evaluation results as a comparison tool for background results. A geochemical analysis was not required for the Load Line #1A MRS based on the evaluation of the metal results in Section 4.0, and the HHRA and ERA conclusions in Section 7.0 and Section 8.0, respectively.



COC = Chemical of Concern
COPC = Chemical of Potential Concern
CUG = Cleanup Goal
EPA = Environmental Protection Agency
HI = Hazard Index
MRS = Munitions Response Site
RSL = Regional Screening Level
SRC = Site Related Chemical

Note: The determination of COCs and COPCs is for human health and evaluation only.

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LOAD LINE #1A MRS
FORMER RVAAP/CAMP RAVENNA
PORTAGE AND TRUMBULL COUNTIES, OHIO

CB&I Federal Services LLC
150 Royall Street
Canton, MA 02021

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FIGURE 4-1 RVAAP DATA SCREENING PROCESS

Essential Nutrient Screen

Chemicals that are considered essential nutrients (calcium, chloride, iodine, iron, magnesium, potassium, phosphorus, and sodium) are an integral part of the food supply and are often added to foods as supplements. The EPA recommends that these chemicals not be evaluated as COPCs as long as they are present at low concentrations (i.e., only slightly elevated above naturally occurring levels) and toxic at very high doses (i.e., much higher than those that could be associated with contact at the MRS). Recommended daily allowance and recommended daily intake values are available for most of the metals identified as essential nutrients. A screen for essential nutrients was not required for the RI since no essential nutrients were analyzed for MC associated with the MRS (USACE, 2005).

4.2.1.4 Data Presentation

Data summary statistics and screening results for SRCs in surface soil collected at the Load Line #1A MRS are presented in the following sections. The designated use for the Load Line #1A MRS samples for evaluation of fate and transport, human health risk, and ecological risk are presented in **Table 4-1**. A summary of the laboratory analytical results are presented in **Table 4-2**. The SRCs that were identified for the MRS following the data screening process are presented in **Table 4-3**. Analytical results for the Load Line #1A MRS inorganic and organic SRCs are presented by sample location in **Figures 4-2** and **4-3**, respectively, and indicate the extent and magnitude of contamination by highlighting SRCs that exceed the facility BSVs. A summary of the laboratory data results for the samples collected at the Load Line #1A MRS during the RI field activities is presented in **Appendix C**.

4.2.2 Data Use Evaluation

During the RI field effort, surface soil samples were collected at two predetermined ISM sampling units to evaluate the nature and extent of SRCs associated with previous activities at the MRS. Available sample data were evaluated to determine suitability for use in the various key RI data screens, which includes evaluation of nature and extent of SRCs, fate and transport, and human and ecological risk assessments. Evaluation of data suitability for use in this RI Report involved two primary considerations: (1) representativeness with respect to current MRS conditions and (2) the sample collection method (i.e., ISM).

The RI surface soil samples were collected using ISM and all data were incorporated into contaminant nature and extent evaluation. These samples are considered to be representative of current MRS conditions, were screened for SRCs, and carried forward into the HHRA and the ERA. An ISM surface soil sample and a duplicate soil sample were collected over the entire MRS as part of the 2007 SI field activities in order to confirm the presence or absence

Table 4-1
Data Use Summary and Collection Rationale

Sample Location ID	Collection Date	Depth (feet bgs)	Sample Type	Data Use Type	Rationale
Surface Soil					
LL1SS-715(I)-0001-SS	8/15/11	0–0.5	ISM	N&E, F&T, R	Northern half of Load Line #1A MRS (100- by 90-foot ISM grid)
LL1SS-716(I)-0001-SS	8/15/11	0–0.5	ISM	N&E, F&T, R	Southern half of Load Line #1A MRS (100- by 90-foot ISM grid)

bgs denotes feet below ground surface.
F&T denotes fate and transport.
ISM denotes incremental sampling methodology.
MEC denotes munitions and explosives of concern.
MRS denotes Munitions Response Site.
N&E denotes nature and extent.
R denotes risk assessment data use.
TOC denotes total organic carbon.

Table 4-2
Summary of Surface Soil Results

Detected Analyte	Location ID:	LL1SS-715		LL1SS-716	
	Sample ID:	LL1SS-715(I)-0001-SS		LL1SS-716(I)-0001-SS	
	Sample Date:	8/15/11		8/15/11	
	Depth (feet bgs):	0–0.5		0–0.5	
	Background[1]	Result	VQ	Result	VQ
Explosives (mg/kg)					
1,3,5-Trinitrobenzene	*NA*	<0.25	UJ	<0.25	U
1,3-Dinitrobenzene	*NA*	<0.2	U	<0.2	U
2,4,6-Trinitrotoluene	*NA*	<0.2	U	<0.2	U
2,4-Dinitrotoluene	*NA*	<0.25	U	<0.25	U
2,6-Dinitrotoluene	*NA*	<0.25	U	<0.25	U
2-Amino-4,6-Dinitrotoluene	*NA*	<0.2	U	<0.2	U
3,5-Dinitroaniline	*NA*	<0.2	U	<0.2	U
4-Amino-2,6-Dinitrotoluene	*NA*	<0.2	U	<0.2	U
HMX	*NA*	<0.2	U	<0.2	U
m-Nitrotoluene	*NA*	<0.2	U	<0.2	U
Nitrobenzene	*NA*	<0.2	U	<0.2	U
Nitroglycerin	*NA*	<1	U	<1	U
Nitroguanidine	*NA*	**0.25**	**J**	**0.22**	**J**
o-Nitrotoluene	*NA*	<0.25	U	<0.25	U
PETN	*NA*	<1	U	<1	U
p-Nitrotoluene	*NA*	<0.2	U	<0.2	U
RDX	*NA*	<0.25	U	<0.25	U
Tetryl	*NA*	<0.2	U	<0.2	U

Table 4-2 (continued)
Summary of Surface Soil Results

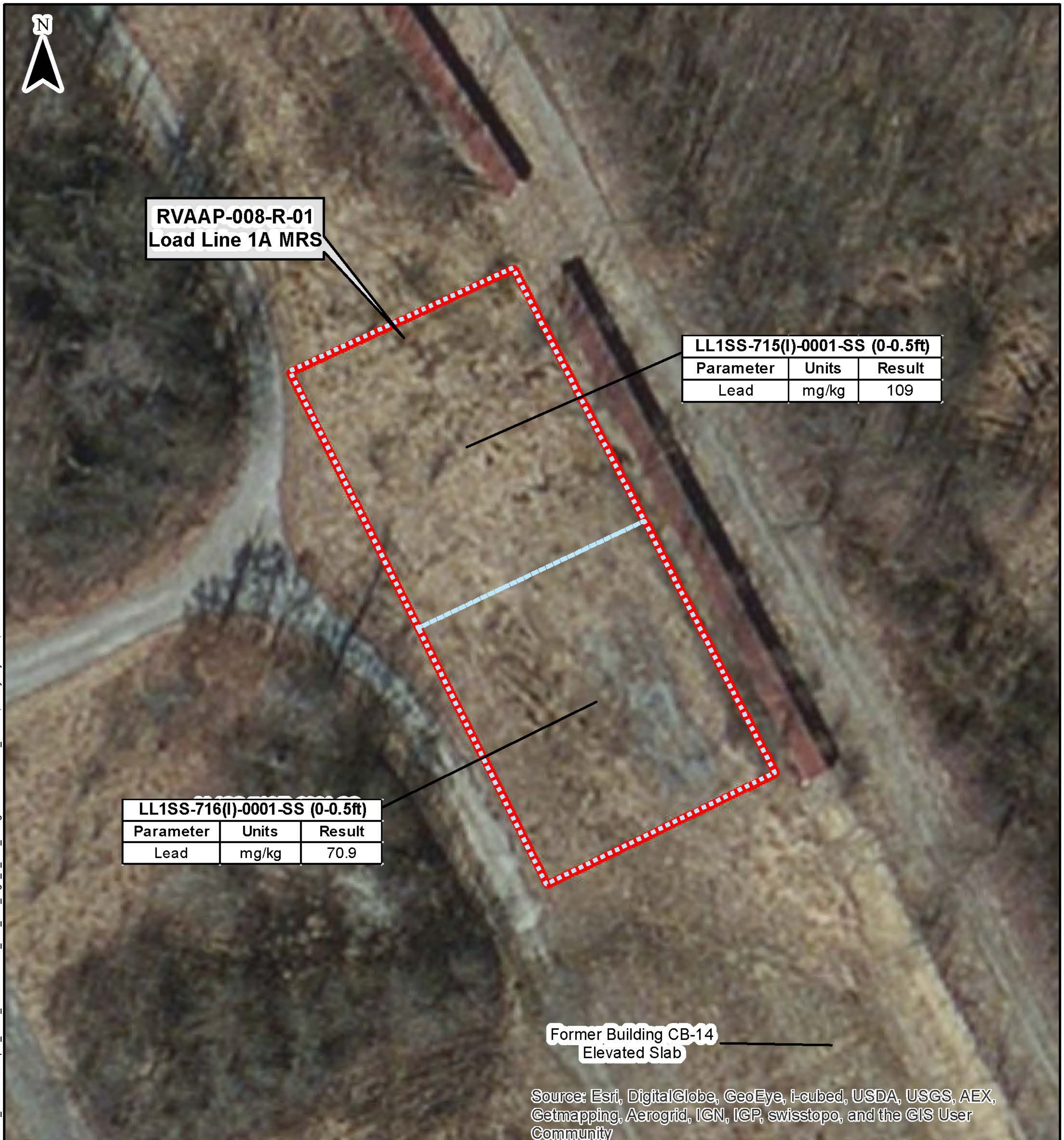
Detected Analyte	Location ID:	LL1SS-715		LL1SS-716	
	Sample ID:	**LL1SS-715(I)-0001-SS**		**LL1SS-716(I)-0001-SS**	
	Sample Date:	**8/15/11**		**8/15/11**	
	Depth (feet bgs):	**0–0.5**		**0–0.5**	
	Background[1]	**Result**	**VQ**	**Result**	**VQ**
Metals (mg/kg)					
Lead	*26.1*	**109**		**70.9**	
Aluminum	17,700	10,300		12,000	
Calcium	15,800	9,560		**63,800**	
Magnesium	3,030	2,270		**4,830**	
Manganese	1,450	963		1,010	
General Chemistry					
Nitrocellulose	*NA*	<50	UJ	<50	U
Total Organic Carbon	*NA*	30,000		36,000	
pH (pH Units)	*NA*	7.68		8.61	

[1]Background values as presented in the Final Facility-Wide Human Health Cleanup Goals at the RVAAP, Ravenna, Ohio (SAIC, 2010).
For metals bold numbering indicates concentration is greater than the RVAAP background value. For organics, bold numbering indicates a detected value.
< denotes less than.
bgs denotes below ground surface.
BSV denotes background screening value.
ID denotes identification.
J denotes the result is less than the reporting limit but greater than or equal to the method detection limit.
mg/kg denotes milligrams per kilogram.
NA denotes that a BSV is not available.
U denotes result is not detected or the concentration is below the detection limit.
UJ denotes result is not detected. The detection limits and quantitation limits are approximate.
VQ denotes validation qualifier.

Table 4-3
SRC Screening Summary in Surface Soil Samples

Analyte	Chemical Abstract Service Number	Frequency of Detection	Minimum Detect (mg/kg)	Maximum Detect (mg/kg)	Mean Result (mg/kg)	BSV (mg/kg)	SRC?	SRC Justification
Explosives and Propellants								
Nitroguanidine	556-88-7	2/2	0.22	0.25	0.24	NA	Yes	Detected organic MC
Metals								
Lead	7439-92-1	2/2	70.9	109	89.9	26.1	Yes	MC above BSV
Calcium	7789-78-8	2/2	9,560	63,800	36,680	15,800	No	Not an MC
Magnesium	7439-95-4	2/2	2,270	4,830	3,550	3,030	No	Not an MC

BSV denotes background screening value.
MC denotes munitions constituents associated with triple-base propellant.
mg/kg denotes milligrams per kilogram.
MRS denotes Munitions Response Site.
NA denotes not applicable.
SRC denotes site-related chemical.



LL1SS-715(I)-0001-SS (0-0.5ft)		
Parameter	Units	Result
Lead	mg/kg	109

LL1SS-716(I)-0001-SS (0-0.5ft)		
Parameter	Units	Result
Lead	mg/kg	70.9

MRS Boundary

ISM Soil Sample Unit

Notes:
1) mg/kg = milligrams per kilogram
2) ft = foot

0 50 100 Feet

Projection : NAD_1983_UTM_Zone_17N

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FIGURE 4-2 INORGANIC SITE-RELATED CHEMICALS

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FIGURE 4-3 ORGANIC SITE-RELATED CHEMICALS

of MC. As discussed in Section 2.3.3, the RI sample results are intended to further characterize the nature and extent of contamination associated with previous activities at the MRS.

4.3 Nature and Extent of SRCs

This section presents a summary of the nature and extent of SRCs for the environmental media samples collected during the RI field activities at the Load Line #1A MRS. Data from the ISM surface soil samples collected during the RI were screened in accordance with the facility data screening process to identify SRCs representing current conditions at the Load Line #1A MRS. The SRC screening data for surface soils (not including field duplicates or QC samples) included samples LL1SS-715(I)-0001-SS and LL1SS-716(I)-0001-SS, where ISM surface soil samples were taken from 0 to 0.5 feet bgs. The SRCs identified in surface soil following the data screening process are presented in **Table 4-3**.

The ISM samples were collected from two same-sized sampling units (approximately 0.2 acres each) and at the same sample depth (0 to 0.5 feet) within the 0.41-acre MRS that constitutes the decision unit to further characterize the nature and extent of SRCs associated with previous activities at the MRS. All ISM surface soil samples collected during the RI sampling event were submitted for laboratory analyses for lead, explosives, nitrocellulose, TOC, and pH.

The samples were also submitted for geochemical parameters that included aluminum, calcium, magnesium and manganese for the rationale discussed in Section 4.2.1.3, "Data Reduction and Screening." However, since a geochemical analysis was not performed for the MRS, the geochemical parameters are not evaluated further.

4.3.1 Inorganics

Lead exceeded the BSV of 26.1 milligrams per kilogram (mg/kg) in both RI samples and was retained as an SRC. The maximum concentration (109 mg/kg) detected was from sampling unit LL1SS-715(I)-0001-SS. **Figure 4-2** presents the distribution of the lead in surface soils.

4.3.2 Explosives and Propellants

Evaluation of the RI data results indicates that the propellant nitroguanidine was detected in both ISM sampling unit locations and is retained as an SRC. The maximum concentration detected was 0.25 mg/kg at sample LL1SS-715(I)-0001-SS. No other explosives or propellants were detected at either of the ISM sample locations. The sample distribution for the detected nitroguanidine results are shown in **Figure 4-3**.

5.0 FATE AND TRANSPORT

This section describes the fate of contaminants in the environment and potential transport mechanisms. Contaminant fate refers to the expected final state that an element, compound, or group of compounds will achieve following release to the environment. Contaminant transport refers to migration mechanisms away from the source area. Section 5.1 and Section 5.2 discuss fate and transport associated with MEC and MC at the MRS, respectively.

5.1 Fate and Transport of MEC

Transport of MEC at a MRS is dependent on many factors, including precipitation, soil erosion, and freeze/thaw events. These natural processes, in addition to human activity, may result in some movement (primarily vertical) of MEC if present at the MRS. The result of these mechanisms and processes is a potentially different distribution of MEC than the one that may have existed at the time of original release. In addition, MEC items may corrode or degrade based on weather and climate conditions and thereby release MC into the environment.

Three triple-base propellant nodules (1 by ¼ inch each) that constitute MEC were identified at the MRS during the SI; however, no MEC was found at the MRS during the RI field activities. It is expected that any propellants at the MRS were on the ground surface only and were not buried. The propellants found during the SI were not found during RI activities, and no record of removal is documented for these propellants. Since no propellants were identified during the RI, an explosive safety hazard is not considered to be present at the MRS. Therefore, a discussion of the fate and transport of MEC at the MRS is not warranted.

5.2 Fate and Transport of MC

This section describes the fate and transport of the MC identified as SRCs in the environment and potential transport mechanisms. A MEC source was not observed at the Load Line #1A MRS during the RI field activities; however, surface soil samples were collected during the RI for MC at locations predetermined in the Work Plan (Shaw, 2011). The sample locations were chosen to further evaluation the nature and extent of SRCs associated with previous activities at the MRS. The SRCs detected are consistent with the chemical constituents associated with the triple-base propellants that have been historically observed on the ground surface at the MRS. Therefore, for the purposes of this fate and transport discussion, the SRCs will be conservatively evaluated as MC associated with the previously observed propellants. A discussion of the fate and transport mechanisms is presented herein.

The release of MC is a process unique to the military. The sources and magnitude are distinctly different from the release of chemicals from industrial processes typically investigated under the IRP (Strategic Environmental Research and Development Program and Environmental Security Technology Certification Program, 2012). Once a MC released from MEC enters an environmental medium, the fate and transport of MC are dependent on a wide variety of factors. Migration pathways often include air, water, soil, and the interfaces between the phases of the contaminant (i.e., solid, liquid, or gas). The fate and transport of contaminants occur in all three environments: (1) terrestrial, (2) aquatic, and (3) atmospheric. Terrestrial environments are comprised of soil and groundwater, aquatic environments are comprised of surface water and sediment, and air is the only component of the atmospheric environment.

Several important physical and chemical properties of environmental media govern the distribution and behavior of contaminants in these media. Depending upon the specific contaminant and soil conditions, a contaminant may migrate from surface soil to subsurface soil, stream/wetland sediments, or surface water. A contaminant may also migrate from each of the aforementioned medium to the air. The propensity for a contaminant to attain equilibrium conditions in the environment and migrate from one medium to another is an important factor in determining the mobility of a contaminant.

In the terrestrial environment, if the contaminant is released to soil, the contaminant may volatilize, adhere to the soil by sorption, leach into the surface water bodies or groundwater, or degrade because of chemical (abiotic) or biological (biotic) processes. If the contaminant is volatilized, it may be released to the atmosphere. Contaminants that are dissolved may eventually be transported to an aquatic environment.

Once a contaminant is released to the aquatic environment, it can either volatilize or remain in the aquatic environment. In the aquatic environment, contaminants may be dissolved in the surface water or sorbed to the sediment. Contaminants may move between dissolved and sorbed states depending on a variety of physical and chemical factors. However, no aquatic environments are present within the MRS boundary to be impacted by the presence of MC.

In the atmospheric environment, contaminants may exist as vapors or as particulate matter. The transport of contaminants relies mostly on wind currents and continues until the contaminants are returned to the earth by wet or dry deposition. Degradation of organic chemicals in the atmosphere can occur due to direct photolysis, reaction with other chemicals, or reaction with photochemically generated hydroxyl radicals.

5.2.1 Contaminant Sources

This section presents a discussion of the detected lead and nitroguanidine concentrations that are identified as SRCs in the environmental media at the Load Line #1A MRS. The physical and chemical properties and potential release mechanisms and routes of migration for each of these SRCs are discussed below.

- **Lead** is a naturally occurring metal found in small amounts in the earth's crust. Lead salts were used as a ballistic modifying agent in triple-base propellants to modify the general laws of combustion (Folly and Mader, 2004). The use of lead in the manufacture of propellants has been phased out over the years due to its toxicity. The most common form of lead (Pb) found in nature is Pb^{+2}, although lead also exists to a lesser extent as Pb^{+4} and in the organic form with up to four lead-carbon bonds (Kabata-Pendias, 2001). Most lead deposited on surface soil is retained and eventually becomes mixed into the surface layer. However, lead can migrate into subsurface environments. The migration of lead in the subsurface environment is controlled by the solubility of lead complexes and adsorption to aquifer materials. Adsorption to soil and aquifer material greatly limits the mobility of lead in the subsurface environment. The capacity of soil to adsorb lead increases with pH, cation exchange capacity, organic carbon content, redox potential, and phosphate levels. At pH values above 6, lead adsorbs on clay surfaces or forms lead carbonate. Lead exhibits a high degree of adsorption in clay-rich soil (Kabata-Pendias, 2001).

- **Nitroguanidine** (also called 1-nitroguanidine) is used as an explosive propellant notably in triple-base propellant smokeless powder. The nitroguanidine reduces the propellant's flash and flame temperature without sacrificing chamber pressure. Nitroguanidine is manufactured from guanine, a naturally occurring substance typically found in the excrement of bats and birds (guano). It is not flammable and is an extremely low sensitivity explosive; however, its detonation velocity is high. Nitroguanidine is expected to have high mobility in soil and volatilization from soils is not anticipated to be a primary fate process given an estimated Henry's law constant of 4.45×10^{-16} atmospheric cubic meters per mole based upon its vapor pressure and water solubility (Gorontzy et al., 1994). In aquatic environments, nitroguanidine is not expected to adsorb to suspended solids or sediment. Volatilization is also not anticipated (Gorontzy et al., 1994). The aquatic fate of nitroguanidine is dominated by photolysis and is not anticipated to bioconcentrate (Haag et al., 1990). In the atmosphere, nitroguanidine is expected to exist solely in the particular phase and be removed from the atmosphere through either wet or dry deposition. As it absorbs light at approximately 260 nanometers and above, nitroguanidine is susceptible to direct photolysis (NIST Chemistry WebBook, 2010).

5.2.2 Summary of Fate and Transport

Based on current soil conditions at the facility, which consisted primarily of silty clay loam with low permeability and an MRS-specific pH of approximately 8.4, it is expected that lead would tend to bind to the soil and is considered relatively immobile. Therefore, any MC would be expected to be found in the top several inches where it was deposited and subsurface has mostly likely not been impacted. Nitroguanidine is considered mobile in soil; however, the impact to subsurface soils at the MRS has not been evaluated. The low permeability of the soil and the low concentrations detected suggest that significant sources of nitroguanidine were not deposited on or leached into the ground surface as a result of either dumping of triple-base propellants at the MRS or other activities (i.e., munitions loading operations) conducted at this portion of Load Line #1 when the facility was in operation.

The most recent groundwater elevations and sampling data collected throughout the Load Line #1 AOC were evaluated for fate and transport (Environmental Quality Management, Inc., 2012). The depth to groundwater at the nearest well location to the MRS (approximately 400 feet to the southeast) is 32 feet bgs. Several inorganics were detected exceeding the screening criteria at the Load Line #1 AOC; however, lead was not identified as a SRC indicating that groundwater has not been impacted by the presence of elevated lead concentrations in surface soil at the MRS. Although, the impact of nitroguanidine on the groundwater directly beneath the MRS has not been evaluated, groundwater results from the July 2011 sampling event that included samples collected at the Load Line #1 AOC, exhibited elevated concentrations of explosives but no propellants. Although mobile in soil, it does not appear that nitroguanidine in surface soil at the MRS has impacted groundwater beneath Load Line #1.

6.0 MEC HAZARD ASSESSMENT

In accordance with the Work Plan (Shaw, 2011), an evaluation of the MEC hazard at the Load Line #1A MRS was to be prepared in accordance with the *Interim Munitions of Concern Hazard Assessment (MEC HA) Methodology* (EPA, 2008); herein referred to as the MEC HA. The MEC HA process was developed to evaluate the potential explosive hazard associated with conventional MEC present at a MRS under a variety of MRS-specific conditions, including various cleanup scenarios and land use assumptions. The MEC HA addresses human health and safety concerns associated with potential exposure to MEC at a MRS. No MEC or MD items were identified at the MRS during RI field activities, which has been interpreted to indicate that no MEC source or explosive safety hazard is present at the MRS. Based on the findings of the RI field work, the calculation of a MEC HA score was not warranted for the Load Line #1A MRS.

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7.0 HUMAN HEALTH RISK ASSESSMENT

The purpose of this HHRA is to document whether SRCs identified at the Load Line #1A MRS may pose a risk to current or future human receptors, and to identify which, if any, MRS conditions need to be addressed further under the CERCLA process. This risk assessment was prepared in accordance with the Work Plan (Shaw, 2011) using the streamlined approach to risk decision-making, as described in the FWCUG Report (SAIC, 2011). In particular, the *RVAAP Position Paper for the Application and Use of Facility-Wide Cleanup Goals* (USACE, 2012); hereafter referred to as the Position Paper, describes the use of the Facility-Wide Cleanup Goals (FWCUGs) in the following steps:

- Identify COPCs at the 1×10^{-6} (one in a million) excess cancer risk level or noncarcinogenic hazard quotient (HQ) of 0.1 (most stringent value) for the MRS by comparing concentrations to BSVs, eliminating essential nutrients, and comparing the concentrations of SRCs to the final FWCUGs.
- Identify COCs at the 1×10^{-5} (one in one hundred thousand) excess cancer risk level or noncarcinogenic HQ risk value of 1 by comparing concentrations to specific final FWCUGs, and using a “sum of ratios” approach to account for cumulative effects. This method sums the ratios of the SRC concentrations to the final FWCUG for all COPCs. A sum of ratios greater than 1 represents an unacceptable risk, and cancer and noncancer effects are considered separately.

The following sections discuss the HHRA approach, the data used in the HHRA, and the COPC and COC evaluation for the samples collected at the Load Line #1A MRS during the RI field activities. This HHRA was initiated before the finalization of the U.S. Army's technical memorandum (ARNG, 2014); therefore, evaluation for the Commercial Industrial Land Use using the Regional Screening Levels (RSLs) for industrial exposure (EPA, 2012) was not included.

7.1 Data Used in the HHRA

The available data set used in this HHRA consisted of two ISM surface soil samples (LL1SS-715(I)-0001-SS and LL1SS-716(I)-0001-SS) collected as part of the RI field effort, which are considered to be representative of current conditions. A third sample (LL1SS-717(I)-0001-SS) was collected as a field duplicate and is; therefore, excluded from the risk evaluation process. The Load Line #1A MRS is considered as a single EU based on the future land use that is discussed in the following sections. The samples included in the HHRA data set are identified in **Table 7-1**.

Table 7-1
Summary of Data Used in the Human Health Risk Assessment

Sample ID	Sample Date	Depth (feet bgs)	Sample Type	Analyses
LL1SS-715(I)-0001-SS	8/15/11	0–0.5	ISM	• Lead • Explosives • Nitrocellulose • TOC • pH
LL1SS-716(I)-0001-SS	8/15/11	0–0.5	ISM	

bgs denotes below ground surface.
ID denotes identification
TOC denotes total organic carbon.

7.2 Human Receptors

The future land use for the Load Line #1A MRS is military training, and the Representative Receptor is the National Guard Trainee. The Representative Receptor for military training, in conjunction with the evaluation of the Resident Receptor (Adult and Child) for Unrestricted Land Use, forms the basis for identifying COCs in the RI. Evaluation for Unrestricted (Residential) Land Use is performed to assess for baseline conditions and the no action alternative under CERCLA, and as outlined in the HHRAM (USACE, 2005).

The facility has defined exposure depth scenarios for the identified receptors that are presented in the FWCUG Report (SAIC, 2010). Surface soil for the Resident Receptor (Adult and Child) is defined as 0 to 1 foot bgs. Surface soil for the National Guard Trainee is defined as 0 to 4 feet bgs. Sampling for MC under the MMRP is selective in general to evaluate identified munitions-related source areas and the potential that MC may have been released from the source areas. The data used in the HHRA are used to evaluate for the receptors at the depths that the samples were collected; however, the data are not intended to evaluate for predefined exposure depth scenarios as is typically performed under the IRP. The presence of munitions-related source areas at an MRS is the primary driver for determining future actions under the MMRP; however, the HHRA is valuable in identifying potential releases of MC from the source areas and if the MC poses risks to likely human receptors.

The media of concern that was evaluated in the HHRA consists solely of surface soil that was biased by collecting samples across the entire MRS at a sample depth of 0 to 0.5 feet bgs. The 0.5-foot sample depth across the MRS is the focus of this HHRA since it is the maximum depth that MC associated with the propellants would be expected to vertically migrate in the soil column and is the deepest that MC has been detected at the MRS during the SI field activities (e^2M, 2008). This sampling method is consistent with the sample depth intervals recommended in the U.S. Army's guidance (U.S. Army, 2009). Therefore, for the

RI, surface soil for the Resident Receptor (Adult and Child) and the National Guard Trainee is evaluated as 0 to 0.5 feet bgs, the depth at which the ISM surface soil samples were collected.

7.3 COPC Identification

This section presents the evaluation of the MRS data and the identification of COPCs for the intended receptors based on the future land use as military training. The data for this RI Report were evaluated in accordance with the initial evaluation step presented in the Position Paper (USACE, 2012) to identify SRCs as presented in Section 4.2, "MC Data Evaluation." The evaluation incorporates the same criteria described in Section 4.2.1.3 to eliminate chemicals that are not SRCs (i.e., infrequently detected chemicals, background comparisons, and essential nutrients). Some chemicals were analyzed for a specific purpose other than for identifying MC (i.e., the collection of magnesium concentrations for the purposes of performing a geochemical analysis on chemical concentration ratio data), and are not known or suspected MC at the MRS. The chemicals that had not been eliminated to this point were lead and nitroguanidine and were evaluated to establish if they were COPCs using the following steps:

- The final FWCUGs developed for the Resident Receptor (Adult and Child) and the National Guard Trainee for each chemical were used. If there were no final FWCUGs developed for a particular chemical, then the RSLs for residential exposure (EPA, 2012) were used. If neither a final FWCUG nor an RSL is available, then a cleanup goal can be developed in concurrence with the USACE and the Ohio EPA. Final FWCUGs or RSLs were available for all chemicals not previously eliminated.
- The final FWCUGs at the 1×10^{-6} (one in a million) excess cancer risk level and noncarcinogenic risk HQ using the 0.1 risk value for each of the receptors will be selected.
- A comparison of the selected final FWCUG to the exposure point concentration (EPC) was completed. The EPCs used in this screening step were the maximum detected concentrations.
- The chemical was retained as a COPC if the EPC exceeded the most stringent risk value for the Resident Receptor (Adult and Child) or the National Guard Trainee for either one of the 1×10^{-6} excess cancer risk values and the noncarcinogenic HQ using the 0.1 risk value.

The Work Plan (Shaw, 2011) specifies that in addition to screening for the Resident Receptor (Adult and Child) and the National Guard Trainee, evaluation will also be made against the remaining OHARNG receptors in order to ensure that the most stringent receptor is identified. Based on this consideration, the Representative Receptors identified for COPC evaluation included the Resident Receptor (Adult and Child) and the National Guard Trainee, the most stringent OHARNG receptor identified based on the anticipated future land use.

Table 7-2 presents the screening results for COPCs for the Resident Receptor (Adult and Child) and the National Guard Trainee in accordance with the FWCUG Report (SAIC, 2010). For both lead and nitroguanidine, no FWCUGs are available and the RSLs were used. The RSLs are based on the lower of values derived considering excess cancer risk of 1×10^{-6} (one in a million) and noncancer hazard considering an HQ of 1. The RSLs derived based on noncancer hazard were adjusted to an HQ of 0.1 in order to be consistent with the noncancer final FWCUGs. The RSL for lead, however, was not adjusted in this manner, since it was not derived using the hazard index approach. The RSL for lead in soil is based on the value recommended by the EPA as generally safe for residential settings.

To establish COPCs, the maximum detected concentrations for the SRCs were compared to the applicable screening criteria. Substances that are considered SRCs, and for which the maximum detected concentration is greater than the RSL since no final FWCUGs are available, were considered COPCs. The entire MRS was adequately characterized to the anticipated depth that MC, if any, would be expected to be found (0 to 0.5 feet bgs) and no COPCs were identified for either the Resident Receptor (Adult and Child) or the National Guard Trainee. Therefore, an evaluation for COCs was not required.

7.4 Uncertainty Analysis

There are various sources of uncertainty in the evaluation of exposure and risk that are common to all risk assessments. These general sources of uncertainty are not described here. However, those specific to this assessment are discussed in the following sections. These uncertainties generally relate to sampling considerations, the determination of EPCs, and the selection of appropriate receptors. There are numerous uncertainties related to the final FWCUGs, including exposure assumptions and toxicity values. These uncertainties are inherent to the use of these values, and are similar for all assessments using them. Therefore, these uncertainties are not discussed here unless there is a particular issue relevant to this evaluation.

Uncertainty can arise from sampling techniques or approaches. In this assessment, surface soil was sampled using the ISM technique. This technique provides good representation of average concentrations over the area sampled. While it may not identify small areas of higher concentrations, this approach is useful for estimating exposure, which is expected to occur over an area and not at discrete locations.

Table 7-2
Summary of Screening Results for COPCs in Surface Soil (0 to 0.5 feet)

Chemical	Range of Values, mg/kg						Location of MDC	R(A) FWCUG[1] (mg/kg)	R(C) FWCUG[1] (mg/kg)	NGT FWCUG[1] (mg/kg)	RSL[2] (mg/kg)	COPC?	COPC Justification
	Detected Concentrations				Reporting Limits								
	Minimum	VQ	Maximum	VQ	Minimum	Maximum							
Metals													
Lead	70.9		109		0.25	0.25	LL1SS-715	-	-	-	400	No	Below risk screening criteria
Explosives													
Nitroguanidine	0.22	J	0.25	J	0.25	0.26	LL1SS-715	-	-	-	610	No	Below risk screening criteria

[1] FWCUG is lower of noncarcinogenic FWCUG at a hazard index of 0.1 and excess carcinogenic FWCUG risk of 10^{-6}.
[2] RSL is for residential soil and is based on noncancer risk adjusted to a hazard index of 0.1 (as opposed to published value based on a hazard index of 1), except lead.
- denotes that no value is available for this criterion.
COPC denotes chemical of potential concern.
EPA denotes U.S. Environmental Protection Agency.
FWCUG denotes Final Facility-Wide Cleanup Goal.
J denotes result should be considered estimated.
MDC denotes maximum detected concentration.
mg/kg denotes milligrams per kilogram.
NGT denotes National Guard Trainee.
R(A) denotes Resident Receptor (Adult).
R(C) denotes Resident Receptor (Child).
RSL denotes Regional Screening Level (2012).
U.S. denotes United States.
VQ denotes validation qualifier.

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No final FWCUGs were available for the SRCs (lead and nitroguanidine) detected at the MRS. In these cases, the RSLs were used as the screening values for these receptors. This provides a conservative evaluation, since the RSLs used are based on residential exposure.

The selection of the maximum detected concentration as the EPC for the ISM samples provides a conservative evaluation of potential exposures in the area with the greatest concentrations. The selection of receptors also represents an uncertainty to the risk assessment. The Resident Receptor (Adult and Child) is assumed to be the future receptor in the COPC evaluation, representing a conservative evaluation of possible future exposures. Therefore, risks are not expected to be underestimated for other future uses.

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8.0 ECOLOGICAL RISK ASSESSMENT

This ERA evaluates the potential for adverse effects posed to ecological receptors from potential releases at the Load Line #1A MRS. This ERA is consistent with the process described in the EPA *Ecological Risk Assessment Guidance for Superfund* (1997) and the *Ohio EPA Ecological Risk Assessment Guidance Document* (2008); hereafter referred to as the EPA Guidance and Ohio EPA Guidance, respectively. Other supporting documents used in the preparation of this ERA include the *RVAAP Facility-Wide Ecological Risk Assessment Work Plan* (USACE, 2003b) and the *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE, 2010). The ERA also follows the facility Unified Approach (USACE, 2011) to ERAs established at sites under environmental investigation at the facility.

Consistent with the RVAAP Unified Approach for performing ERAs, a screening-level ERA (SLERA) was performed on the Load Line #1A MRS. The SLERA is an initial screening step in the ERA 8-step approach as described in EPA (1997) guidance. The SLERA comprises Steps 1, 2, and the first part of Step 3 (often referred to as Step 3a), in which a refinement of the chemicals initially selected as chemicals of potential ecological concern (COPECs) is performed prior to determining whether additional investigation is necessary. If the SLERA indicates that additional investigation is warranted, it is followed by a more comprehensive baseline ERA (BERA) by completing the second part of Step 3 (i.e., “Step 3b”) through Step 7. Step 8 is a risk management step that occurs after information presented in the previous steps of the ERA has been fully considered. The Ohio EPA Guidance (2008) presents a similar “tiered” approach that allows for a progression through four levels of the ERA as required by the findings and conclusions of each level: Level I Scoping, Level II Screen, Level III Baseline, and Level IV Field Baseline. Levels I and II are approximately equivalent to Steps 1 and 2 of a SLERA. Level III includes food chain modeling using exposure dose and toxicity estimates for generic receptors using conservative assumptions, and is incorporated as part of Step 3a in the SLERA if it is considered necessary to refine COPECs. The Level IV Field Baseline is equivalent to the BERA (Steps 3b through 7), where conservative assumptions used in the Level III Baseline are modified using MRS-specific information.

As stated previously, the SLERA includes Steps 1 through 3a of the 8-step process for ERAs (EPA, 1997). This is equivalent to a Level I and II evaluation according to the Ohio EPA process, and is also consistent with the ERA approach described in USACE guidance (2003b and 2010) and the facility Unified Approach (USACE, 2011). Because the conclusion of the Load Line #1A MRS SLERA was that no chemicals require additional evaluation, a BERA is not considered necessary for this MRS, and the ERA process is terminated following the completion of the SLERA.

8.1 Scope and Objectives

The goal of the SLERA was to evaluate the potential for adverse effects to ecological receptors from MC at the Load Line #1A MRS. This objective was met by characterizing the ecological communities in the vicinity of the MRS, determining the particular contaminants present, identifying pathways for receptor exposure, and estimating the magnitude of the likelihood of potential adverse effects to identified receptors. The SLERA addressed the potential for adverse effects to the wildlife, threatened and endangered species, and wetlands or other sensitive habitats that may be associated with the MRS.

The objective of this SLERA was to provide an estimate of the potential for adverse ecological effects associated with contamination resulting from former activities at the Load Line #1A MRS. The results of the SLERA contribute to the overall characterization of the MRS and may be used to determine the need for additional investigations or to develop, evaluate, and select appropriate remedial alternatives.

The SLERA used MRS-specific analyte concentration data for surface soil from the Load Line #1A MRS. Risks to ecological receptors were evaluated by performing a multistep screening process in which, after each step, the detected analytes in soil were either deemed to pose negligible risk and eliminated from further consideration or carried forward to the next step in the screening process to a final conclusion of being a COPEC. COPECs are analytes whose concentrations are great enough to pose potential adverse effects to ecological receptors. Following the determination of COPECs, an ecological CSM was developed that described the selection of receptors, exposure pathways, and assessment and measurement endpoints.

8.2 Level I Scoping

The scoping step of the SLERA included descriptions of habitats; biota; and threatened, endangered, and other rare species; selection of an EU; and identification of COPECs at the MRS. If a potential threat to ecological receptors was suspected, the SLERA proceeded to Level II.

8.2.1 Site Description and Land Use

The Load Line #1A MRS a 0.41-acre area that is located at the north end of the 164-acre Load Line #1. The MRS is located near the northwest side of the former elevated building CB-14 where triple-base propellants were observed on the ground surface and elevated lead concentrations and low concentrations of explosives were detected in surface soil during the 2007 SI field activities.

Current activities at the Load Line #1A MRS include security patrols, maintenance, environmental sampling, remediation, and natural resource management activities. The OHARNG projected future use at the MRS is military training.

8.2.2 Ecological Significance

Topography across the Load Line #1A MRS is relatively flat with little change in elevation. The MRS is in a slight depression related to its immediate surroundings. Based on topographical maps, local surface drainage is to the east. There are no natural streams or ponds located within the MRS and the MRS is not located within a flood plain (AMEC, 2008).

The vegetation community present at the Load Line #1A MRS is categorized as the “Dry Midsuccessional Cold-Deciduous Shrubland Alliance” (AMEC, 2008). This shrubland alliance is associated with relatively open areas characterized by shrub species covering more than 50 percent of the area, with relatively few large trees. This alliance often is found within previously disturbed areas, and is dominated by gray dogwood, northern arrowwood, blackberry, hawthorn, and multiflora rose. Additional details pertaining to the ecological setting are provided in the following sections.

8.2.3 Facility Management Goals

The INRMP (AMEC, 2008) was developed for the OHARNG as the primary guidance document and tool for managing natural resources at the facility (AMEC, 2008). Several of these management goals have relevance to the SLERA because they articulate overarching objectives regarding ecological resources that should be considered when identifying whether adverse impacts associated with a release have occurred. Specifically, the following goals listed in the INRMP are pertinent to the Load Line #1A MRS SLERA:

- Protect and maintain populations of rare plant and animal species on the facility in compliance with federal and state laws and regulations.
- Manage wildlife resources in a manner compatible with the military mission and within the limits of the natural habitat.
- Manage wetlands and other surface waters in accordance with applicable federal, state, and local regulations and to protect water quality and ecological function while facilitating the military mission.
- Manage soil to maintain productivity, and prevent and repair erosion in accordance with state and federal laws and regulations.

8.2.4 Terrestrial and Aquatic Resources

This section summarizes the terrestrial and aquatic resources identified for the Load Line #1A MRS that is evaluated in the ERA.

8.2.4.1 Special Interest Areas

Special interest areas are ecosystems that are not federally protected and have no legal standing, but are areas that host state-listed species, are representative of historic ecosystems, or are otherwise noteworthy. The ODNR and the USFWS did not identify any special interest areas on or near the Load Line #1A MRS during their natural heritage data searches (AMEC, 2008).

8.2.4.2 Wetlands

A planning-level survey (i.e., desktop review of wetlands data and resources [National Wetlands Inventory maps, aerials etc.]) for wetlands was conducted for the entire facility, including at Load Line #1. A jurisdictional wetlands delineation has not been completed at the MRS. No wetlands have been identified at the Load Line #1A MRS (AMEC, 2008).

8.2.4.3 Animal Populations

The plant communities at the facility provide diverse habitats that support many species of animals. Through casual observations and various studies, the following number of species have been identified at the facility: 35 land mammals, 214 birds, 34 reptiles and amphibians, 46 fish (including 2 hybrids), 4 crayfish, 17 mollusks (clams), 12 aquatic snails, 45 terrestrial snails, 64 damselflies and dragonflies, 64 butterflies, 793 moths, and 800 beetles (AMEC, 2008).

Nearly the entire load line is covered by open shrubland habitat. Common bird species that could be expected to use the habitat include the song sparrow (*Melospiza melodia*), gray catbird (*Dumetella carolinensis*), and rufous-sided towhee (*Pipilo erythrophthalmus*). Common large mammals include white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), and woodchuck (*Marmota monax*), while the eastern cottontail (*Sylvilagus floridanus*), white-footed mouse (*Peromyscus leucopus*), and short-tailed shrew (*Blarina brevicauda*) are common small mammals present at the RVAAP (ODNR, 1997) that may use the habitat present at the Load Line #1 that includes the MRS.

8.2.4.4 Threatened, Endangered, and Other Rare Species Information

The relative isolation of the facility that helps to protect habitat at the facility has created an important area of refuge for a number of plant and animal species considered rare by the State of Ohio. No federally listed species are known to reside at the facility. To date, 77 state-listed species are confirmed to be on the facility and are listed in **Table 1-3**. The Load Line #1A MRS has not been specifically surveyed for threatened or endangered species;

however, none are known to exist at the MRS (Camp Ravenna Joint Military Training Center, 2010).

8.2.5 Level I Conclusions and Recommendations

Based on the presence of ecological resources at the facility, and the potential presence of detected SRCs associated with historical activities at the MRS that could adversely affect these resources, proceeding to a Level II Screening step is recommended for this SLERA. This Level II Screening is presented in Section 8.3.

8.3 Level II Screening

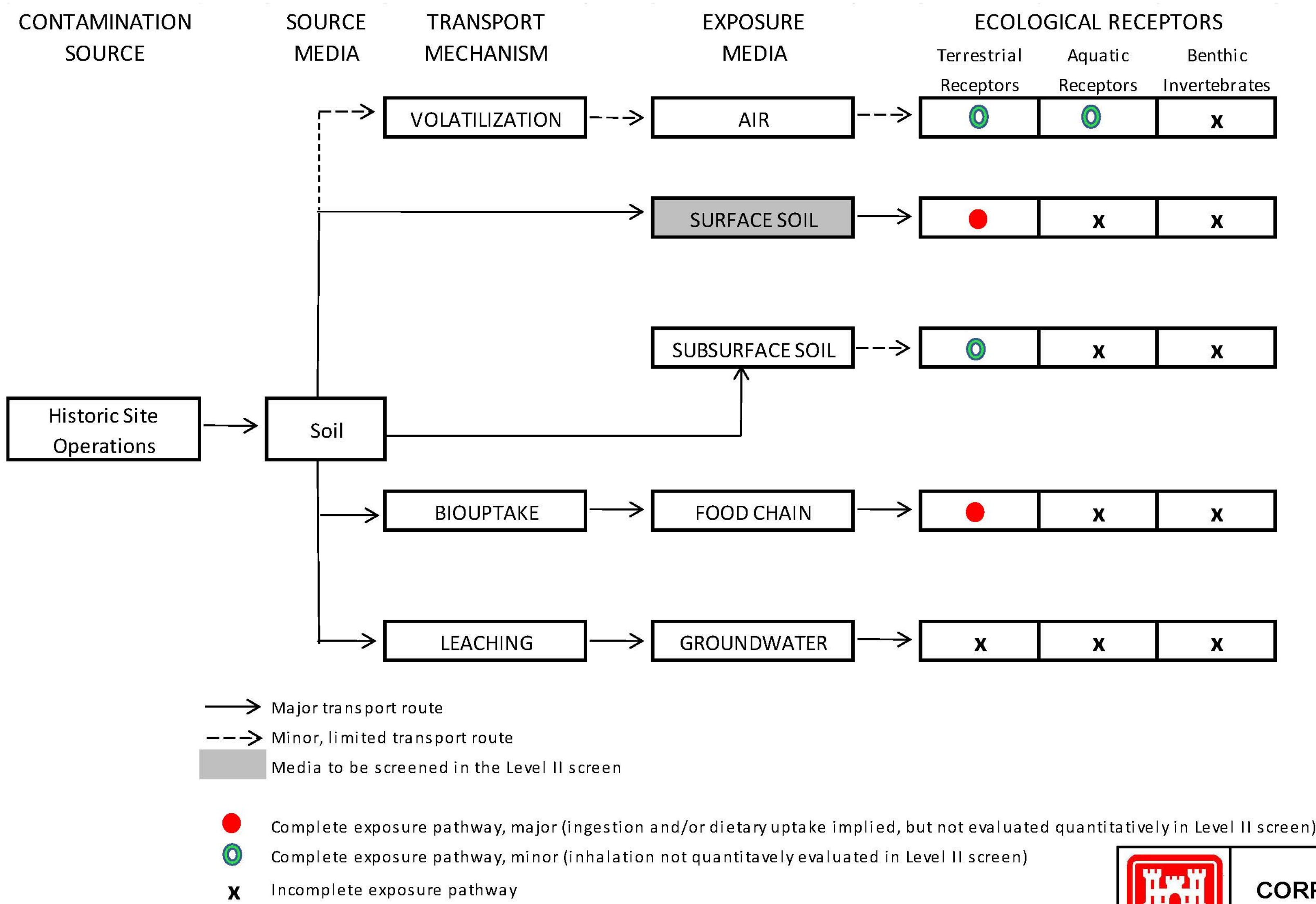
A Level II Screening was performed at the MRS to compare MRS-specific data to appropriate ecological screening values (ESVs) and other criteria to determine the need for further evaluation. An ecological CSM was developed to identify the potential ecological receptors at risk and the exposure pathways by which these receptors could be exposed to contamination in site media. Specific assessment and measurement endpoints are identified based on the CSM to describe ecological features targeted for protection. Then, a COPEC identification step is performed to determine what chemicals, if any, potentially represent a threat to the ecological receptors present at the MRS.

8.3.1 Ecological Conceptual Site Model

The ecological CSM depicts and describes the known and expected relationships among the stressors, pathways, and assessment endpoints that are considered in the risk assessment, along with a rationale for their inclusion. Two ecological CSMs are presented for this Level II Screen. One ecological CSM is associated with the media screening conducted during the Level II Screen (**Figure 8-1**). The other ecological CSM (**Figure 8-2**) represents a preliminary CSM for a Level III Baseline, should one be considered necessary. The ecological CSMs for the Load Line #1A MRS were developed using the available MRS-specific information and professional judgment. The contamination mechanism, source media, transport mechanisms, exposure media, exposure routes, and ecological receptors for the ecological CSMs are described below.

8.3.1.1 Chemical Source

The chemical source includes releases of triple-base propellant onto the ground surface at the northern portion of Load Line #1 where munitions loading activities occurred when Load Line #1 was in operation.



U.S. ARMY
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BALTIMORE DISTRICT

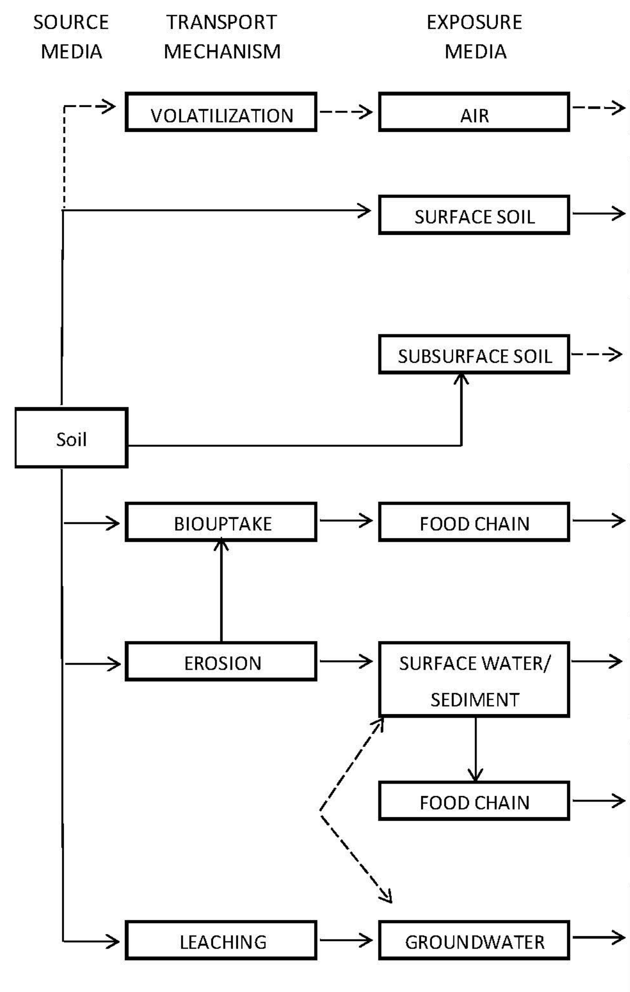
MILITARY MUNITIONS RESPONSE PROGRAM

LOAD LINE #1A MRS
FORMER RVAAP/CAMP RAVENNA
PORTAGE AND TRUMBULL COUNTIES, OHIO

CB&I Federal Services LLC
150 Royall Street
Canton, MA 02021

H:\MAMMS\Ravenna\GIS_Documents\Project_Maps\MMRP\RIFS\RIFS_LoadLine1\April_2014_Rev1\RVAAP_LL1_015_Fig8_1_LevelIICSM_r1.mxd; Analyst: jclarke; Date: 5/2/2014 2:46:16 PM

FIGURE 8-1 ECOLOGICAL CSM FOR LEVEL II SCREEN



Exposure Media	Exposure Routes	Terrestrial Plants	Terrestrial Inverts	Rabbit Vole	Shrew Robin	Fox Hawk	Aquatic biota	Muskrat Duck	Mink Heron	Benthic Inverts
AIR	INHALATION (VAPORS)	x	x	◎	◎	◎	x	x	x	x
SURFACE SOIL	INGESTION	x	●	●	●	●	x	x	x	x
	DIRECT/DERMAL CONTACT	●	●	◎	◎	◎	x	x	x	x
	INHALATION (FUGITIVE DUST)	x	x	◎	◎	◎	x	x	x	x
SUBSURFACE SOIL	INGESTION	x	x	x	x	x	x	x	x	x
	DIRECT/DERMAL CONTACT	x	x	x	x	x	x	x	x	x
	INHALATION (FUGITIVE DUST)	x	x	x	x	x	x	x	x	x
FOOD CHAIN	PLANTS	x	x	●	◎	◎	x	x	x	x
	INVERTEBRATES	x	x	◎	●	◎	x	x	x	x
	HERBIVORES	x	x	x	x	●	x	x	x	x
	OMNIVORES	x	x	x	x	●	x	x	x	x
SURFACE WATER/ SEDIMENT	INGESTION	x	x	x	x	x	x	x	x	x
	DIRECT/DERMAL CONTACT	x	x	x	x	x	x	x	x	x
FOOD CHAIN	PLANTS	x	x	x	x	x	x	x	x	x
	INVERTEBRATES	x	x	x	x	x	x	x	x	x
	FISH	x	x	x	x	x	x	x	x	x
GROUNDWATER	INGESTION	x	x	x	x	x	x	x	x	x
	DIRECT/DERMAL CONTACT	x	x	x	x	x	x	x	x	x
	INHALATION (VAPORS)	x	x	x	x	x	x	x	x	x

→ Major route
- - → Minor route (not quantified)

● Complete exposure pathway, major
◎ Complete exposure pathway, minor
x Incomplete exposure pathway

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FIGURE 8-2 ECOLOGICAL CSM FOR LEVEL III BASELINE

8.3.1.2 Source Medium

The source medium is surface soil within the identified MRS boundaries where triple-base propellants have been historically found on the ground surface. For this ERA, surface soil is defined as 0 to 0.5 feet bgs and is the depth that concentrated MC associated with triple-base propellants on the ground surface would be expected to vertically migrate in the soil column.

8.3.1.3 Selection of Exposure Units

From the ecological assessment viewpoint, an EU is the area where ecological receptors potentially are exposed to the SRCs. Although some ecological receptors are likely to gather food, seek shelter, reproduce, and move around, spatial boundaries of the ecological EUs are the same as the spatial boundaries of aggregates defined for historical use, nature and extent, fate and transport, and the HHRA. Surface soil to a maximum depth of 0.5 feet is considered to be representative of the terrestrial EU at the Load Line #1A MRS. No other EUs are identified for this MRS.

8.3.1.4 Transport Mechanisms

Potential transport mechanisms at the MRS include volatilization into the air, biota uptake, erosion to surface water and sediment, and leaching to groundwater. Biota uptake is a transport mechanism because some of the MRS contaminants are known to accumulate in biota, which may act as a vehicle to spatially disperse contaminants, as well as representing a secondary exposure medium for upper trophic-level receptors that prey on the biota.

8.3.1.5 Exposure Media

Sufficient time has elapsed for contaminants in the source medium to have migrated to potential exposure media, resulting in possible exposure of receptors that come into contact with these media. Potential exposure media include air, surface soil, and the food chain. Surface soil (typically 0 to 1 foot bgs for the facility) was not collected greater than 0.5 feet bgs at the MRS since most MC would be expected to have concentrated in the top several inches of soil. Subsurface soil includes soil at depths that ecological receptors typically do not come into contact with (greater than 1 foot bgs), and is not being evaluated at the Load Line #1A MRS. Groundwater is not considered an exposure medium because ecological receptors are unlikely to contact groundwater. Therefore, surface soil (0 to 0.5 feet bgs) and biota comprising of prey items for higher-trophic-level receptors are the two principal exposure media for the Load Line #1A MRS.

8.3.1.6 Exposure Routes

Exposure routes are functions of the characteristics of the media in which the sources occur, and reflect how both the released chemicals and receptors interact with those media. For example, for MRSs with aquatic habitat, chemicals in surface water may be dissolved or suspended as particulates and be highly mobile, whereas those same constituents in soil may be much more stationary. The ecology of the receptors is important because it dictates their home range, whether the organism is mobile or immobile, local or migratory, burrowing or above ground, plant eating, animal eating, or omnivorous.

For the Level II Screen CSM (**Figure 8-1**), specific exposure routes were not identified because the screen is not receptor specific and only focuses on comparison of maximum detected concentrations of chemicals in the exposure media against published ecological toxicological benchmark concentrations derived for those media. However, the preliminary Level III Baseline ecological CSM (**Figure 8-2**) identifies specific exposure routes and indicates whether the exposure routes from the exposure media to the ecological receptors are major or minor. Major exposure routes are evaluated quantitatively, whereas minor routes are evaluated qualitatively. The preliminary Level III Baseline ecological CSM (**Figure 8-2**) shows major exposure routes of soil to ecological receptors and an incomplete exposure route of groundwater.

The major exposure routes for chemical toxicity from surface soil include ingestion (for terrestrial invertebrates, voles, shrews, American robins, foxes, and hawks) and direct contact (for terrestrial invertebrates). The ingestion exposure routes for voles, shrews, American robins, foxes, and hawks include soil, as well as plant and/or animal food items (i.e., food chain transfer) that were also exposed to the surface soil. Minor exposure routes for surface soil include direct contact and inhalation of fugitive dust. Inhalation and dermal contact, however, are typically not assessed in terrestrial ERAs because these routes are not well studied for wildlife. Additionally, since most wildlife have protective features such as fur or feathers, dermal contact is typically a negligible exposure pathway (though dermal contact with soil is a potentially significant exposure route for soil-dependent terrestrial animals such as invertebrates) (USACE, 2010).

Exposure to groundwater is an incomplete pathway for all ecological receptors because receptors typically do not come into direct contact with groundwater. If the groundwater outcrops via seeps or springs into wetlands or ditches, it becomes treated as surface water and would be evaluated as such in the ERA.

8.3.1.7 Ecological Receptors

For the Level II Screen, specific ecological receptors were not identified; rather, terrestrial biota is considered as a whole. However, for the Level III Baseline evaluation, specific terrestrial ecological receptors are identified as part of the ecological CSM (**Figure 8-2**). The terrestrial receptors include terrestrial invertebrates (earthworms), voles, shrews, American robins, foxes, and hawks (USACE, 2003b). These receptors are discussed in more detail in the following sections.

8.3.1.8 Selection of MRS-Specific Ecological Receptor Species

The selection of ecological receptors for the MRS-specific analysis screen was based on animal species that are likely to occur in the terrestrial habitat at the MRS. Three criteria were used to identify the MRS-specific receptors (USACE, 2003b):

1. **Ecological Relevance—**The receptor has or represents a role in an important function such as nutrient cycling (i.e., earthworms), and population regulation (i.e., hawks). Receptor species were chosen to include representatives of all applicable trophic levels identified by the ecological CSM for the MRS. These species were selected to be predictive of assessment endpoints (including protected species/species of special concern and recreational species).
2. **Susceptibility—**The receptor is known to be sensitive to the chemicals detected at the MRS, and given their food and habitat preferences, their exposure is expected to be high. The species have a likely potential for exposure based upon their residency status, home range size, sedentary nature of the organism, habitat compatibility, exposure to contaminated media, exposure route, and/or exposure mechanism compatibility. Ecological receptor species were also selected based on the availability of toxicological effects and exposure information.
3. **Management Goals—**The receptor represents a valued component of the MRS's ecological significance. Furthermore, as a significant natural resource, its presence should be managed in a manner that is compatible with the military mission at the RVAAP (AMEC, 2008).

At the Load Line #1A MRS, the following types of ecological receptors are likely to be present: terrestrial invertebrates, meadow voles (*Microtus pennsylvanicus*), short-tailed shrews (*Blarina brevicauda*), American robins (*Turdus migratoris*), red foxes (*Vulpes vulpes*), and red-tailed hawks (*Buteo jamaicensis*). Each of these receptors is described in the following paragraphs.

Terrestrial Invertebrate Exposure to Soil

Terrestrial invertebrate exposure to soil is applicable to soils for the Load Line #1A MRS. Earthworms represent the receptor for the terrestrial invertebrate class, and there is sufficient habitat present for them on site. Earthworms have ecological relevance because they are important for decomposition of detritus and for energy and nutrient cycling in soil (Efroymson et al., 1997b), and as prey items for other species. Earthworms are probably the most important of the terrestrial invertebrates for promoting soil fertility due to the volume of soil that they process.

Earthworms are susceptible to exposure to and toxicity from COPECs in soil. Earthworms are nearly always in contact with soil and ingest soil, which results in constant exposure. Earthworms are sensitive to various chemicals. Toxicity benchmarks are available for earthworms (Efroymson et al., 1997b). Although specific management goals for earthworms are not immediately obvious, the role of earthworms in soil fertility and as a food source is significant. Thus, there is sufficient justification to warrant earthworms as a representative receptor for the Load Line #1A MRS.

Mammalian Herbivore Exposure to Soil

Mammalian herbivore exposure to soil is applicable for the Load Line #1A MRS. Cottontail rabbits and meadow voles represent mammalian herbivore receptors, and there is suitable habitat present for them at the MRS. Both species have ecological relevance by consuming vegetation, which helps in the regulation of plant populations and in the dispersion of some plant seeds. Small herbivorous mammals such as cottontail rabbits and voles are prey items for top terrestrial predators.

Both cottontail rabbits and meadow voles are susceptible to exposure to and toxicity from COPECs in soil and vegetation. Herbivorous mammals are exposed primarily through ingestion of plant material and incidental ingestion of contaminated surface soil containing chemicals. Exposures by inhalation of COPECs in air or on suspended particulates, as well as exposures by direct contact with soil, were assumed to be negligible. Dietary toxicity benchmarks are available for many COPECs for mammals (Sample et al., 1996), and there are regulatory statutes for rabbits because they are an upland small game species protected under Ohio hunting regulations. There are no specific regulatory statutes for meadow voles at the Load Line #1A MRS. Meadow voles have smaller home ranges than rabbits, which make them potentially more susceptible to localized contamination. Therefore, they are a more conservative selection as a representative mammalian herbivore than rabbits, and are selected as representative receptors for this foraging guild at the Load Line #1A MRS.

Insectivorous Mammal and Bird Exposure to Soil

Insectivorous mammal and bird exposure to soil is applicable for the Load Line #1A MRS. Short-tailed shrews and American robins represent the receptors for the insectivorous mammal and bird terrestrial exposure classes, respectively. There is sufficient, suitable habitat present at the MRS for these receptors. Both species have ecological relevance because they help to control aboveground invertebrate community size by consuming large numbers of invertebrates. Shrews and robins are a prey item for terrestrial top predators.

Both short-tailed shrews and American robins are susceptible to exposure to and toxicity from COPECs in soil as well as contaminants in vegetation and terrestrial invertebrate. Insectivorous mammals, such as short-tailed shrews, and birds, such as American robins, are primarily exposed by ingestion of contaminated prey (i.e., earthworms, insect larvae, and slugs), as well as ingestion of soil. In addition, shrews ingest a small amount of leafy vegetation, and half of a typical American robin's diet consists of seeds and fruit. Dietary toxicity benchmarks are available for mammals and birds (Sample et al., 1996). Both species are recommended as receptors because there can be different toxicological sensitivities between mammals and birds exposed to the same contaminants. There are regulatory statutes for American robins because they are federally protected under the *Migratory Bird Treaty Act of 1993*, as amended, and are consistent with the INRMP (AMEC, 2008) polices and management goals. There are no specific regulatory statutes for shrews at the MRS. Based on the management goals for American robins, plus the susceptibility to contamination and ecological relevance for both species, there is sufficient justification to warrant shrews and American robins as representative receptors for the Load Line #1A MRS.

Terrestrial Top Predators

Exposure of terrestrial top predators is applicable to the Load Line #1A MRS. Red foxes and red-tailed hawks represent the mammal and bird receptors for the terrestrial top predator exposure class, and there is a limited amount of suitable habitat available for them at the MRS. Both species have ecological relevance; as representatives of the top of the food chain for the MRS terrestrial EUs, they control populations of prey animals such as small mammals and birds.

Both red foxes and red-tailed hawks are susceptible to exposure to and toxicity from COPECs in soil, vegetation, and/or animal prey. Terrestrial top predators feed on small mammals and birds that may accumulate constituents in their tissues following exposure at the MRS. There is a potential difference in toxicological sensitivity between mammals and birds exposed to the same COPECs, so it is prudent to examine a species from both the *Mammalia* and *Aves* classes. Red foxes are primarily carnivorous but consume some plant material. The red-tailed hawk consumes only animal prey. The fox may incidentally consume soil. There are regulatory statutes for both species. Laws (Ohio Trapping Season Regulations for foxes and federal protection of raptors under the *Migratory Bird Treaty Act*, 16 USC 703-711 [1993, as amended]) and the INRMP (AMEC, 2008) policies and management goals also protect these species. In addition, both species are susceptible to contamination and have ecological relevance as top predators in the terrestrial ecosystem. Based on this justification, these two species were selected as representative receptors for the Load Line #1A MRS.

8.3.1.9 Relevant and Complete Exposure Pathways

Relevant and complete exposure pathways for the ecological receptors at the Load Line #1A MRS were described in the previous section. As previously discussed, there are relevant and complete exposure pathways for various ecological receptors including terrestrial invertebrates, and terrestrial herbivores, insectivores, and carnivores. Thus, these types of receptors could be exposed to COPECs in surface soil at the Load Line #1A MRS.

8.3.2 Ecological Endpoint (Assessment and Measurement) Identification

The protection of ecological resources, such as habitats and species of animals, is a primary motivation for conducting SLERAs. Key aspects of ecological protection are presented as general management goals. These are non-site-specific goals established by legislation or agency policy that are based on societal concern for the protection of certain environmental resources. For example, environmental protection is mandated by a variety of legislation and government agency policies (i.e., CERCLA and the NCP). Other legislation includes the ESA; 16 USC 1531-1544 (1993, as amended); and the *Migratory Bird Treaty Act*, 16 USC 703-711 (1993, as amended). To evaluate whether a general management goal has been met, assessment endpoints, measures of effects, and decision rules were formulated. The general management goals, assessment endpoints, measures of effects, and decision rules are discussed below.

Because only terrestrial habitat is present at the Load Line #1A MRS, there is only one primary general management goal for this MRS. However, the assessment endpoints differ between the general screen and the MRS-specific analysis screen. The general management goal for the SLERA is to protect terrestrial animal populations from adverse effects due to the release—or the potential release—of chemical substances associated with past MRS activities.

Ecological assessment endpoints are selected to determine whether this general management goal is met at the unit. An ecological assessment endpoint is a characteristic of an ecological component that may be affected by exposure to a stressor (i.e., COPEC). Assessment endpoints are “explicit expressions of the actual environmental value that is to be protected” (EPA, 1992). Assessment endpoints often reflect environmental values that are protected by law, provide critical resources, or provide an ecological function that would be significantly impaired if the resource was altered. Unlike the HHRA process, which focuses on individual receptors, the SLERA focuses on populations or groups of interbreeding nonhuman, nondomesticated receptors. Population responses are also better defined and predictable than are community and ecosystem responses (USACE, 2010). In the SLERA process, risks to individuals are assessed only if they are protected under the ESA or other species-specific legislation, or if the species is a candidate for listing as threatened or endangered. Because threatened and endangered species are not a concern at the Load Line #1A MRS, potential impacts to populations are the appropriate criterions for consideration.

Due to the uniqueness of local flora and fauna communities, as well as varying societal values placed on these ecological features, a universally applicable list of assessment endpoints does not exist. The Ohio EPA Guidance (2008) was used to select assessment endpoints for this SLERA.

For the Level II Screen, the assessment endpoints are any potential adverse effects on ecological receptors, where receptors are defined as any plant or animal populations, communities, habitats, and sensitive environments (Ohio EPA, 2008). Although the assessment endpoints for the Level II Screen are associated with the General Management Goal (protection of terrestrial receptors and communities), specific receptors are not identified with the assessment endpoints.

Table 8-1 presents the General Management Goal for terrestrial resources, associated assessment endpoints, measures of effect, and decision rule by assessment endpoint number. Furthermore, the table provides definitions of Assessment Endpoints 1, 2, 3, and 4 for terrestrial receptors. As stated, the assessment endpoint table includes a column describing the conditions for making a decision depending on whether the HQ is less than or greater than 1. If the HQ is greater than 1, the scientific management decision point options from the Ohio EPA Guidance (2008) are provided (i.e., no further action, risk management, monitoring, remediation, or further investigation).

For the Level III Baseline evaluation, the assessment endpoints are more specific and stated in terms of types of specific ecological receptors associated with the General Management Goal. Assessment Endpoints 1, 2, 3, and 4 entail the growth, survival, and reproduction of terrestrial receptors such as terrestrial invertebrates; herbivorous mammals; worm-eating/insectivorous mammals and birds; and carnivorous, top-predator mammals and birds, respectively. Assessment Endpoints 1 through 4 are associated with the General Management Goal (protection of terrestrial populations and communities).

The assessment endpoints are evaluated using measurement endpoints. The EPA defines measurement endpoints as ecological characteristics used to quantify and predict change in the assessment endpoints. They consist of measures of receptor and population characteristics, measures of exposure, and measures of effect. For example, measures of receptor characteristics include parameters such as home range, food intake rate, and dietary composition. Measurement endpoints should be selected to provide insights related to the specific assessment endpoint (USACE, 2010). Measures of exposure include attributes of the environment such as contaminant concentrations in soil, sediment, surface water, and biota. The measurement endpoints of effect for the Level II Screening evaluation consist of the comparison of the maximum detected concentrations of each contaminant in soil to ESV benchmarks.

Table 8-1
General Management Goal, Ecological Assessment Endpoints, Measures of Effect, and Decision Rules Identified for a Level II Screening

General Management Goal	Assessment Endpoint	Measures of Effect	Decision Rule
General Management Goal: The protection of terrestrial populations, communities, and ecosystems	**Assessment Endpoint 1:** Growth, survival, and reproduction of soil invertebrate communities and tissue concentrations of contaminants low enough such that higher trophic levels that consume them are not at risk Receptors: earthworms	**Measures of Effect 1:** Earthworm soil toxicity benchmarks and measured RME concentrations of constituents in soil	**Decision Rule for Assessment Endpoint 1:** If HQs, defined as the ratios of COPEC RME concentrations in surface soil to soil toxicity benchmarks for adverse effects on soil invertebrates, are less than or equal to 1, then Assessment Endpoint 1 has been met and soil-dwelling invertebrates are not at risk. If the HQs are greater than 1, a SMDP is reached, at which point it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs and applicable media, or further investigation such as a Level III and Level IV Field Baseline.
	Assessment Endpoint 2: Growth, survival, and reproduction of herbivorous mammal populations and low enough concentrations of contaminants in their tissues so that higher trophic level animals that consume them are not at risk Receptor: meadow vole	**Measures of Effect 2:** Estimates of receptor home range area, body weights, feeding rates, and dietary composition based on published measurements of endpoint species or similar species; modeled COPEC concentrations in food chain based on measured concentrations in physical media; chronic dietary NOAELs applicable to wildlife receptors based on measured responses of similar species in laboratory studies	**Decision Rule for Assessment Endpoint 2:** If HQs, based on ratios of estimated exposure concentrations predicted from COPEC RME concentrations in surface soil to dietary limits corresponding to NOAEL TRV benchmarks for adverse effects on herbivorous mammals are less than or equal to 1, Assessment Endpoint 2 is met, and the receptors are not at risk. If the HQs are greater than 1, a SMDP is reached, at which point it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs in applicable media, or further investigation such as a Level III and Level IV Field Baseline.
	Assessment Endpoint 3: Growth, survival, and reproduction of worm-eating and insectivorous mammal and bird populations and low enough concentrations of contaminants in their tissue so that predators that consume them are not at risk Receptors: shrews and robins	**Measures of Effect 3:** Estimates of receptor home range area, body weights, feeding rates, and dietary composition based on published measurements of endpoint species or similar species; modeled COPEC concentrations in food chain based on measured concentrations in physical media; chronic dietary NOAELs applicable to wildlife receptors based on measured responses of similar species in laboratory studies	**Decision Rule for Assessment Endpoint 3:** If HQs based on ratios of estimated exposure concentrations predicted from COPEC RME concentrations in surface soil to dietary limits corresponding to NOAEL TRV benchmarks for adverse effects on worm-eating and insectivorous mammals and birds is less than or equal to 1, then Assessment Endpoint 3 is met, and these receptors are not at risk. If the HQs are greater than 1, a SMDP is reached, at which point it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs in applicable media, or further investigation such as a Level III and Level IV Field Baseline Decision Rule for Assessment Endpoint 4.
	Assessment Endpoint 4: Growth, survival, and reproduction of carnivorous mammal and bird populations Receptor: red-tailed hawk and red fox	**Measures of Effect 4:** Estimates of receptor home range area, body weights, feeding rates, and dietary composition based on published measurements of endpoint species or similar species; modeled COPEC concentrations in food chain based on measured concentrations in physical media; chronic dietary NOAELs applicable to wildlife receptors based on measured responses of similar species in laboratory studies	**Decision Rule for Assessment Endpoint 4:** If HQs based on ratios of estimated exposure concentrations predicted from COPEC RME concentrations in surface soil to dietary limits corresponding to NOAEL TRV benchmarks for adverse effects on carnivorous mammals and birds are less than or equal to 1, then Assessment Endpoint 4 is met, and the receptors are not at risk. If the HQs are greater than 1, a SMDP is reached, at which point it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs in applicable media, or further investigation such as a Level III and Level IV Field Baseline.

COPEC denotes chemical of potential ecological concern.
HQ denotes hazard quotient.
NOAEL denotes no observed adverse effect level.
RME denotes reasonable maximum exposure.
SMDP denotes scientific management decision point.
TRV denotes toxicity reference value.

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Measurement endpoints for the Level III Baseline, if necessary, include the comparison of estimated doses of chemicals in various receptor animals such as voles, shrews, and American robins to toxicity reference values (TRVs).

In the Level II Screen, maximum detected concentrations in soil were used as the EPC for comparison to generic soil or sediment screening values that are expected not to cause harm to ecological populations. Any COPECs retained following the Level II Screen are potentially subject to a Level III Baseline analysis using EPCs that are more representative of the exposures expected for the representative receptors. The Level III Baseline analysis includes evaluation of exposure of a variety of receptors to the reasonable maximum exposure concentrations of COPECs at each EU, using default dietary and uptake factors. The representative ecological receptors may not all be present at each EU. However, all representative receptors are evaluated at this step.

For the Level III Baseline, decision rules for COPECs were obtained from Ohio EPA Guidance for chemicals (2008). Briefly, for COPECs, the first decision rule is based on the ratio (or HQ) of the dose to a given receptor species (i.e., a vole, representing herbivorous mammals) associated with a chemical's concentration in the environment (numerator) to the ecological effects or TRV (denominator) of the same chemical. A ratio of 1.0 or less means that ecological risk is negligible, while a ratio of greater than 1.0 means that ecological risk from that individual chemical is possible and that additional investigation should follow to confirm or refute this prediction.

The second decision rule is that if "no other observed significant adverse effects on the health or viability of the local individuals or populations of species are identified" and the HQ does not exceed 1, "the site is highly unlikely to present significant risks to endpoint species" (Ohio EPA, 2008). Potential outcomes for the Level III Baseline include the following: no significant risks to endpoint species so no further analysis is needed; conduct field baseline assessment to quantify adverse effects to populations of representative species that were shown to be potentially impacted based on hazard calculations in the Level III Baseline; and remedial action taken without further study.

8.3.3 Identification of COPECs

This section presents the screening of analytical data obtained from samples collected from the Load Line #1A MRS in surface soil. After the Level II Screen is complete, any COPECs identified are discussed in greater detail, and a recommendation is made as to whether the ERA should proceed to a Level III Baseline or Level IV Field Baseline.

8.3.3.1 Data Used in the SLERA

The available data set used in this SLERA consists of two ISM surface soil samples (LL1SS-715(I)-0001-SS and LL1SS-716(I)-0001-SS) collected as part of the RI field effort. A third sample (LL1SS-717(I)-0001-SS) was collected as a field duplicate and is therefore excluded from the risk evaluation process. An ISM sample was collected at the MRS during the SI, but was not included in this SLERA since the samples collected during the RI were intended to further delineate the extent of MC identified during the 2007 SI field activities and are considered to be representative of current conditions. The samples evaluated in the SLERA are presented in **Table 8-2**.

Table 8-2
Summary of Data Used in the Ecological Risk Assessment

Sample ID	Sample Date	Depth (feet bgs)	Sample Type	Analyses
LL1SS-715(I)-0001-SS	8/15/11	0–0.5	ISM	• Lead • Explosives • Nitrocellulose • TOC • pH
LL1SS-716(I)-0001-SS	8/15/11	0–0.5	ISM	

bgs denotes below ground surface.
ID denotes identification.
TOC denotes total organic carbon.

Surface soil at a depth of 0 to 0.5 feet from two ISM sampling units was identified as the only medium of concern at this MRS as described in the Work Plan (Shaw, 2011). The 0- to 0.5-foot sample depth was selected as the EU depth since it is the maximum depth of vertical migration expected of MC associated with triple-base propellant on the ground surface. Each ISM sample was comprised of 30 increments that were combined and homogenized. The ISM data are considered relevant for estimating ecological exposure because they provide the best representation of current MRS conditions, and because the ISM approach provides an accurate estimate of average concentrations that receptors would be exposed to at the MRS. Only surface soil (0- to 0.5-foot sampling interval) samples were used in the SLERA because surface soil had been previously identified as the only medium of concern at the Load Line #1A MRS (Shaw, 2011), and because most ecological exposure occurs within the top 1 foot of soil. No soil removal or remediation has been performed at the MRS specifically but demolition of the adjacent slab foundations may have resulted in heavy equipment traffic and disturbance of surface soil over the MRS, which would likely decrease the attractiveness to burrowing receptors. Therefore, the 0- to 0.5-foot interval is assumed to represent the zone of maximum exposure for most ecological receptors.

The MC analytical data were reviewed and evaluated for quality, usefulness, and uncertainty, as described in Section 4.2. From the MC chemical results of samples described above, a selection process was performed to develop a subset of chemicals that are identified as COPECs.

8.3.3.2 COPEC Selection Criteria

This section describes the selection criteria used to identify COPECs in the SLERA. The screen incorporates the same criteria described in Section 4.2.1.3 to eliminate chemicals that are not SRCs (i.e., infrequently detected chemicals, background comparisons, and essential nutrients). Lead and nitroguanidine are considered the only SRCs associated with the Load Line #1A MRS and are included in the COPEC screening step. The SRCs identified in surface soil following the facility data screening process are summarized in Section 4.2.1.3. The evaluation for process to identify SRCs as COPECs is presented in **Table 8-3**.

Comparison to Ecological Screening Values

The maximum detected concentrations of chemicals detected in various media were compared with ESVs for ecological endpoints following recommendations obtained from the Ohio EPA Guidance (2008). Chemicals that exceed the ESVs, or for which no ESVs are available, were retained as COPECs. The following ESV hierarchy was used for the ecological evaluation of soil:

- EPA: *Ecological Soil Screening Levels* (online updates from http://www.epa.gov/ecotox/ecossl/) (2010)
- Oak Ridge National Laboratory: *Preliminary Remediation Goals for Ecological Endpoints*, ES/ER/TM-162/R2 (Efroymson et al., 1997a)
- EPA: *Ecological Screening Levels, EPA Region 5* (August 2003)
- Los Alamos National Laboratory: *ECORISK Database*, *Release 2.5* (November 2010)
- Talmage et al.: *Nitroaromatic Munitions Compounds: Environmental Effects and Screening Values*, Rev. Environ. Contamin. Toxicol., 161:1–156 (1999)

Chemicals that were considered persistent, bioaccumulative, and toxic (PBT) were retained as COPECs even if they were detected at concentrations below their ESVs, unless the ESV was protective of food chain effects (Ohio EPA, 2008). PBT compounds include those chemicals listed in Ohio EPA Guidance (2008), including chemicals whose log octanol-water partition coefficient values are greater than or equal to 3, and chemicals listed as important bioaccumulative compounds in the EPA DQO Guidance (2000). The ESVs used for the SLERA are presented in **Appendix F**.

Essential Nutrients

Evaluating essential nutrients is a special form of risk-based screening applied to certain ubiquitous elements that are generally considered to be required nutrients. Essential nutrients such as calcium, iron, magnesium, potassium, and sodium are usually eliminated as COPECs because they are generally considered to be innocuous in environmental media. Other essential nutrients, including chloride, iodine, and phosphorus, may be eliminated as COPECs, provided that their presence in a particular medium is unlikely to cause adverse effects to biological health. A screen for essential nutrients was not required for the SLERA since no essential nutrients were evaluated as SRCs as part of the facility data screening process conducted (Section 4.2.1.3).

8.3.4 Summary of COPEC Selection

The results of the COPEC screening for surface soil are presented in **Table 8-3** for the ISM samples. The table presents the following information:

- Identified SRC
- Frequency of detection
- Range of detected concentrations
- Range of detection limits
- Arithmetic mean (average) of site concentrations
- ESV
- HQ
- Determination as to whether the chemical is a PBT pollutant
- Determination as to whether the chemical is a COPEC

The HQ is calculated as the detected concentration divided by the ESV. An HQ greater than 1 indicates that the concentration in the medium exceeds the conservative ESV, and may indicate that a potential ecological threat may exist. Chemicals with HQs less than 1 are considered to be of low concern, and are not carried forward as COPECs, unless the chemical is a PBT pollutant and its screening value is not protective of food chain effects. A description and summary of the COPECs identified in surface soil is presented in the following section.

Table 8-3
Statistical Summary and Ecological Screening of Surface Soil (0–0.5 feet bgs)

SRC	Range of Values, mg/kg						Mean (mg/kg)	Location of MDC	BSV	ESV[1] (mg/kg)	Below ESV?	HQ	PBT?[1]	COPEC?[2]
	Detected Concentrations				Reporting Limits									
	Minimum	VQ	Maximum	VQ	Minimum	Maximum								
Metals														
Lead	70.9		109		0.25	0.25	89.95	LL1SS-715	26.1	11	No	9.9	No	Yes
Explosives														
Nitroguanidine	0.22	J	0.25	J	0.25	0.26	0.235	LL1SS-715	NA	NA	NA	NA	No	Yes

[1] See Appendix F.
[2] Selection of COPECs:
Yes denotes MDC for COPEC exceeds the ESV, or the COPEC lacks an ESV.
bgs denotes below ground surface.
COPEC denotes chemical of potential ecological concern.
ESV denotes ecological screening value.
J denotes estimated concentration (difference in concentrations between the primary and confirmation column results exceeds 40%).
HQ denotes hazard quotient.
MDC denotes maximum detected concentration.
mg/kg denotes milligrams per kilogram.
NA denotes not applicable.
PBT denotes persistent, bioaccumulative, and toxic.
SRC denotes site-related chemical.
VQ denotes validation qualifier.

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8.3.4.1 Soil COPEC Selection

Lead exceeded its ESV, and nitroguanidine lacked an ESV. Following the initial COPEC screen, both SRCs were identified as COPECs. The results of the soil screening process used to evaluate for COPECs are presented in **Table 8-3**.

8.3.5 Refinement of COPECs (Step 3a)

Prior to making the determination as to whether a Level III Baseline is warranted, it is appropriate to evaluate various lines of evidence that might suggest whether or not additional ecological investigation is needed at this MRS. Of primary importance in a SLERA is determining whether any ecological threats exist, and if so, whether they are related to chemical contamination (USACE, 2010). To make this determination, additional factors should be considered in the Unified Approach ERA Process (USACE, 2012) for facility sites. Some of these factors are discussed in the following paragraphs.

Due to the highly conservative nature of the Level II Screen, the identification of COPECs does not necessarily indicate that the potential for adverse effects is realistic at this MRS. For example, HQs developed during the initial (screening) steps of a SLERA assume chemicals are 100-percent bioavailable.

Another source of uncertainty in the Level II Screen results from the fact that toxicity studies upon which the benchmark values are based are highly conservative. These studies typically use naive (i.e., laboratory) organisms comprised of a single genetic strain that have no inherent resistance to chemical insults. Nonlaboratory organisms have both a more diverse genetic makeup and exposure history to ambient levels of chemicals (both natural and anthropogenic in origin) that favor the development of resistances to chemical exposure in nature. Also, toxicity studies usually dose the test organisms with a chemical that is fully bioavailable (i.e., in solution) and that uses the most toxic chemical form. However, when a chemical is released to the environment, it reacts with other compounds and is affected by ambient conditions that often reduce the chemical's ability to be absorbed by and/or retained in an organism (i.e., metals released to terrestrial systems often sorb to soil, reducing their bioavailability). The form of the chemical may change in the natural environment as well, which often results in the reduction of its toxic properties. For example, under reducing conditions, hexavalent chromium is readily transformed to less toxic trivalent chromium in soil (however, it should be noted that conversion to a more toxic form in the environment is also possible, such as the conversion of inorganic mercury to methyl mercury by microorganisms under certain conditions).

Because of these factors, the correlation between the total concentration of a chemical in a given medium and its toxic effect is often quite poor, and predictions regarding potential toxicity must be used with caution. Although any chemical with an HQ greater than 1 must be identified as a COPEC and is recognized as being a potential concern (Ohio EPA, 2008), the uncertainties associated with the HQs must be considered when making recommendations based on the results of the SLERA, particularly with regards to the interpretation of the HQ values. HQs are not measures of risk, are not population-based statistics, and are not linearly scaled statistics. Therefore, an HQ greater than 1, even exceedingly so, does not definitively indicate that there is even one individual expressing the toxicological effect associated with a given chemical to which it was exposed (Tannenbaum, 2005; Bartell, 1996). Furthermore, the spatial area affected and the magnitude of the HQ exceedance must be taken into account when considering the potential for local populations (rather than individuals) to experience adverse effects, because population-level effects are the endpoints of concern in the SLERA. To account for some of these uncertainties, HQs less than 10 are considered to represent a low potential for environmental effects, HQs greater than or equal to 10 but less than 100 are considered to represent a significant potential that effects could result from greater exposure, and HQs greater than 100 represent the highest potential for expected effects (Wentsel et al., 1996).

The findings of the Level II Screen are discussed in additional detail in this section to support final recommendations for this stage of the risk assessment process.

8.3.6 Level II Screen Weight of Evidence Discussion

As presented in Section 8.3.4.1, “Soil COPEC Selection,” two COPECs were identified in the ISM soil samples, including one metal (lead) and one explosives compound (nitroguanidine). **Table 8-4** presents the concentrations of all COPECs by soil sample, and **Table 8-5** presents the HQs associated with each COPEC in the individual samples.

Table 8-4
Summary of COPECs in Surface Soil (0 to 0.5 feet)

			Sample Location:	**LL1SS-715**		**LL1SS-716**	
			Sample Number:	**LL1SS-715(I)-0001-SS**		**LL1SS-716(I)-0001-SS**	
			Sample Date:	**8/15/11**		**8/15/11**	
			Sample Depth (foot bgs):	**0–0.5**		**0–0.5**	
COPEC	**BSV**	**ESV**	**Units**	**Result**	**VQ**	**Result**	**VQ**
Metals							
Lead	26.1	11	mg/kg	***109***		***70.9***	
Explosives							
Nitroguanidine	-	-	mg/kg	*0.25*	J	*0.22*	J

Table 8-4 (continued)
Summary of COPECs in Surface Soil (0 to 0.5 feet)

Detects in bold exceed the ESV. Detects in italic exceed the BSV or indicate that a BSV is not available.
- denotes that a value is not available for this criterion.
bgs denotes below ground surface.
BSV denotes background screening value.
COPEC denotes chemical of potential ecological concern.
ESV denotes ecological screening value.
ISM denotes incremental sampling methodology.
J value denotes estimated value.
mg/kg denotes milligrams per kilogram.
VQ denotes validated qualifier.

Table 8-5
Summary of HQs for COPECs in Surface Soil (0 to 0.5 feet)

Sample Location:	**LL1SS-715**	**LL1SS-716**
Sample Number:	**LL1SS-715(I)-0001-SS**	**LL1SS-716(I)-0001-SS**
Sample Date:	**August 15, 2011**	**August 15, 2011**
Sample Depth (foot bgs):	**0–0.5**	**0–0.5**
COPEC	**HQ[1]**	**HQ[1]**
Metals		
Lead	9.9	6.4
Explosives		
Nitroguanidine	-	-

[1] *Only HQs greater than 1 are presented.*
- denotes no value is available for this criterion.
bgs denotes below ground surface.
COPEC denotes chemical of potential ecological concern.
HQ denotes hazard quotient.
ISM denotes incremental sampling methodology.

The HQ for lead was below 10 in both soil samples (range = 6.4 to 9.9; **Table 8-5**). The ESV for lead is an ecological soil screening level (EPA, 2008) that is based on the protection of a woodcock, an avian insectivore. Although woodcocks or other similar species in this feeding guild may occasionally visit the Load Line #1A MRS, the use of a screening value protective of this feeding guild is highly conservative because the MRS is too small (0.41 acres) to support populations of woodcocks, which have an average home range of over 50 acres (Sample et al., 1996), or other avian insectivores. The lead BSV of 26.1 mg/kg is greater than the ESV of 11 mg/kg, and the fact that naturally occurring concentrations of lead are more than double the risk-based screening value illustrates the highly conservative nature of the ESVs. Lead in the two ISM samples collected at the Load Line #1A MRS exceeded the BSV as well, by a factor of approximately four to five times. Therefore, lead in soil can be characterized as moderately elevated at the Load Line #1A MRS.

No ESV was identified for nitroguanidine; therefore, no HQs were calculated, and its potential toxicity to ecological receptors is unknown. However, this chemical was only detected in the two samples at estimated concentrations that approximate its reporting limit. Although an ESV is not available for nitroguanidine, a review of the ESVs for other explosives compounds reveals that its reported concentrations of 0.25 mg/kg and 0.26 mg/kg exceed the ESV of only one other explosives compound, 2,6-dinitrotoluene, which has an ESV of 0.0328 mg/kg. The fact that nitroguanidine was detected at a concentration that is not toxic for related compounds provides some limited assurance that its presence is not a significant threat to ecological receptors. Furthermore, explosives compounds typically are not bioaccumulative and this chemical was not identified as a PBT compound. Therefore, although the presence of this chemical represents a small uncertainty in this SLERA, nitroguanidine is unlikely to pose a significant threat to ecological receptors.

8.4 Level II Screen Conclusions and Recommendations

Most of the MC detected in the Load Line #1A MRS soil was detected at concentrations that are unlikely to be ecologically relevant. Lead in soil was present at concentrations that exceeded both its ESV and BSV; however, HQs for lead were below 10, which indicate that the potential for impacts is expected to be low. Furthermore, due to the very small size of the MRS (0.41 acres), and although individual ecological receptors may occasionally be exposed to the elevated lead, it is unlikely that populations would be regularly exposed to lead at the Load Line #1A MRS. Because the protection of populations of receptors is the appropriate assessment endpoints for this MRS (see **Table 8-1**), adverse ecological impacts associated with these endpoints are not expected. Nitroguanidine was detected in both ISM samples at estimated concentrations approximating its reporting limit. Although no ESV was available, its detected concentrations are below the ESVs for all other related (i.e., explosives) compounds except 2,6-dinitrotoluene.

In summary, slightly elevated concentrations of lead and trace amounts of one explosives compound were detected in the soil at the Load Line #1A MRS, and the potential for localized ecological impacts cannot be completely discounted. However, given the fact that the terrestrial area evaluated for the Load Line #1A MRS is less than 1 acre in size, and that the Phase II Screen uses highly conservative assumptions, it is unlikely that exposure to the surface soil COPECs identified in this SLERA would adversely impact populations of ecological receptors at the Load Line #1A MRS. Therefore, no further investigation (i.e., a Level III Baseline) or action is considered necessary at the Load Line #1A MRS for ecological purposes.

9.0 REVISED CONCEPTUAL SITE MODELS

This section presents the revised CSMs for MEC and MC at the Load Line #1A MRS based on the results of the data collected for the RI and previous information provided in the SI Report (e^{2}M, 2008) and the HRR (e^{2}M, 2007). The preliminary CSMs for MEC and MC were discussed in Section 2.0. The summary of the RI results were presented in Section 4.0. Potential human health and environmental risks were evaluated in Section 7.0 and Section 8.0, respectively. Following the integration of the RI results into the CSMs for MEC and MC, the MRSPP evaluation for the MRS was reevaluated to include the results of the RI and is discussed at the end this section.

9.1 MEC Exposure Analysis

This section summarizes the RI data results for the MEC exposure pathway analysis for the MRS. As discussed in Section 2.1, "Preliminary CSMs and Project Approach," each pathway includes a source, activity, access, and receptor, with complete, potentially complete, and incomplete exposure pathways identified for each receptor. A pathway is considered complete when a source (MEC) is known to exist and when receptors have access to the MRS while engaging in some activity that results in contact with the source. A pathway is considered potentially complete when a source (MEC) has not been confirmed, but is suspected to exist and when receptors have access to the MRS while engaging in some activity which results in contact with the source. Lastly, an incomplete pathway is any case where one of the four components (source, activity, access, or receptors) is missing from the MRS.

9.1.1 Source

A MEC source is the location where MPPEH or ordnance is situated or expected to be found. The principle sources of MEC at the Load Line #1A MRS were reported to be accidental releases during the loading of munitions during World War II and the Korean War. These activities resulted in the potential for MEC and MD, including propellants, to be present in surface soil at the Load Line #1A MRS (e^{2}M, 2008). The 2007 SI UXO survey activities resulted in the discovery of three pieces of triple-base propellant on the ground surface at the MRS. At the conclusion of the SI Report (e^{2}M, 2008), it was determined that the extent of MEC lying on the ground surface at the MRS was not fully understood. The propellants of interest are not ferrous or detectable using a magnetometer; therefore, minimal uncertainty exists regarding whether propellants are present below ground surface. However, based on historical operations at the MRS, the MEC source would be expected to be found on or very close to the ground surface only.

During the RI field activities, no MEC or MD was identified during the two 100-percent nonintrusive visual surveys. In addition, MEC clearance activities did not identify any subsurface anomalies. Therefore, a subsurface investigation was not warranted. Based on the RI survey results, a MEC source is not considered to be present at the Load Line #1A MRS.

9.1.2 Activity

Activity describes ways that receptors are exposed to a source. Current activities at the Load Line #1A MRS include maintenance, environmental sampling, remediation, and natural resource management. The OHARNG future land use at the MRS is military training. Biota activities at the MRS may include occasional meandering and occupation on the MRS by associated species and burrowing activities.

9.1.3 Access

Access describes the degree to which a MEC source or environment containing MEC is available to potential receptors. The facility boundary fence is well maintained to prevent unauthorized access into the installation and although access to Load Line #1 is intended to be controlled by a fenced perimeter; there is a section of fence missing behind the former guard building and various gaps and holes in the Load Line #1 perimeter fence exist. Therefore, once inside the facility, Load Line #1 can be accessed, including the MRS.

9.1.4 Receptors

A receptor is an organism (human or ecological) that comes into physical contact with MEC. Human receptors identified for the Load Line #1A MRS include both current and future potential users. Ecological receptors (biota) for the purposes of the revised MEC CSM are animal species that are likely to occur in the terrestrial habitats at the MRS. The terrestrial receptors identified include terrestrial invertebrates (represented by earthworms), voles, shrews, American robins, foxes, and hawks (USACE, 2003b).

Current potential users for the MRS include facility personnel, contractors, and potential trespassers. The National Guard Trainee has been identified as a potential user associated with military training, the future land use at the MRS, and is the most sensitive among the identified current and future potential users that may become exposed to MEC at the MRS (USACE, 2005).

9.1.5 MEC Exposure Conclusions

The information collected during the RI was used to update the preliminary MEC CSM for the Load Line #1A MRS and to identify all actual, potentially complete, or incomplete source-receptor interactions for the MRS for current and anticipated future land uses. Evaluation of the end use receptors for future land use in the revised CSM is consistent with the facility HHRA approach (USACE, 2005). The revised MEC exposure pathway analysis is presented in **Figure 9-1**.

Taking into consideration the historical activities that occurred at the MRS, it is expected that triple-base propellants that may be present at the MRS would be found primarily on the ground surface. Two nonintrusive visual surveys were performed over 100 percent of the Load Line #1A MRS during the RI field activities. No MEC or MD items were observed on the ground surface of the MRS during the visual survey; therefore, the MEC exposure pathway for surface soil is considered incomplete for all receptors.

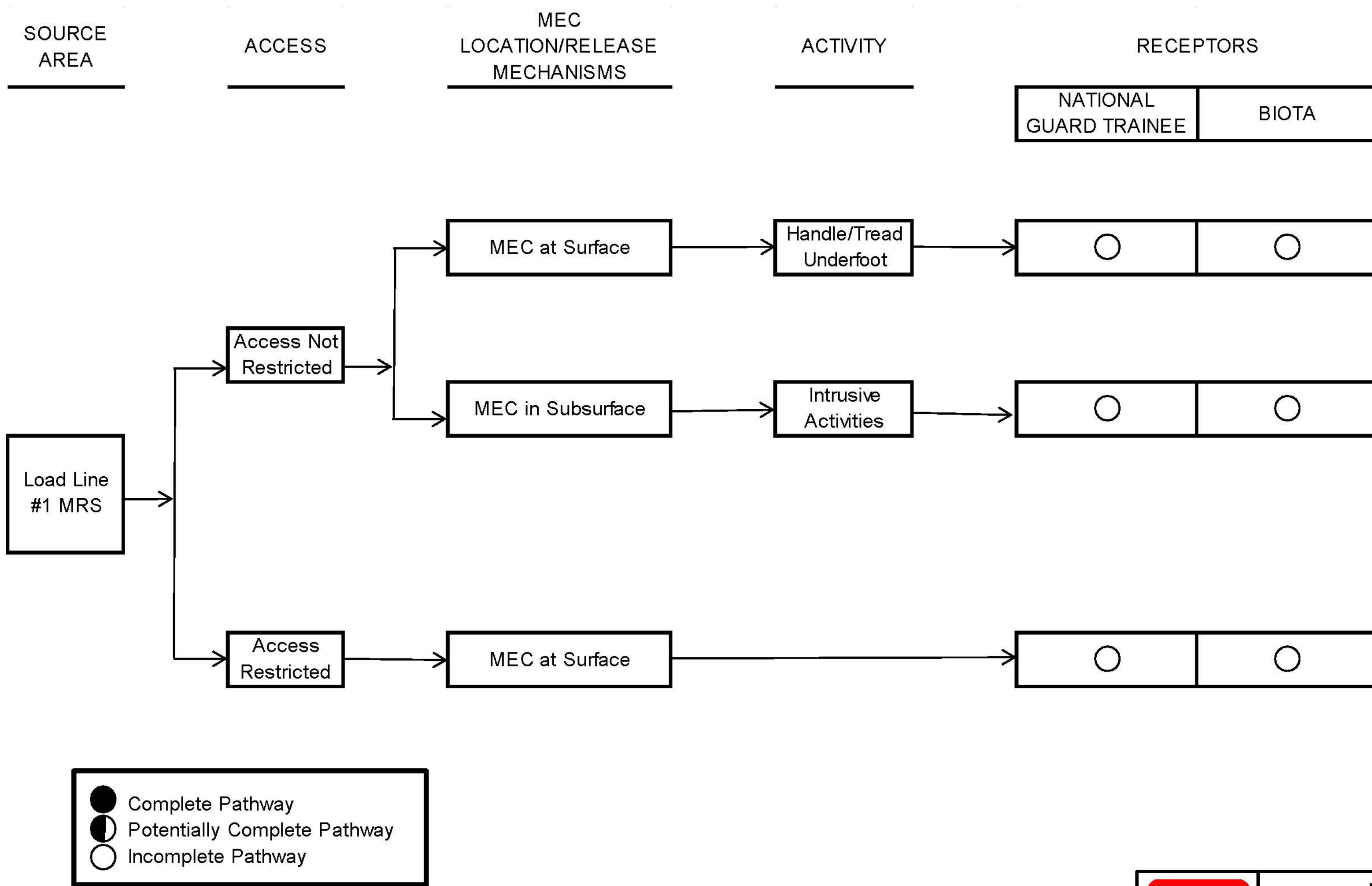
Since a MEC source was not found on the ground surface, a subsurface investigation was not warranted. Given the lack of a MEC source, the MEC exposure pathway for subsurface soil is considered incomplete for all receptors.

9.2 MC Exposure Analysis

A MC is defined as any material originating from MPPEH or munitions, or other military munitions including explosive and nonexplosive material, and emission degradation, or breakdown elements of such ordnance and munitions (10 USC 2710(e)(4)). The information collected during the RI was used to update the CSM for MC at the Load Line #1A MRS and identify all complete, potentially complete, or incomplete source-receptor interactions for the MRS for current and reasonably anticipated future land-use activities.

An MC source is an area where MC has entered (or may enter) the environment. MC contamination may result from a corrosion of munitions or from low-order detonation. Additionally, MC that is found at concentrations high enough to pose an explosive hazard is considered MEC. If MC was present at the MRS, it would mostly likely have resulted from the degradation of the propellants on the ground surface. No MEC source was identified at the MRS during the RI field activities that could have been a potential source of MC on the ground surface.

Sampling was performed at the Load Line #1A MRS to further characterize the nature and extent of contamination associated with previous activities at the MRS. The SRCs detected at the MRS consisted of lead and nitroguanidine in surface soil. Although a MEC source was not found, the identified SRCs may have resulted from degradation due to exposure to the elements for the propellants previously encountered at the MRS and were conservatively evaluated as such. None of the detected concentrations were determined to pose potential risks to human or ecological receptors at the MRS. The MC CSM has been updated to reflect a lack of source and incomplete pathways for the receptors in the terrestrial environment at the MRS. The revised MC exposure pathway analysis is presented in **Figure 9-2**.



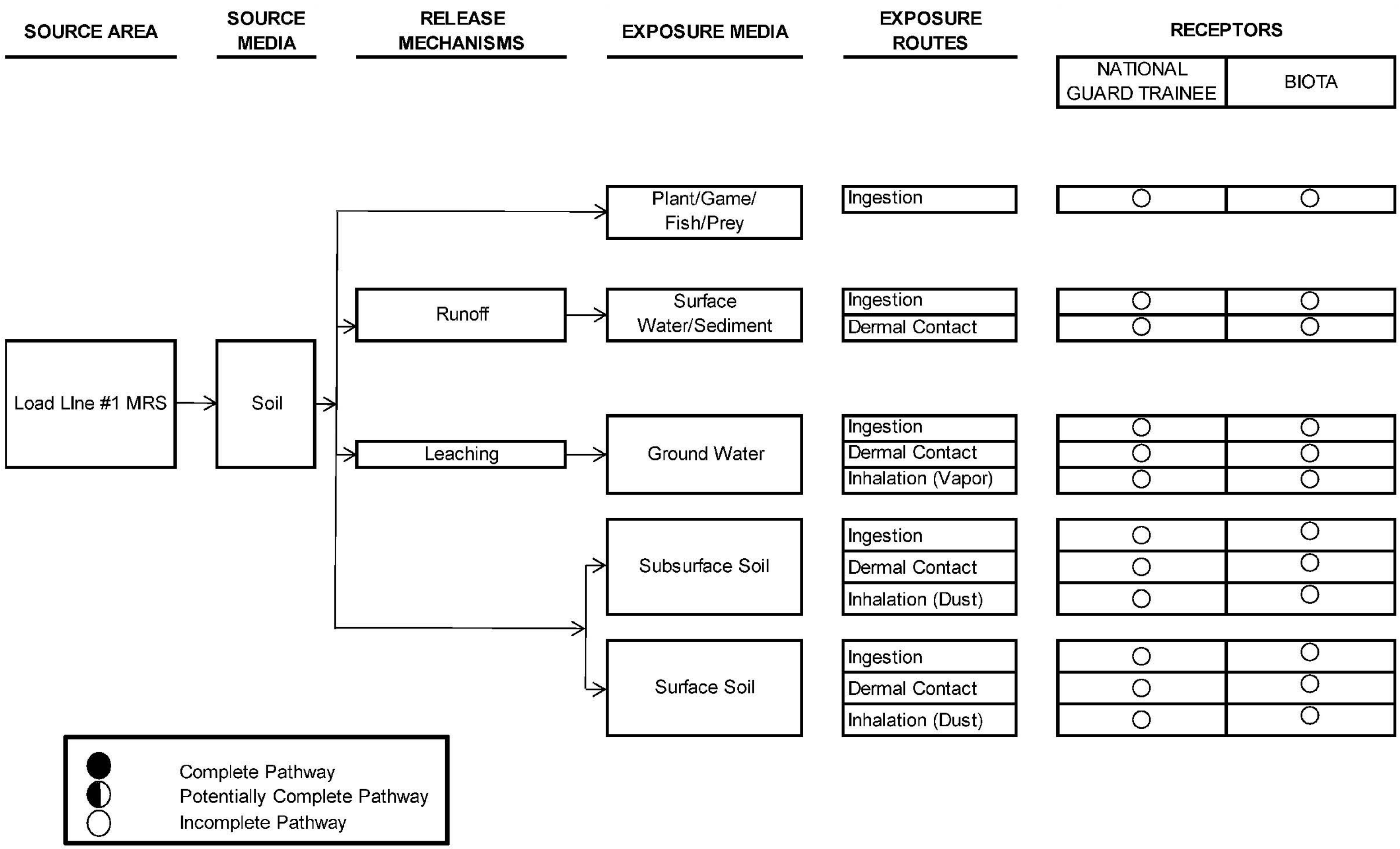
U.S. ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT

MILITARY MUNITIONS RESPONSE PROGRAM

LOAD LINE #1A MRS
FORMER RVAAP/CAMP RAVENNA
PORTAGE AND TRUMBULL COUNTIES, OHIO

CB&I Federal Services LLC
150 Royall Street
Canton, MA 02021

FIGURE 9-1 REVISED MEC CONCEPTUAL SITE MODEL



Receptor Exposure Scenarios		
Receptor	Surface Soil (ft bgs)	Subsurface Soil (ft bgs)
National Guard Trainee	0-4	4-7
Biota	0-1	> 1

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FIGURE 9-2 REVISED MC CONCEPTUAL SITE MODEL

9.3 Uncertainties

There are minimal levels of uncertainties associated with the MEC and MC results at the Load Line #1A MRS. The propellants of interest are not ferrous or detectable using a magnetometer; therefore, minimal uncertainty exists regarding whether propellants are present below ground surface. However, given the MRS history, the presence of MEC in the subsurface was not anticipated, as no burial activities were known to occur (e^2M, 2008). The nonintrusive instrument-assisted visual survey conducted during the RI field work did not find evidence of any surface propellants or other ferrous MEC/MD items, which satisfies the DQOs and reduces uncertainties associated with buried MEC at the MRS.

No MEC or MD was found during the RI field activities that would be considered a potential MC source. It is therefore uncertain whether the detected SRCs are actually associated with MEC previously identified directly on the ground surface at the MRS or are byproducts associated with the historical activities (munitions loading operations) conducted at this portion of the Load Line #1. Regardless of the uncertainty, evaluation of the detected SRCs indicates that the concentrations do not pose risks to likely receptors and there is no hazard associated with MC at the MRS.

9.4 Munitions Response Site Prioritization Protocol

The DoD proposed the MRSPP (32 CFR Part 179) to assign a relative potential risk priority to each defense MRS in the MMRP Inventory for response activities. These response activities are to be based on the overall conditions at each location and taking into consideration various factors related to explosive safety and environmental hazards (68 Federal Regulations 50900 [32 CFR 179.3]). The revised MRSPP document for the Load Line #1A MRS is being prepared separately from the RI and is included as **Appendix G** for reference only.

10.0 SUMMARY AND CONCLUSIONS

This section summarizes results of the RI field activities conducted at the Load Line #1A MRS. The purpose of the RI was to determine whether the Load Line #1A MRS warranted further response action pursuant to CERCLA and the NCP. More specifically, the RI was intended to determine the nature and extent of MEC and MC and subsequently determine the potential hazards and risks posed to likely human and ecological receptors by MEC and MC. Additional data are also presented in this RI Report to support the identification and evaluation of alternatives in a FS, if required. A summary of the RI results is presented in **Table 10-1**.

Table 10-1
Summary of Remedial Investigation Results

MRS Name	Proposed Investigation Area Size (Acres)	Actual Investigation Area Size (Acres)	MEC and/or MD Found?	MC Detected?	MC Risk Analysis
Load Line #1A	0.41	0.41	No	Yes	No Further Action

MC denotes munitions constituents.
MD denotes munitions debris.
MEC denotes munitions and explosives of concern.
MRS denotes Munitions Response Site.

10.1 Summary of Remedial Investigation Activities

The information from the Load Line #1A MRS relating to the potential presence of MEC and MC is compiled and evaluated in this RI Report. The sources of this information were information obtained during previous investigations, including the ASR (USACE, 2004), the HRR (e^2M, 2007), and the SI Report (e^2M, 2008).

The preliminary MEC and MC CSMs were developed during the SI phase of the CERCLA process and were used to identify the data needs and the DQOs as outlined in the Work Plan (Shaw, 2011). The data needs were determined at the planning stage and included characterization for MEC and/or MC associated with the former activities at the MRS. The DQOs were developed to ensure the reliability of field sampling, chemical analyses, and physical analyses; the collection of sufficient data; the acceptable quality of data generated for its intended use; and valid assumptions could be inferred from the data. The DQOs for the Load Line #1A MRS identified the following four decision rules that were implemented in evaluating the MRS:

- Perform a visual survey investigation to identify if MEC source (triple-base propellant) was present on the ground surface.
- Collect ISM samples at two sampling units over the entire MRS to evaluate for MC.
- Collect additional discrete samples (surface and subsurface) in areas with concentrated MEC/MD, if any are identified during the field work, in order to evaluate for MC.
- Process the information to evaluate whether there are unacceptable risks to human health and the environment associated with MEC and/or MC and make a determination if further investigation was required under the CERCLA process.

Separate full coverage instrument-assisted nonintrusive visual surveys were conducted in April and May 2011, respectively, to identify potential surface MEC and/or MD at the Load Line #1A MRS. No MEC or MD was found on the ground or shallow surface soils during either survey.

Environmental samples for MC were collected at the Load Line #1A MRS following completion of the visual surveys. Two ISM surface soil samples, each comprising one half of the MRS acreage (0.2 acres), were collected at depths between 0 and 0.5 feet. Together, the two ISM sampling units represent 100-percent coverage of the MRS that is the decision unit and is considered the EU area where human and ecological receptors potentially are exposed to the SRCs.

The DQOs stated that discrete samples (surface and subsurface soil) would be collected in areas with concentrated MEC or MD. Since no MEC or MD was identified at the Load Line #1A MRS during the RI field activities, additional sampling for MC was not performed.

10.2 Nature and Extent of SRCs

The SRCs for the Load Line #1A MRS were determined for the surface soil samples collected during the RI field activities through the facility data screening process as presented in the FWCUG Report (SAIC, 2010). Lead exceeded the facility BSV in both surface soil samples collected for the RI and was retained as an SRC. The only explosive detected in the RI surface soil samples was nitroguanidine and was retained as an SRC.

10.3 Fate and Transport

No MEC or MD was observed at the Load Line #1A MRS during the RI field activities. Since no MEC source is present at the Load Line #1A MRS, MEC fate and transport is not a concern. Although a MEC source was not found during the RI, the identified SRCs were conservatively evaluated as MC associated with triple-base propellant previously encountered at the MRS and fate and transport and potential transport mechanisms were evaluated.

The SRCs in the environmental media collected for the RI at the MRS were lead and nitroguanidine in surface soil (0 to 0.5 feet bgs). Based on current soil conditions at the facility, which consisted primarily of silty clay loam with low permeability and an MRS-specific pH of approximately 8.4, it is expected that lead would tend to bind to the soil and is considered relatively immobile. Therefore, any MC would be expected to be found in the top several inches where it was deposited and subsurface has mostly likely not been impacted. Nitroguanidine is considered mobile in soil; however, the impact to subsurface soils at the MRS has not been evaluated. The low permeability of the soil and the low concentrations detected suggest that significant sources of nitroguanidine were not deposited on or leached into the ground surface as a result of either dumping of triple-base propellants at the MRS or other activities (i.e., munitions loading operations) conducted at this portion of Load Line #1 when the facility was in operation.

10.4 MEC Hazard Assessment

The *Interim Munitions and Explosives of Concern (MEC HA) Methodology* (EPA, 2008) addresses human health and safety concerns associated with potential exposure to MEC at a MRS under a variety of site conditions, including various cleanup scenarios and land use assumptions. If an explosive hazard is identified for this RI, the MEC HA evaluation will include the information available for the MRS up to and including the RI field activities and provide a scoring summary for the current and future land use activities. If no explosive hazard is found at the MRS, then there is no need to calculate a MEC HA score since there are no human health safety concerns. No MEC or MD items were identified at the MRS during RI field activities, which indicates that no MEC source or explosive safety hazard is present at the MRS. Therefore, calculation of a MEC HA score was not warranted for the Load Line #1A MRS.

10.5 MC Risk Assessment Summary

Following the identification of the SRCs at the Load Line #1A MRS through the facility data screening process, the SRCs (lead and nitroguanidine) were then carried through the HHRA and ERA processes to evaluate for potential receptors. The risk assessments resulted in the following conclusions.

10.5.1 Human Health Risk Assessment

A HHRA was conducted for surface soil samples collected at the Load Line #1A MRS to determine if the identified SRCs were COPCs and/or COCs that may pose a risk to current or future human receptors. The future land use for the Load Line #1A MRS is military training, and the Representative Receptor is the National Guard Trainee. The Representative Receptor for military training, in conjunction with the evaluation of the Resident Receptor (Adult and Child) for Unrestricted Land Use, was the basis for identifying COCs in the RI. Evaluation for Unrestricted (Residential) Land Use is performed to assess baseline conditions and the no action alternative under CERCLA, and as outlined in the HHRAM (USACE, 2005).

The two SRCs that consisted of lead or nitroguanidine were not identified as COPCs in the first screening step. Therefore, these SRCs were not further evaluated as COCs and are not likely to pose risks to human receptors. Since no COCs were identified for the Resident Receptor (Adult and Child), Unrestricted Land Use was achieved for MC.

10.5.2 Ecological Risk Assessment

Both of the SRCs, lead and nitroguanidine, were identified as COPECs in the soil samples collected at 0 to 0.5 feet for the RI at the Load Line #1A MRS. COPECs are determined in the ERA and may differ from COPCs. Given the conservativeness of the ERA and the low overall concentrations detected, the potential that exposure to the COPECs identified to adversely impact populations of ecological receptors at the Load Line #1A MRS is considered to be very low and not pose a concern to ecological receptors. Therefore, no further investigation or action is considered necessary at the Load Line #1A MRS for ecological purposes.

10.6 Conceptual Site Model

The information collected during the RI field activities was used to update the MEC and MC CSMs for the Load Line #1A MRS as presented in the SI Report (e^2M, 2008). The purpose of the CSMs is to identify all complete, potentially complete, or incomplete source-receptor interactions for future land use activities at the MRS. An exposure pathway is the course a MEC item or MC takes from a source to a receptor. Each pathway includes a source, activity, access, and receptor.

Taking into consideration the historical activities that occurred at the MRS, it is expected that triple-base propellants that may be present at the MRS would be found primarily on the ground surface. Two nonintrusive visual surveys were performed over 100 percent of the Load Line #1A MRS during the RI field activities. No MEC or MD items were observed on the ground surface of the MRS during the visual survey; therefore, the MEC exposure pathway for surface soil is considered incomplete for all receptors.

Since a MEC source was not found on the ground surface, a subsurface investigation was not warranted. Given the lack of a MEC source, the MEC exposure pathway for subsurface soil is considered incomplete for all receptors.

Sampling was performed at the Load Line #1A MRS to further characterize the nature and extent of contamination associated with previous activities at the MRS. The SRCs detected at the MRS consisted of the lead and nitroguanidine in surface soil. Although a MEC source was not found, the identified SRCs may have resulted from degradation due to exposure to the elements of the propellants previously encountered at the MRS. None of the SRC concentrations were determined to pose a hazard to human health or the environment. The MC CSM has been updated to reflect a lack of source and incomplete pathways for all the receptors at the MRS.

10.7 Uncertainties

There are minimal levels of uncertainties associated with the MEC and MC results at the Load Line #1A MRS. The propellants of interest are not ferrous or detectable using a magnetometer; therefore, minimal uncertainty exists regarding whether propellants are present below the ground surface. However, given the MRS history, the presence of MEC in the subsurface was not anticipated, as no burial activities were known to occur (e^2M, 2008). The nonintrusive instrument-assisted visual survey conducted during the RI field work did not find evidence of any surface propellants or other ferrous MEC/MD items, which satisfies the DQOs and reduces uncertainties associated with buried MEC at the MRS.

No MEC or MD was found during the RI field activities that would be considered a potential MC source. It is therefore uncertain whether the detected SRCs are actually associated with MEC previously identified directly on the ground surface at the MRS or are byproducts associated with the historical activities (munitions loading operations) conducted at this portion of the Load Line #1. Regardless of the uncertainty, evaluation of the detected SRCs indicates that the concentrations do not pose risks to likely receptors and there is no hazard associated with MC at the MRS.

10.8 Conclusions and Recommendations

The RI was prepared in accordance with the project DQOs and included evaluations for explosives hazards and potential sources of MC that may pose threats to likely receptors. The following statements can be made for the Load Line #1A MRS based on the results of the RI field activities:

- Instrument-assisted nonintrusive visual survey coverage was performed over the entire Load Line #1A MRS during the RI and no subsurface anomalies were detected.
- No physical evidence of MEC or MD was found on the ground surface during the RI and no explosive hazard is anticipated to be present at the MRS.

- Although no MEC source was found during the RI, ISM surface soil samples were analyzed for MC and represent 100-percent coverage of the MRS.
- Detected concentrations of SRCs in surface soil (0 to 0.5 feet) do not pose potential risks to human or ecological receptors; therefore, no further action is required for MC at this MRS.

Based on these conclusions, it is determined that the Load Line #1A MRS has been adequately characterized and that the DQOs presented in the Work Plan (Shaw, 2011) have been satisfied. Therefore, No Further Action is recommended for the Load Line #1A MRS under the MMRP, and the next course of action will be to proceed to a No Further Action Proposed Plan. Since the RI was initiated before the finalization of the U.S. Army's *Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the Ravenna Army Ammunition Plant Installation Restoration Program* (Army National Guard, 2014), the Commercial Industrial Land Use using the Industrial Receptor was not included. However, since the Unrestricted (Residential) Land Use was identified and the recommendation for the MRS is a No Further Action, an evaluation of the Commercial Industrial Land Use would not be needed according to the technical memorandum.

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Appendix A
Field Documentation

Appendix B
Data Validation Report

Appendix C
Summary of Laboratory Analytical Results

Note: Laboratory data packages prepared by CT Laboratories are submitted on a separate compact disc.

Appendix D
Investigation-Derived Waste Management

Appendix E
Photograph Documentation Log

Appendix F
Ecological Risk Assessment Tables

Appendix G
Munitions Response Site Prioritization Protocol Data Tables

Appendix H
Ohio EPA Correspondence

Appendix I
Responses to Ohio EPA Comments

Appendix J
Ohio EPA Approval Letter

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