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14. ABSTRACT

This Remedial Investigation (RI) Report presents the findings and conclusions of the RI field activities conducted at the RVAAP-063-R-01 Group 8 Munitions Response Site (MRS) between October 2011 and February 2012 at the Ravenna Army Ammunition Plant. The purpose of this RI Report is to determine whether the Group 8 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 Control Plan. More specifically, this RI Report 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 ecological receptors by MEC and MC. This RI Report also presents additional data to assist in determining which remediation alternatives, if any, are appropriate. This RI report was prepared in accordance with the Army's Final Munitions Response RI/FS guidance dated November 2009.

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Shaw Environmental & Infrastructure Inc., a CB&I company, has completed the *Draft Remedial Investigation Report for RVAAP-063-R-01 Group 8 MRS* at the Ravenna Army Ammunition Plant, 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 Corps policy.

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Draft Remedial Investigation Report for
RVAAP-063-R-01 Group 8 MRS
Version 1.0

Ravenna Army Ammunition Plant
Ravenna, Ohio

Contract No. W912DR-09-D-0005
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Prepared for:

US Army Corps of Engineers®

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ARNG—Army National Guard
BRAC—Base Realignment and Closure
OHARNG—Ohio Army National Guard
Ohio EPA – Ohio Environmental Protection Agency
RVAAP—Ravenna Army Ammunition Plant
USACE—U.S. Army Corps of Engineers
Shaw—Shaw Environmental & Infrastructure, Inc.

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Acronyms and Abbreviations

°F	degrees Fahrenheit
°C	degrees Celsius
ADD	average daily dose
AEDB-R	Army Environmental Data Base Restoration
AGP	above ground plant tissue concentration
AMEC	AMEC Earth and Environmental, Inc.
amsl	above mean sea level
AOC	area of concern
ARAR	applicable or relevant and appropriate requirement
ARNG	Army National Guard
ASR	Final Archives Search Report
ASTM	American Society of Testing and Materials
atm-m^3/mole	atmospheric cubic meters per mole
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	area use factor
BAF	bioaccumulation factor
BCF	bioconcentration factor
BERA	baseline ecological risk assessment
bgs	below ground surface
BRAC	Base Realignment and Closure
BSV	background screening value
CAS	Chemical Abstracts Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	chemical of concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CRJMTC	Camp Ravenna Joint Military Training Center
CSM	conceptual site model
CT Laboratories	CT Laboratories, Inc.
DERP	Defense Environmental Restoration Program
DGM	digital geophysical mapping
DID	Data Item Description
DMM	discarded military munitions
DoD	U.S. Department of Defense
DQO	data quality objectives
e^{2}M	engineering-environmental Management, Inc.
ELAP	Environmental Laboratory Accreditation Program
EM	Engineer Manual
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EQM	Environmental Quality Management, Inc.
ERA	ecological risk assessment

Acronyms and Abbreviations (continued)

ESA	Endangered Species Act
ESQD	explosive safety-quantity distance
ESV	ecological screening value
EU	exposure unit
EW	earthworm tissue concentration
F&T	fate and transport
FS	Feasibility Study
FWCUG	facility-wide cleanup goal
FWSAP	Facility-Wide Sampling and Analysis Plan for Environmental Investigations at the RVAAP
ha	hectare
HE	high explosive
HEAT	high explosive anti-tank
Hg	mercury
HHRA	human health risk assessment
HHRAM	Facility-Wide Human Health Risk Assessment Manual
HI	hazard index
HQ	hazard quotient
HRR	Final Historical Records Review
HSDB	Hazardous Substances Data Bank
IAEA	International Atomic Energy Agency
ID	identification
IDW	investigation-derived waste
INRMP	Integrated Natural Resources Management Plan
IRP	Installation Restoration Program
ISM	incremental sampling methodology
IVS	instrument verification strip
kg	kilogram
K_{oc}	organic carbon/water partition coefficient
K_{ow}	octanol/water partition coefficient
L	liter
lbs	pounds
LCS	laboratory control sample
LOAEL	lowest observed adverse effect level
LOD	limit of detection
M	mammal tissue concentration
MB	method blank
MC	munitions constituents
MD	munitions debris
MDC	maximum detection concentration
MDL	method detection limit
MEC HA	Munitions and Explosives of Concern Hazard Assessment

Acronyms and Abbreviations (continued)

MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
mg/kg/d	milligrams per kilogram per day
MKM	MKM Engineers, Inc.
mm	millimeter(s)
MMRP	Military Munitions Response Program
MPPEH	material potentially presenting an explosive hazard
MRS	munitions response site
MRSPP	Munitions Response Site Prioritization Protocol
MS/MSD	matrix spike/matrix spike duplicate
mV	millivolt
N&E	nature and extent
NA	not applicable/available
NCBI	National Center for Biotechnology Information
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NGT	National Guard Trainee
nm	nanometer
NOAEL	no observed adverse effect level
OB	open burn
OD	open detonation
ODNR	Ohio Department of Natural Resources
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
PAH	polycyclic aromatic hydrocarbon
Pb	lead
PBA	Performance-Based Acquisition
PBT	persistent, bioaccumulative, and toxic
PCB	polychlorinated biphenyl
PRG	Preliminary Remediation Goal
QA	quality assurance
QC	quality control
QSM	Quality Systems Manual
R	risk evaluation
redox	oxidation/reduction
RFA	Residential Farmer Adult
RFC	Residential Farmer Child
RI	remedial investigation
RME	reasonable maximum exposure
RPD	relative percent difference
RSL	Regional Screening Level
RTS	robotic total station
RVAAP	Ravenna Army Ammunition Plant

Acronyms and Abbreviations (continued)

SAIC	Science Applications International Corporation
SDG	sample delivery group
Shaw	Shaw Environmental and Infrastructure, Inc.
SI	site inspection
SLERA	screening level ecological risk assessment
SMDP	scientific management decision point
SOP	standard operating procedure
SRC	site-related chemical
SSL	soil screening level
SVOC	semivolatile organic carbon
TBC	to be considered
TDS	total dissolved solid
TEC	threshold effect concentration
TNT	2,4,6-trinitrotolune
TOC	total organic carbon
TRV	toxicity reference value
U.S.	United States
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers
USC	United States Code
UV	ultraviolet
UXO	unexploded ordnance
UXOQCS	UXO Quality Control Specialist
VQ	validation qualifier

EXECUTIVE SUMMARY

This Remedial Investigation (RI) Report documents the findings and conclusions of the RI field activities for the Group 8 (RVAAP-063-R-01) Munitions Response Site (MRS) located at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio. This RI Report is being prepared by Shaw Environmental & Infrastructure, Inc. (Shaw), a CB&I company, under Delivery Order 0002 for Military Munitions Response Program (MMRP) environmental services at the RVAAP 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 Army Corps of Engineers, Baltimore District (USACE) on May 27, 2009.

The purpose of this RI Report is to determine whether the Group 8 MRS warrants further response action pursuant to the *Comprehensive Environmental Responsibility, Compensation, and Liability Act of 1980* (CERCLA) and the *National Oil and Hazardous Substances Pollution Contingency Plan.* More specifically, this RI Report is intended to determine the nature and extent of munitions and explosives of concern (MEC) and munitions constituents (MC), and to 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, if required.

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 Archives Search Report* (USACE, 2004), the *Final MMRP Historical Records Review* (engineering-environmental Management, Inc. [e^2M], 2007), and the *Final Site Inspection Report* (e^2M, 2008), herein referred to as the SI Report.

The Group 8 MRS is a 2.65-acre MRS located between Buildings 846 and 849, which was used for an undetermined amount of time to burn construction debris and rubbish. Although it has not been documented, previous discoveries of MEC and munitions debris (MD) indicate that the area may have also received various munitions items, including M397 series 40 millimeter (mm) high explosive (HE) grenades, M49 series 60 mm mortars, M72 series 75 mm projectiles, M557 series fuzes, 175 mm projectiles, HE anti-tank warheads, and assorted fuzes, which may have been burned at the MRS. The area was used by the Ohio Army National Guard (OHARNG) as a vehicle staging area until it was designated as a MRS. The OHARNG still utilizes the road network within the MRS to access adjacent buildings. The MRS is currently vacant, grassy land with no improvements.

In 1996, one antipersonnel fragmentation bomb with HE and a demilitarized (i.e., cut in half) 175 mm projectile were both found on the ground surface within the Group 8 MRS boundary. The antipersonnel fragmentation bomb was removed from the MRS and detonated at Open Demolition Area #2. The demilitarized 175 mm projectile was removed and taken to Building 1501 (e^2M, 2007).

Material potentially presenting an explosive hazard was encountered during the 2007 site inspection (SI) and consisted of two unidentifiable T-bar fuzes. A large amount of MD was recovered at the MRS during the SI field activities as well.

Sampling for MC was conducted at the MRS during the SI field activities and included the collection of five incremental sampling methodology (ISM) surface soil samples. Various metals consisting of antimony, arsenic, aluminum, cadmium, copper, iron, lead, manganese, and thallium were detected at concentrations that exceeded the screening criteria (e^2M, 2008).

Current activities at the Group 8 MRS include security patrols, maintenance activities, and access to the road network to access adjacent buildings. Human receptors associated with the current land uses at the MRS include facility personnel and contractors.

The OHARNG projected future land use for the Group 8 MRS is military training. The most representative receptor for the future land use is the National Guard Trainee (USACE, 2005).

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 data quality objectives (DQOs) as outlined in the *Final Work Plan Addendum for MMRP Remedial Investigation Environmental Services* (Shaw, 2011). The data needs and DQOs were determined at the planning stage and included characterization of MEC and MC associated with 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 Group 8 MRS identified the following decision rules that were implemented in evaluating the MRS:

- Perform a geophysical investigation to identify if buried MEC or MD is present.
- Perform an intrusive investigation of anomalies identified during the geophysical investigation to evaluate if MEC/MD is present.

- Collect incremental and/or discrete soil samples (surface and subsurface) in areas with concentrated MEC/MD, if any.
- 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 is required under the CERCLA process.

Between October 31, 2011, and November 14, 2011, a full-coverage digital geophysical mapping (DGM) investigation was performed to identify potential subsurface areas of MEC and/or MD at the Group 8 MRS. The DGM data were collected in all accessible areas within the MRS and the spatial coverage was 2.563 acres or nearly 97 percent of the 2.65-acre MRS. No MEC or MD was identified on the ground surface during the DGM survey.

Evaluation of the data collected during the DGM survey identified 2,690 anomalies which had signal strength greater than or equal to 8 millivolts (Channel 2) for an average anomaly density of 1,015 anomalies per acre. Three areas were considered to have localized high anomaly densities, which accounted for 1,049 of the 2,690 anomalies. The majority of the high density areas were located south of the gravel roadways. Outside of these high density areas, the remaining 1,641 anomalies were identified as individual target locations for potential investigations. In general, the geophysical data indicate that the anomaly density at the MRS is high and dispersed throughout the MRS with defined localized areas of higher density than found throughout the other areas at the MRS.

Following the completion of the DGM survey in November 2011, an intrusive investigation was conducted for the locations identified as potentially containing subsurface MEC and/or MD based on an analysis of the DGM survey data. A total of 264 of the 1,641 single point anomalies (16 percent) and 14 trenches within the three areas of high anomaly density were successfully investigated. The intrusive investigation activities were conducted at increments of 12 inches from 1 inch to 4 feet in depth, which allowed the Unexploded Ordnance Team to visually inspect the soil with a Schonstedt magnetometer as it was removed. No MEC was identified during the intrusive investigation activities; however, 359 individual MD items that weighted approximately 1,418 pounds were recovered.

The determination as to whether MC characterization was required at the MRS was made based on historical evidence and the results of the MEC investigation. In accordance with the Work Plan Addendum (Shaw, 2011), four ISM surface soil samples were collected from sampling units of the same size for the entire MRS at depths between 0 and 0.5 feet below ground surface (bgs). Additional samples were proposed in areas with concentrated MEC/MD and three additional ISM soil samples were collected from the bottom of the trenches at depths of 4 to 4.5 feet bgs where concentrated buried MD was encountered during the intrusive investigation activities. The trench samples were evaluated/considered as subsurface samples in the human health and ecological risk assessments.

ES.3 MEC Hazard Assessment

The MEC Hazard Assessment (HA) evaluation in this RI Report is inclusive of the information available for the MRS up to and including the RI field activities and provides a scoring summary for the current and future land use activities, assuming no response actions. A MEC HA is performed for an MRS when an explosive safety hazard is identified. In the case for the Group 8 MRS, MEC items were reportedly found on the ground surface at the MRS by OHARNG personnel in the past and during the 2007 SI field activities; however, only MD items were found during complete coverage of the MRS during the RI field activities. Taking into consideration the amount of buried MD that was removed during the RI field work (1,418 pounds), the various types of MD found, the distribution and depth at which the MD was found, the relatively minimal size of the MRS at 2.65 acres, and that MEC items were found at the MRS prior to the RI field activities; it was determined that a potential explosive safety hazard may be present at the Group 8 MRS and calculation of a MEC HA score was warranted.

The MEC HA score for current conditions at the Group 8 MRS was calculated to be 705, which equates to a Hazard Level of 3 (moderate potential explosive hazard condition). The future land use at the MRS will be military training with the potential for intrusive activities, and resulted in a MEC HA score of 805. This equates to a Hazard Level of 2 (high potential explosive hazard condition). The increase in the hazard level score is solely the result of an increase in receptor hours for the future land use.

ES.4 MC Risk Assessment Summary

Site-related chemicals (SRCs) for the Group 8 MRS were determined for the surface and subsurface soil collected during the RI field activities through the RVAAP data screening process as presented in the *Final Facility-Wide Human Health Cleanup Goals for the RVAAP* (Science Applications International Corporation [SAIC], 2010). The detected chemicals retained as SRCs were as follows:

- Surface Soil (0 to 0.5 feet bgs):
  - *Explosives and Propellants*: nitroguanidine and 2,4,6-trintrotoluene
  - *Metals:* antimony, barium, cadmium, chromium, copper, iron, lead, mercury, strontium, and zinc
  - *Semivolatile Organic Compounds:* 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene,

benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, carbazole, chrysene, dibenzo(a,h)anthracene, dibenzofuran, di-n-butyl phthalate, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene

  - *Polychlorinated Biphenyls:* Aroclor-1254 and Aroclor-1260

- Subsurface Soil (4 to 4.5 feet bgs):
  - *Metals:* antimony, cadmium, copper, iron, lead, mercury, strontium, and zinc
  - *Semivolatile Organic Compounds:* 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, dibenzofuran, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene
  - *Polychlorinated Biphenyls:* Aroclor-1254 and Aroclor-1260

No explosives or propellants were detected in subsurface soils. 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.

Protection of Human Health

A human health risk assessment (HHRA) was conducted for the surface and subsurface soil samples 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 OHARNG future land use at the MRS is military training. Evaluation of the future land use, in conjunction with the evaluation of agricultural-residential land uses and associated receptors, form the basis for identifying COPCs and COCs in the RI. Residential Land Use, specifically the Residential Farmer (Adult and Child) scenario, is included to evaluate COCs for unrestricted land use at the MRS as required by the CERCLA process.

The RVAAP has defined exposure depth scenarios for the identified receptors. Surface soil for the residential land use receptors is defined as 0 to 1 foot bgs and surface soil for the military training land use receptors is defined as 0 to 4 feet bgs (i.e., deep surface soil). Subsurface soil for the residential land use receptors is defined as 1 to 13 feet bgs and 4 to 7 feet bgs for the military training land use receptors (SAIC, 2010). 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 Installation Response Program. 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 ISM surface soil and bottom of trench samples collected during the RI field activities at the Group 8 MRS were all collected at 0- to 0.5-foot (6-inch) increments since this is the maximum depth that contamination from the presumed burning activities at the MRS or directly beneath MEC or MD on the ground surface or buried in trenches would be expected to vertically migrate in the soil column. This sampling methodology is consistent with the *MMRP Munitions Response Remedial Investigation/Feasibility Study Guidance* (Army, 2009). Therefore, for the RI, surface and deep surface soil for the residential land use and military training land use receptors, respectively, is evaluated as 0 to 0.5 feet bgs, the depth at which the ISM surface soil samples were collected. The subsurface soils for the residential and military training land use receptors are evaluated at 4 to 4.5 feet bgs, the depths at which the ISM soil samples were collected at the trench locations.

Nine COCs that included cadmium, iron, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, Aroclor-1254, and Aroclor-1260, were identified in surface soils for the Residential Farmer (Adult and Child). Cadmium and lead were identified as two COCs in surface soil for the National Guard Trainee. Only iron was identified as a COC in subsurface soil for the residential land use receptors. No COCs were identified for the National Guard Trainee in subsurface soils.

Based on the results of the HHRA, it can be concluded that COCs pose a hazard to both the unrestricted land use and likely military training future land use receptors in surface soil. Weight of evidence suggests that the iron concentrations in subsurface soil are unlikely to pose a hazard to human receptors.

Protection of Ecological Receptors

Ten chemicals of potential ecological concern (COPECs) in the surface soil were recommended to be evaluated under the Level III Baseline evaluation following the Level II Screening. COPECs are determined in the ecological risk assessment and may differ from COPCs. The COPECs identified included antimony, cadmium, copper, lead, mercury, zinc, bis(2-ethylhexly)phthalate, di-n-butyl phthalate, Aroclor-1254, and Aroclor-1260.

Multiple COPECs were identified for the MRS that resulted in elevated hazard quotients in many of the ISM sampling units. These COPECs represent a potential for localized impacts to soil invertebrates and small range receptors (particularly the short-tailed shrew and American robin) at the Group 8 MRS. Based on the small size of the MRS (less than 3 acres), the conservative nature of the Level III Baseline, and the low habitat quality of the

MRS, the potential for adverse effects to populations of ecological receptors is most likely overestimated; however, the potential risks posed to the ecological receptors at the MRS are not discounted in this RI Report and are considered to be representative of the site conditions.

ES.5 Conceptual Site Model

The information collected during the RI field activities was used to update the CSM for MEC and MC for the Group 8 MRS as presented in the SI Report (e^2M, 2008). The purpose of the CSM is to identify all complete, potentially complete, or incomplete source-receptor interactions for reasonably anticipated 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.

Complete DGM coverage of accessible land-based areas was conducted at the MRS during the RI and a statistical approach was taken for the selection of anomalies for intrusive investigation. No MEC was identified at the MRS during the RI intrusive investigation activities; however, numerous MD items of various types were encountered at depths ranging from 1 inch to 4 feet bgs. A MEC explosive hazard was not identified at the MRS during the RI, and statistical analysis of the intrusive investigation results indicates that no MEC is present at the remaining 1,377 individual anomaly locations that were not investigated at a 99 percent confidence level. Therefore, the amount of MD encountered (359 items), the distribution of the MD items throughout the MRS, and the previously documented MEC items at the MRS are taken into consideration. Based on this consideration, a MEC explosive hazard may remain at the MRS and potentially complete pathways are identified for all receptors accessing surface or subsurface soils.

Sampling for MC was performed at the Group 8 MRS based on historical evidence and the results of the RI intrusive investigation. Although no MEC was found during the RI, various MD items were encountered and detected SRCs were evaluated as MC. The SRCs were carried through the risk assessment process to determine if they were COCs or COPECs that may pose risks to future human and ecological receptors, respectively.

The National Guard Trainee is considered as the most sensitive of the identified current and future human land use receptors that have the potential to be exposed to COCs at the Group 8 MRS. The COCs in surface soil (0 to 0.5 feet bgs) were considered to pose a risk to the National Guard Trainee, but the COCs identified for the National Guard Trainee in subsurface soil (4 to 4.5 feet bgs) were not considered to be present at concentrations great enough to pose a risk. Therefore, the MC CSM for the National Guard Trainee has been updated to reflect a complete pathway for surface soil and incomplete pathway for subsurface soil.

Sufficient time has elapsed for COCs and COPECs in the surface soil to have migrated to potential exposure media including surface water and sediment, resulting in possible exposure of plants, fish, and animals that come into contact with these media. With the exception of a small drainage ditch along the south side of the MRS, there are no significant surface water features where COCs or COPECs in surface soil may have migrated. Therefore, the MC exposure pathways for all receptors at the MRS to the aquatic environments, including surface water and sediment, and the plant/game/fish/prey exposure media are considered incomplete.

The major exposure routes for chemical toxicity from surface soil to the environmental receptors include ingestion (for terrestrial invertebrates, voles, shrews, robins, foxes, and hawks) and direct contact (for terrestrial plants and invertebrates). The ingestion exposure routes for voles, shrews, robins, foxes, owls, and hawks include soil, as well as plant and/or animal food (i.e., food chain) that was exposed to the surface soil. Minor exposure routes for surface soil include direct contact and inhalation of fugitive dust. Various COPECs in surface soil were determined to present potential threats to likely ecological receptors; therefore, the MC exposure pathways for ecological receptors in surface soil are considered complete.

Groundwater beneath the RVAAP is evaluated on a facility-wide basis and MRS-specific sampling is not intended for an MRS being investigated under the MMRP unless there is a likely impact from a MEC source. The soil conditions at the MRS are considered low to moderately permeable, the detected concentrations of explosives are low, and the detected metals, SVOCs, and PCBs are expected to remain in the top several inches of soil on the ground surface or in subsurface soils beneath concentrated areas of buried MD where they were deposited; therefore, groundwater conditions have most likely not been impacted. No groundwater samples were collected at the Group 8 MRS during the RI field work and the groundwater exposure pathway is considered incomplete for all receptors.

ES.6 Conclusions

The following conclusions can be made for the Group 8 MRS based on the results of the RI field activities:

- Complete DGM coverage was performed at the MRS for the RI and nearly 97 percent coverage of the 2.65-acre MRS was achieved.
- Subsurface MD was encountered at various locations throughout the MRS at depths ranging between 1 inch and 4 feet bgs.
- No MEC was encountered during the RI field activities; however, the MEC items identified at the MRS prior to the RI and the amount, types, distribution, and

depth of MD encountered during the intrusive investigations are taken into consideration, and an explosive hazard may be present at the MRS.

- The HHRA indicates that detected COCs in surface soil present risks to the unrestricted and likely military training future land use receptors.
- The ERA indicates that detected COPECs in surface soil have the potential for localized impacts to soil invertebrates and small range receptors.

Based on these conclusions, it is determined that the Group 8 MRS has been adequately characterized and the DQOs presented in the Work Plan Addendum (Shaw, 2011) have been satisfied. The Army National Guard's next course of action for the Group 8 MRS will be to conduct a Feasibility Study.

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1.0 INTRODUCTION

This Remedial Investigation (RI) Report documents the finding and conclusions of the RI field activities for the Group 8 (RVAAP-063-R-01) Munitions Response Site (MRS) located at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio. This RI Report is being prepared by Shaw Environmental & Infrastructure, Inc. (Shaw), a CB&I company, under Delivery Order 0002 for Military Munitions Response Program (MMRP) environmental services at the RVAAP under the Multiple Award Military Munitions Services Performance-Based Acquisition (PBA) Contract No. W912DR-09-D-0005. The Delivery Order was issued by the United States (U.S.) Army Corps of Engineers, Baltimore District (USACE) on May 27, 2009.

This RI Report presents the results of the RI field activities that were conducted at the Group 8 MRS between November 2011 and February 2012. This report was developed in accordance with the *Final Work Plan Addendum for Military Response Program Remedial Investigation Environmental Services Version 1.0* (Shaw, 2011) at the RVAAP, hereafter referred to as the "Work Plan Addendum," and the *MMRP Munitions Response Remedial Investigation/Feasibility Study Guidance* (Army, 2009).

1.1 Purpose

Environmental cleanup decision making under the MMRP follows the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) 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 likely human and environmental receptors 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 this RI Report is to determine whether the Group 8 MRS warrants further response action pursuant to CERCLA and the NCP. More specifically, this RI Report is 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 environmental receptors by MEC and MC. This RI Report also presents additional data to support the identification and evaluation of alternatives in the FS, if required.

1.2 Problem Identification

The Group 8 MRS is approximately 2.65 acres and is located between Buildings 846 and 849, southeast of Load Line #12 and just north of the facility's southern boundary. This area is disturbed land that has been used for vehicle staging and historically was used for the open burning (OB) of construction debris and rubbish in the past.

MEC consisting of an antipersonnel fragmentation bomb with high explosive (HE) has been found at the MRS in addition to munitions debris (MD) consisting of a demilitarized 175-millimeter (mm) projectile (engineering-environmental Management, Inc. [e^2M, 2008]). Material potentially presenting an explosive hazard (MPPEH) was encountered during the 2007 site inspection (SI) and consisted of two unidentifiable T-bar fuzes. A large amount of MD was recovered at the MRS during the SI field activities as well.

Sampling for MC was conducted at the MRS during the SI field activities and included the collection of five incremental sampling methodology (ISM) surface soil samples. Various metals consisting of antimony, arsenic, aluminum, cadmium, copper, iron, lead, manganese and thallium were detected at concentrations that exceeded the screening criteria (e^2M, 2008).

Based on the results of the SI field activities, the *Final Site Inspection Report,* hereafter referred to as the SI Report, recommended further characterization of MEC and MC at the MRS (e^2M, 2008).

1.3 Physical Setting

This section presents the physical characteristics of the RVAAP, the Group 8 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 RVAAP were compiled from information originally presented in the SI Report (e^2M, 2008) that included the Group 8 MRS and the *Integrated Natural Resources Management Plan* (AMEC Earth and Environmental, Inc. [AMEC], 2008), hereafter referenced as the INRMP, which was prepared for the Ohio Army National Guard (OHARNG).

1.3.1 Location

The RVAAP (Federal Facility Identification number OH213820736), which is located in northeastern Ohio within Portage and Trumbull counties, is approximately 3 miles east-northeast of the city of Ravenna. The RVAAP is approximately 11 miles long and 3.5 miles wide. The RVAAP 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 RVAAP is surrounded by the communities of Windham, Garrettsville, Newton Falls, Charlestown, and Wayland (**Figure 1-1**).

Administrative control of 20,423 acres of the 21,683-acre RVAAP have been transferred to the Army National Guard (ARNG) Directorate and subsequently licensed to the OHARNG for use as the Camp Ravenna Joint Military Training Center (CRJMTC). The remaining 1,260 acres of RVAAP consist of several distinct parcels scattered throughout the confines of Camp Ravenna. These 1,260 acres are being managed by the Base Realignment and Closure Division (e^2M, 2008).

The Group 8 MRS is an approximately 2.65-acre parcel located at the south portion of the RVAAP within Portage County (**Figure 1-2**). The MRS is currently under the administrative control of the ARNG. **Table 1-1** summarizes the administrative descriptions for the Group 8 MRS. The table includes the RVAAP Army Environmental Database-Restoration (AEDB-R) numerical designation for the MRS, the current MRS acreage, and the agency responsible for management activities for the MRS.

Table 1-1
MRS Management Responsibilities at RVAAP

MRS Name	AEDB-R MRS Number	MRS Area (Acres)	MRS Management Responsibility
Group 8	RVAAP-063-R-01	2.65	ARNG

AEDB-R denotes Army Environmental Database-Restoration.
ARNG denotes Army National Guard.
MRS denotes munitions response site.
RVAAP denotes Ravenna Army Ammunition Plant.

1.3.2 Current and Projected Land Use

This section presents the current and future land use for the Group 8 MRS. The future land use description for the MRS is based on information provided in the *RVAAP Facility-Wide Human Health Risk Assessment Manual* (USACE, 2005), hereafter referred to as the HHRAM, and information provided by the OHARNG during preparation of the Work Plan Addendum (Shaw, 2011).

Current activities at the Group 8 MRS include security patrols, maintenance activities, and access to the road network to access adjacent buildings. Human receptors associated with the current land uses at the MRS include facility personnel and contractors.

Note:
The Scale is for the Upper Map Only
Showing the RVAAP Location

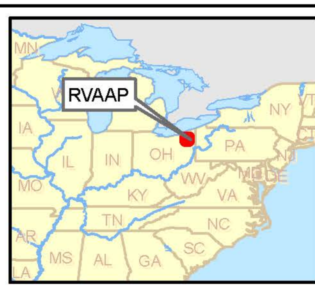

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FIGURE 1-1 RVAAP INSTALLATION LOCATION MAP

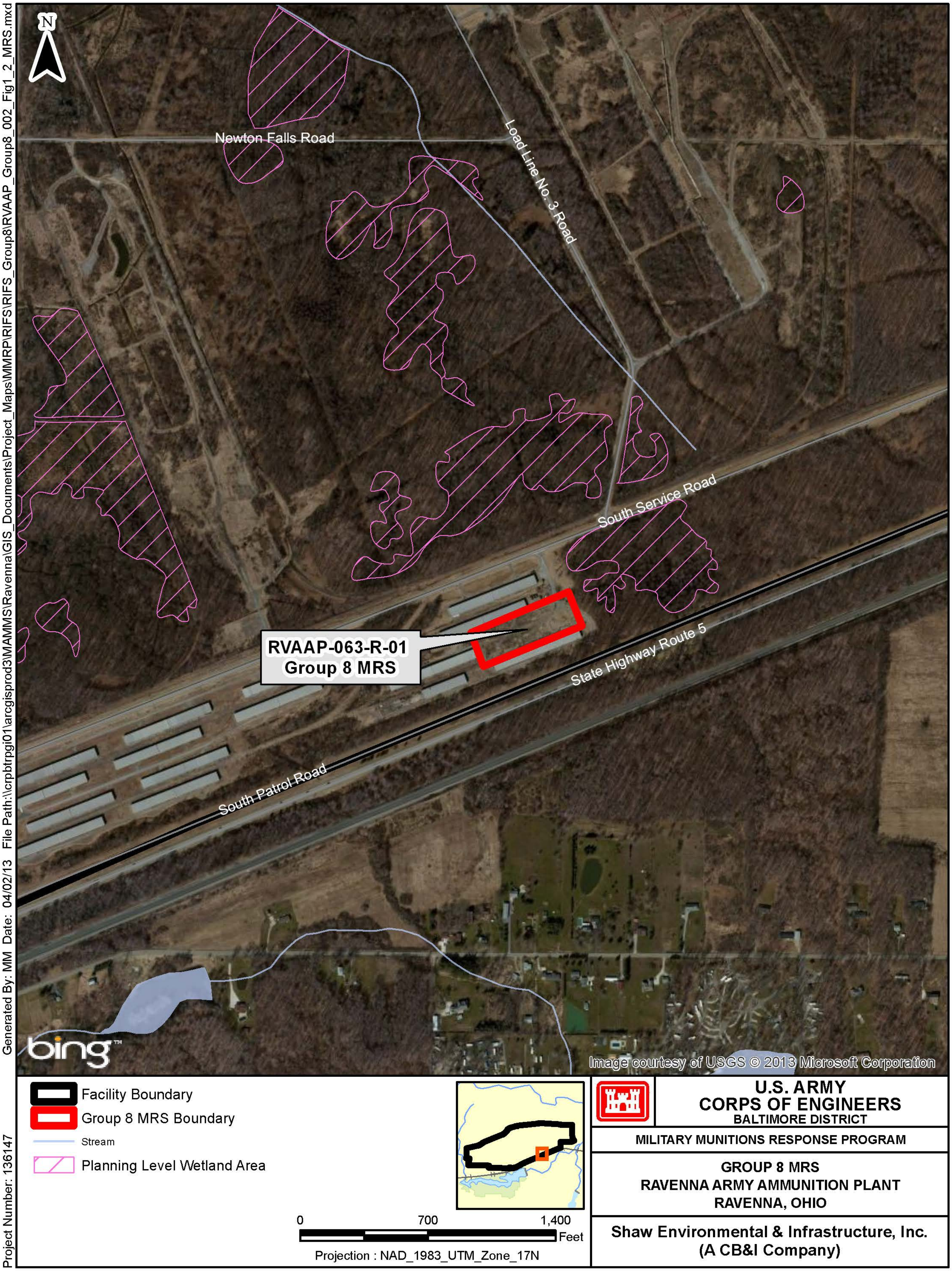

FIGURE 1-2 MRS LOCATION MAP

The OHARNG projected future land use for the Group 8 MRS is military training. The most representative receptor for the future land use is the National Guard Trainee (USACE, 2005).

1.3.3 Topography

The RVAAP is located within the Southern New York Section of the Appalachian Plateaus physiographic province. Rolling topography containing incised streams and dendric 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. Old stream drainage patterns were disturbed and wetlands were created within the province as a result of past glacial activity (e^2M, 2008).

The topography at the Group 8 MRS is flat and the relative elevation at the MRS is approximately 985 feet above mean sea level (amsl). No bogs, kettle lakes, or kames are present at the MRS. The topography for the Group 8 MRS is presented in **Figure 1-3**.

1.3.4 Climate

The climate at RVAAP 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, OH

Temperature Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Maximum 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 Minimum 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. 20 1971–2000.
°F denotes degrees Fahrenheit.

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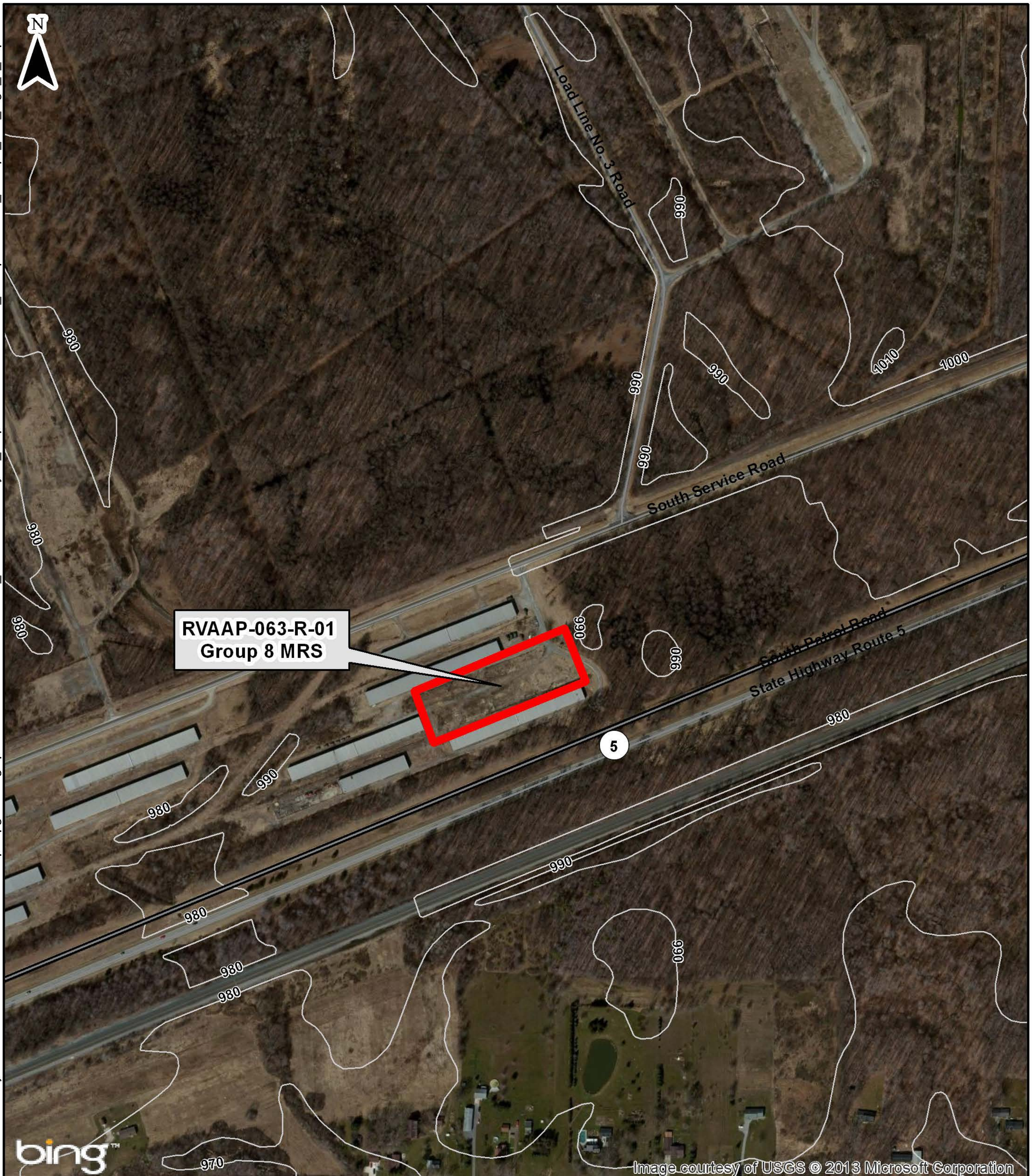

Facility Boundary
Group 8 MRS Boundary
Elevation Contour (10 Foot Intervals)

0 500 1,000 Feet
Projection : NAD_1983_UTM_Zone_17N

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FIGURE 1-3 TOPOGRAPHY

1.3.5 Hydrology and Hydrogeology

The RVAAP is located within the Ohio River Basin. The major surface stream at RVAAP is the West Branch of the Mahoning River, which flows adjacent to the western end of the RVAAP, 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 RVAAP.

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

Three primary watercourses drain the RVAAP: (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 Ohio State 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 RVAAP (AMEC, 2008). 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.

Planning level surveys (i.e., desktop review of wetlands data and resources [National Wetland Inventory maps, aerials, etc.]) for wetlands were conducted for the facility, including the Group 8 MRS. A jurisdictional wetlands delineation has not been completed at the MRS. Wetlands located within the RVAAP include seasonally saturated wetlands, wet fields, and forested wetlands (MKM Engineers, Inc. [MKM], 2007). 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 RVAAP were primarily located within the sandstone facies of the Sharon Member (MKM, 2007).

Although groundwater recharge and discharge areas have not been delineated at the RVAAP, it is assumed that the extensive uplands areas, located at the western portion of the RVAAP, are regional recharge zones. Sand Creek, Hinkley Creek, and Eagle Creek are presumed to be major groundwater discharge areas (e^2M, 2008).

Group 8 MRS Hydrology and Hydrogeology

Surface water drainage at the Group 8 MRS generally flows into drainage ditches along the roadside where it eventually infiltrates the soil. No wetlands were identified within the MRS boundary (AMEC, 2008).

No groundwater monitoring wells have been installed at the Group 8 MRS. Based on the RVAAP data collected for the facility-wide groundwater monitoring program, the groundwater elevation at the MRS and the immediate vicinity is approximated at a potentiometric high of 960 feet amsl. Groundwater flow direction is towards the southeast. The approximate depth to groundwater in the unconsolidated aquifer at the Group 8 MRS is between 15 to 20 feet below ground surface (bgs) (Environmental Quality Management [EQM], 2012).

1.3.6 Geology and Soils

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

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

Bedrock is present near the ground surface in many locations at the RVAAP. 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 RVAAP, 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 RVAAP. In the northeastern corner of the RVAAP, the Meadville Shale Member of the Cuyahoga Group is present close to the surface. The Meadville Shale Member of the Cuyahoga Group is a 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 Member conglomerate where it was deposited in a broad channel cut into Mississippian-age rocks. In marginal areas of the channel, the conglomerate unit may thin out to approximately 20 feet, or in places it may be missing, owing to nondeposition on the uplands of the early Pennsylvanian-age 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 RVAAP. The Sharon Member shale unit outcrops in many locations in the eastern half of RVAAP.

The remaining members of the Pottsville Formation overlie the Sharon Member in the western portion of the RVAAP. 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 RVAAP.

The Connoquenessing Sandstone Member, which is sporadic, relatively thin-channel sandstone comprised of gray to white, coarse-grained quartz with a higher percentage of feldspar and clay than the Sharon Member conglomerate unit, 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).

Group 8 MRS Geology and Soil

The Group 8 MRS is located over the Sharon Member conglomerate unit. The bedrock elevation is approximately 975 feet amsl. **Figure 1-4** illustrates the bedrock formations beneath the Group 8 MRS.

The soils identified at the RVAAP are generally derived from the Wisconsin-age silty clay glacial till. The majority of native soil at the RVAAP has been reworked or removed during construction activities. The major soil types found in the Group 8 MRS are silt or clay loams, ranging in permeability from 6.0×10^{-7} to 1.4×10^{-3} centimeters per second (U.S. Department of Agriculture et al., 1978). The soil type at the Group 8 MRS is the Mahoning-Urban land complex with undulating 2 to 6 percent slopes (AMEC, 2008). **Figure 1-5** illustrates the soil types at the Group 8 MRS.

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Facility Boundary

Group 8 MRS Boundary

Geologic Formation

Sharon Sandstone - Conglomerate Unit

Bedrock Elevation Contour (feet above sea level)

0 500 1,000 Feet

Projection : NAD_1983_UTM_Zone_17N

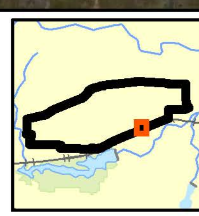

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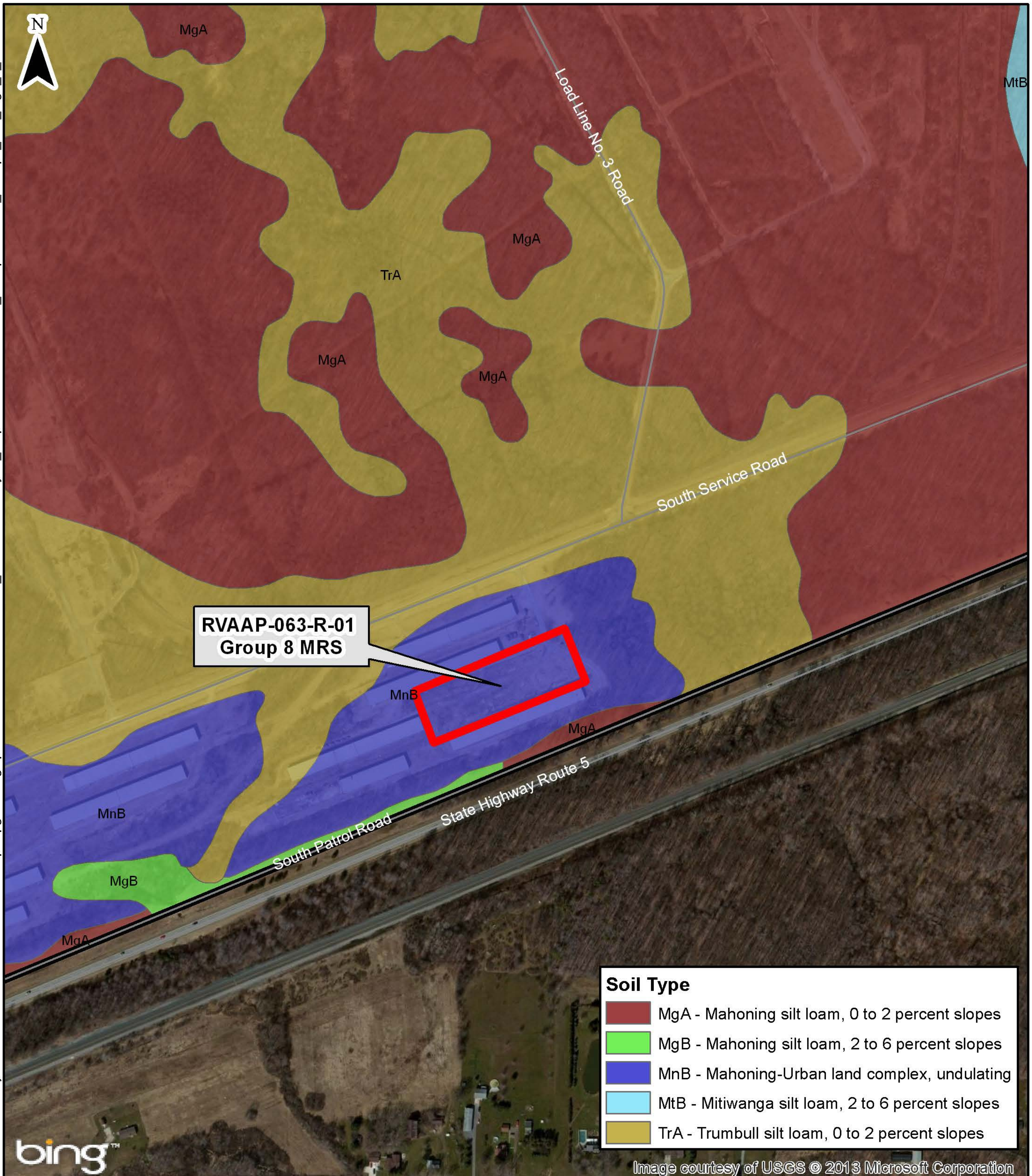
FIGURE 1-4 BEDROCK MAP



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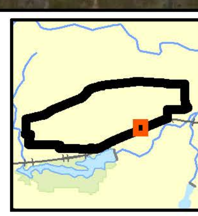
Project Number: 136147

Facility Boundary
Group 8 MRS Boundary



0 500 1,000 Feet

Projection : NAD_1983_UTM_Zone_17N

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FIGURE 1-5 SOILS MAP

1.3.7 Vegetation

The RVAAP has a diverse range of vegetation and habitat resources. Habitats present within the RVAAP include large tracts of closed-canopy hardwood forest, scrub/shrub open areas, grasslands, wetlands, open-water ponds and lakes, and semi-improved administration areas. Vegetation at the RVAAP 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 on the RVAAP. Shrub vegetation covers approximately 4,200 acres. A plant species survey identified 18 vegetation communities on the RVAAP. The RVAAP has seven forest formations, four shrub formations, eight herbaceous formations, and one nonvegetated formation (AMEC, 2008).

The habitat at the Group 8 MRS has been influenced and impacted by man-made improvements, including gravel roads. Additionally, historical use of the Group 8 MRS as a burning area has also influenced the habitat at the site. The vegetation community present at the Group 8 MRS is categorized as "other land" (AMEC, 2008), which presumably refers to disturbed areas that do not support any particular plant community.

1.3.8 Threatened, Endangered, 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 United States Fish and Wildlife Service. While there are species under federal review for listing, there are currently no federally listed species or critical habitats at the RVAAP. 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 threatened, endangered, and candidate species at the RVAAP was obtained from the CRJMTC Rare Species List (2010). **Table 1-3** presents state-listed species that have been identified to be on the RVAAP by biological inventories and confirmed sightings.

Table 1-3
Camp Ravenna Joint Military Training Center 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*

Common Name	**Scientific Name**
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*
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*

Common Name	Scientific Name
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*
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*

Common Name	Scientific Name
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 Joint Military Training Center Rare Species List*, April 27, 2010.*

1.3.9 Cultural and Archeological Resources

A number of archeological surveys have been conducted at the RVAAP. Cultural and archeological resources have been identified at the RVAAP during past surveys. The Group 8 MRS has not been previously surveyed for cultural or archaeological resources; however, due to the disturbed nature of the ground from former activities, it is unlikely that cultural/archaeological resources exist at the MRS.

1.4 History and Background

During operations, the RVAAP was a government-owned and contractor-operated industrial facility. Industrial operations at the former RVAAP 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.

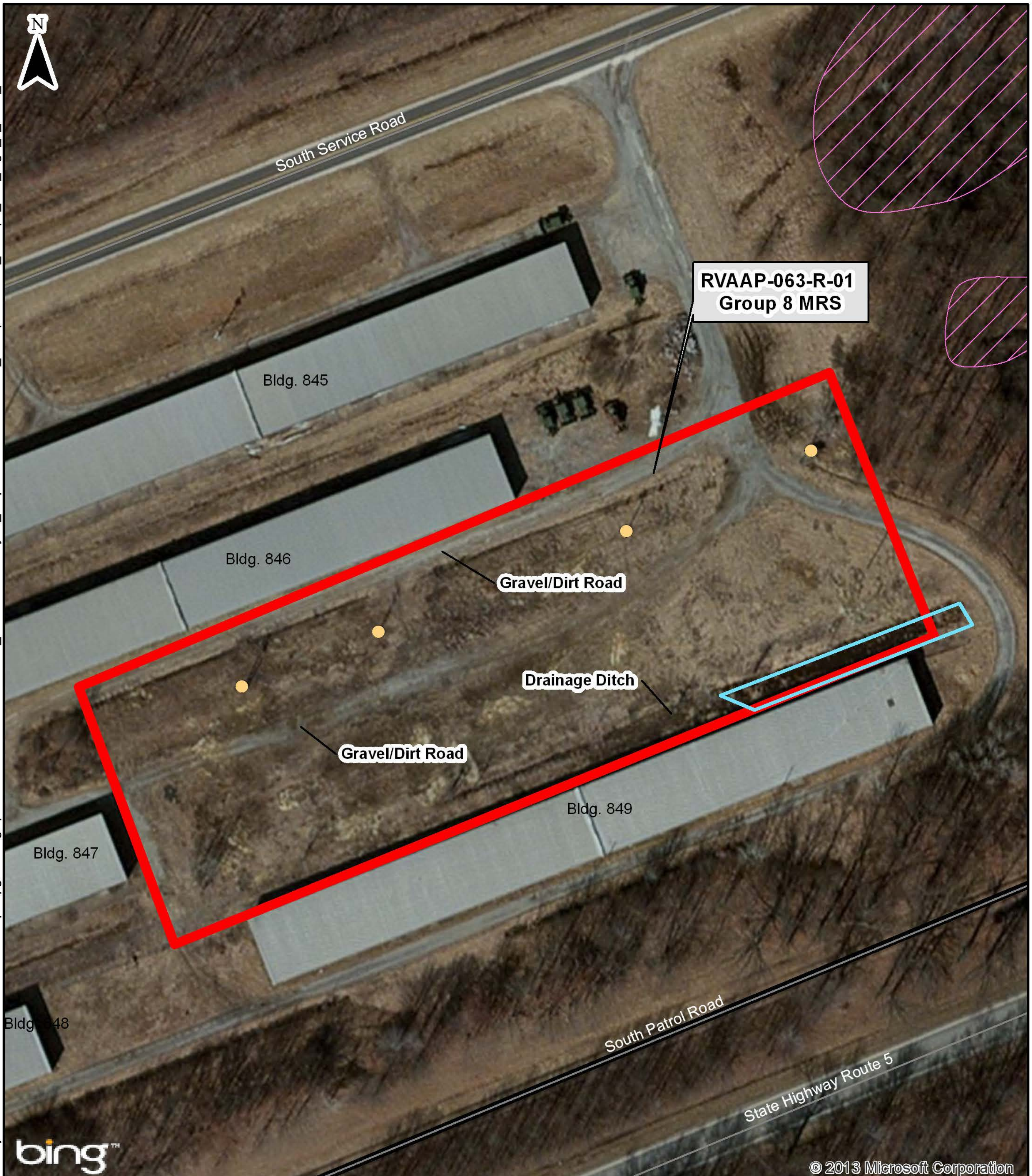
In 1950, the RVAAP was placed in standby status and operations were limited to renovation, demilitarization, and normal maintenance of equipment, along with storage of munitions. Production activities were resumed from July 1954 to October 1957 and again from May 1968 to August 1972. In addition to production 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 RVAAP include MRSs that were used for the burning, demolition, and testing of munitions. These burning and demolition grounds consisted of large parcels of open space or abandoned quarries. Potential contaminants at these MRSs include explosives, propellants, metals, and waste oils. Other areas of concern (AOCs) present at RVAAP include landfills, an aircraft fuel tank testing facility, and various general industrial support and maintenance facilities (Science Applications International, Inc. [SAIC], 2011).

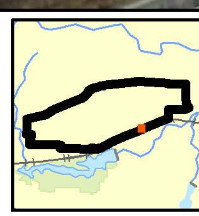
Group 8 MRS History and Background

The Group 8 MRS is a 2.65-acre MRS located between Buildings 846 and 849, which was used for an undetermined amount of time to burn construction debris and rubbish. Although it has not been documented, previous discoveries of MEC and MD indicate that the area may have also received various munitions items, including M397 series 40 mm HE grenades, M49 series 60 mm mortars, M72 series 75 mm projectiles, M557 series fuzes, 175 mm projectiles, HE anti-tank warheads, and assorted fuzes, which may have been burned at the MRS. The area was used as a staging area for military vehicles until it was designated as a MRS. The OHARNG still utilizes the road network within the MRS to access adjacent buildings. The MRS is currently vacant, grassy land with no improvements.

In 1996, one antipersonnel fragmentation bomb with HE was found at the MRS by OHARNG personnel. The antipersonnel fragmentation bomb was detonated at Open Demolition Area #2 by an ordnance company that had been dispatched from Wright-Patterson Air Force Base. In addition, MD consisting of one demilitarized (i.e., cut in half) 175 mm projectile was found on the ground surface at the MRS. The MD item was removed and taken to Building 1501 (e^2M, 2008). The MRS layout and primary features are presented in **Figure 1-6**.



Facility Boundary
Group 8 MRS Boundary
Planning Level Wetland Area
Standing Water Area
Utility Pole



0 100 200 Feet

Projection : NAD_1983_UTM_Zone_17N

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GROUP 8 MRS
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Project Number: 136147 Generated By: MM Date: 04/02/13 File Path:\\crpbtrpgi01\arcgisprod3\MAMMS\Ravenna\GIS_Documents\Project_Maps\MMRP\RIFS\RIFS_Group8\RVAAP_Group8_025_Fig1_6_MRS_Features.mxd

FIGURE 1-6 MRS FEATURES MAP

1.5 Previous Investigations and Actions

This section briefly summarizes the investigations and actions as it pertains to the Group 8 MRS. This information was obtained primarily from the *Final Historical Records Review* (e^{2}M, 2007), hereafter referred to as the HRR, and the SI Report (e^{2}M, 2008).

1.5.1 2004 USACE Final 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 RVAAP. 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). The Group 8 MRS was not identified as one of the original sites that contained MEC as part of the 2004 ASR.

1.5.2 2007 e^{2}M Final 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 RVAAP, 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 were conducted on the MRSs that resulted in the possible presence of MEC and/or MC and where the releases occurred prior to September 2002 (e^{2}M, 2008). The 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)
- Areas 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 RVAAP to 17.

The HRR identified the Group 8 MRS as the 2.65-acre "Area Between Buildings 846 and 849" and also documented the requested name change to the Group 8 MRS. At the time the records research was being performed for the HRR, the area was being used by the OHARNG as a vehicle staging area. Historical activities at the MRS included the burning of construction debris and rubbish. The time frame for these activities is not known. In 1996, MEC in the form of a single antipersonnel fragmentation bomb with HE and MD in the form of a demilitarized (i.e. cut in half) 175 mm projectile was found at the MRS. The antipersonnel fragmentation bomb with HE was removed and detonated at Open Demolition Area #2. The 175 mm projectile was also removed from the MRS and was taken to Building 1501.

1.5.3 2008 e²M Final Site Inspection Report

In 2007, e²M conducted an SI at each 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, 14 were further recommended for additional characterization under the MMRP that included the Group 8 MRS (RVAAP-063-R-01). A summary of the SI Report (e²M, 2008) recommendations for the Group 8 MRS are presented in **Table 1-4** and are discussed below.

Table 1-4
Site Inspection Report Recommendation

MRS	MRSPP Priority	Recommendation	Basis for Recommendation	
			MEC	MC
Group 8 MRS (RVAAP-063-R-01)	4	Further characterization of MEC and MC	The presence of potential MEC was identified during the SI.	MC was found in concentrations exceeding screening levels.

MC denotes munitions constituent.
MEC denotes munitions and explosives of concern.
MRS denotes munitions response site.
MRSPP denotes Munitions Response Site Prioritization Protocol.
SI denotes site inspection.

The Group 8 MRS was assigned a Munitions Response Site Prioritization Protocol (MRSPP) priority of 4. 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 priority identified for the MRS in the SI Report (e²M, 2008), the Group 8 MRS was selected for inclusion for "further characterization" under the MMRP. The following summarizes the investigation activities performed at the Group 8 MRS during the 2007 SI and the conclusions and recommendations for the MRS as identified in the SI Report (e²M, 2008).

During the SI field activities, magnetometer and metal detector assisted MEC surveys were completed over 100 percent of the MRS. Two unidentifiable T-bar fuzes were found partially buried in the southwest portion of the MRS and were determined to be potential MEC. MD items identified during the SI field activities included metal fragments from casings and projectiles, burster tubes, and fragments of fuzes. The majority of the MD items found had most likely been pressed into the surface soils by the heavy equipment and vehicles that had been stored at the MRS prior to the SI. In addition to the MEC and MD a significant amount of nonmunitions related debris consisting of metal trash, fence materials, and wood scraps were found in the general areas where the MEC and MD were found. No MEC, MD, or other debris was identified on the ground surface at the northeast portion of the MRS during the SI field activities.

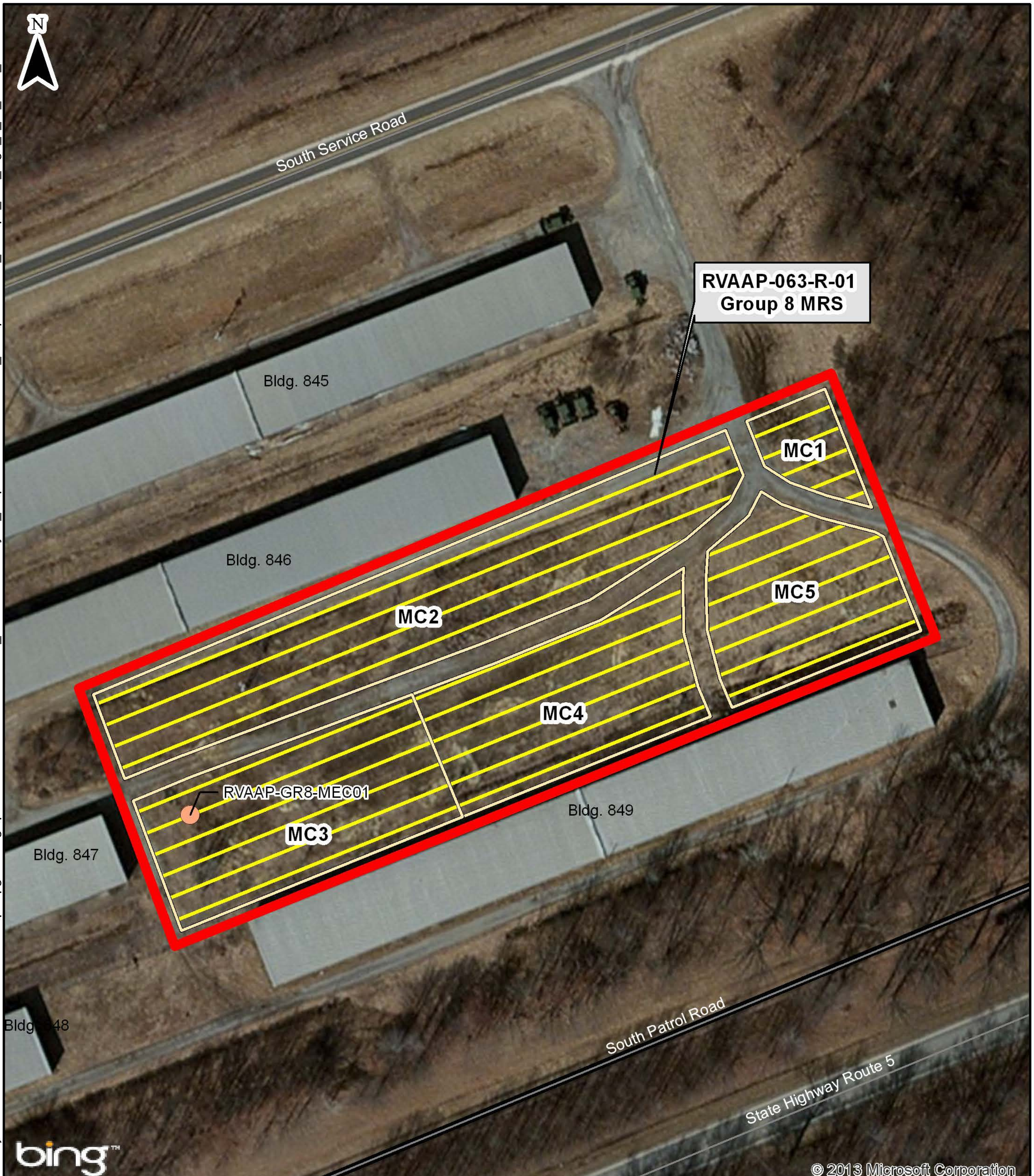
Five ISM surface soil samples were collected at the MRS during the SI field activities and were analyzed for explosives, propellants, and target analyte list metals. Lead and thallium were detected in all five samples above the RVAAP screening criteria for background values and the U.S. Environmental Protection (EPA) residential soil Preliminary Remediation Goals (PRGs). Thallium was dismissed as an MC as it was nonmunitions related. Antimony, arsenic, aluminum, cadmium, copper, iron, lead, and manganese were detected in at least one sample at concentrations greater than the RVAAP screening criteria and were considered as MC. Explosives and propellants were also detected; however no exceedances of above the PRGs were identified. **Figure 1-7** provides a summary of the investigation activities conducted at the Group 8 MRS during the SI field activities.

Based on the finding of the SI field work, both MEC and MC were identified as concerns at the MRS. The SI Report recommended that the 2.65 acre MRS footprint remain the same and that further characterization was necessary to address the MEC and MC concerns (e^2M, 2008).

1.6 RI Report Organization

The contents and order of presentation of this RI Report are based on the requirements of *MMRP Munitions Response Remedial Investigation/Feasibility Study Guidance* (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 Models
- **Section 10.0**—Summary and Conclusions
- **Section 11.0**—References



Facility Boundary
Group 8 MRS Boundary
Multi-incremental Sample Area
Line Abreast Survey Area
Suspect MEC Location

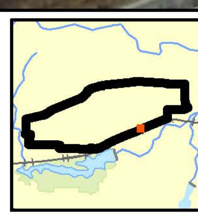


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FIGURE 1-7 SI FIELD WORK AND FINDINGS

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

- **Appendix A**—Digital Geophysical Mapping Report
- **Appendix B**—Field Documentation
- **Appendix C**—Data Validation Report
- **Appendix D**—Laboratory Data Reports
- **Appendix E**—Investigation-Derived Waste Management
- **Appendix F**—Photograph Documentation Log
- **Appendix G**—Intrusive Investigation Results
- **Appendix H**—Statistical Analysis of Intrusive Findings
- **Appendix I**—Waste Shipment and Disposal Records for Munitions Debris
- **Appendix J**—MEC Hazard Assessment Workbook
- **Appendix K**—Ecological Screening Values
- **Appendix L**—SLERA Risk Characterization Worksheets
- **Appendix M**—Munitions Response Site Prioritization Protocol Worksheets

2.0 PROJECT OBJECTIVES

This chapter presents the preliminary conceptual site models (CSMs) for MEC and MC at the Group 8 MRS based on historical information, identified data gaps associated with the preliminary CSMs, and the data quality objectives (DQOs) necessary to achieve the project objectives.

A CSM for an 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 MPPEH or ordnance is situated or is expected to be found. An 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 come into contact with 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 come into contact with a source. The presence of access controls helps 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 OHARNG/RVAAP personnel, contractors, visitors, trespassers, and biota.

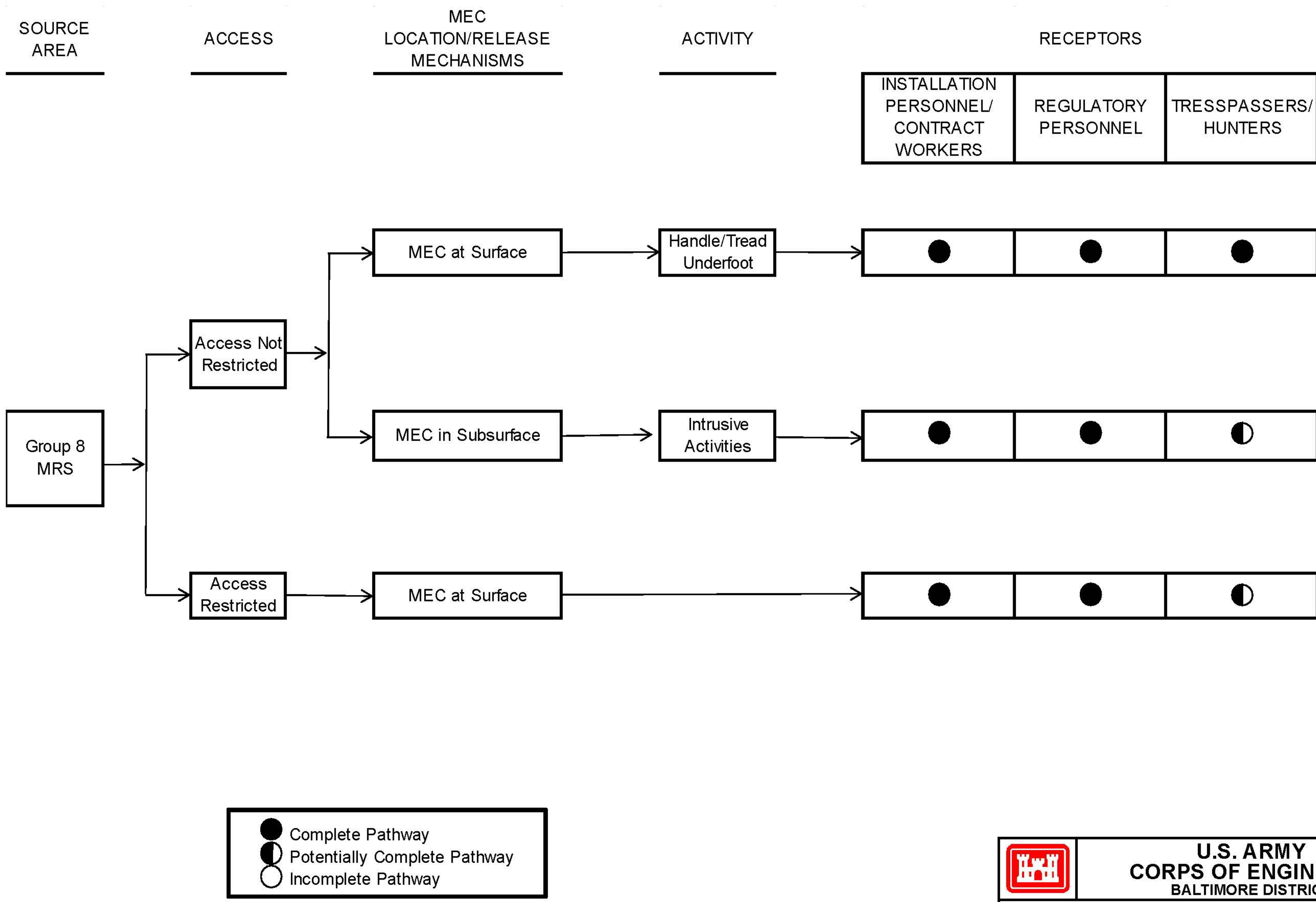
A pathway is considered complete when a source (MEC) is known to exist and when receptors have access to the MRS while engaging in some activity that results in contact with the source. A pathway is considered potentially complete when a source has not been confirmed but is suspected to exist and when receptors have access to the MRS while engaging in some activity that results in contact with the source. Lastly, an incomplete pathway is any case where one of the three components (source, activity, or receptors) is missing from the MRS.

In general, the CSM for each MRS is 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 Group 8 MRS, as presented in the SI Report (e^{2}M, 2008), is presented in the following section. The data collected during the RI are evaluated in the following chapters and are incorporated into this model as discussed in Section 9.0, "Revised Conceptual Site Models."

2.1 Preliminary CSM and Project Approach

The preliminary CSMs for the Group 8 MRS are based on site-specific data and general historical information including literature reviews, maps, training and technical manuals, and field observations. The preliminary MEC and MC CSMs were originally developed during the SI process based on guidance from USACE Engineer Manual (EM) 1110-1-1200, *Conceptual Site Models for Ordnance and Explosives (OE) and Hazardous, Toxic, and Radioactive Waste (HTRW) Projects* (USACE, 2003a). The preliminary MEC and MC CSMs are represented by the diagrams provided as **Figure 2-1** and **Figure 2-2**, respectively. A summary of each of the factors evaluated for the preliminary MEC and MC CSMs is discussed below:

- **Sources—**Munitions-related burning was considered to be the primary source of potentially explosive MEC at the Group 8 MRS. Based on a review of the archival records and available documentation, the principle source areas at the Group 8 MRS have not been identified; however, potential burning of munitions



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

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FIGURE 2-1 PRELIMINARY MEC CONCEPTUAL SITE MODEL

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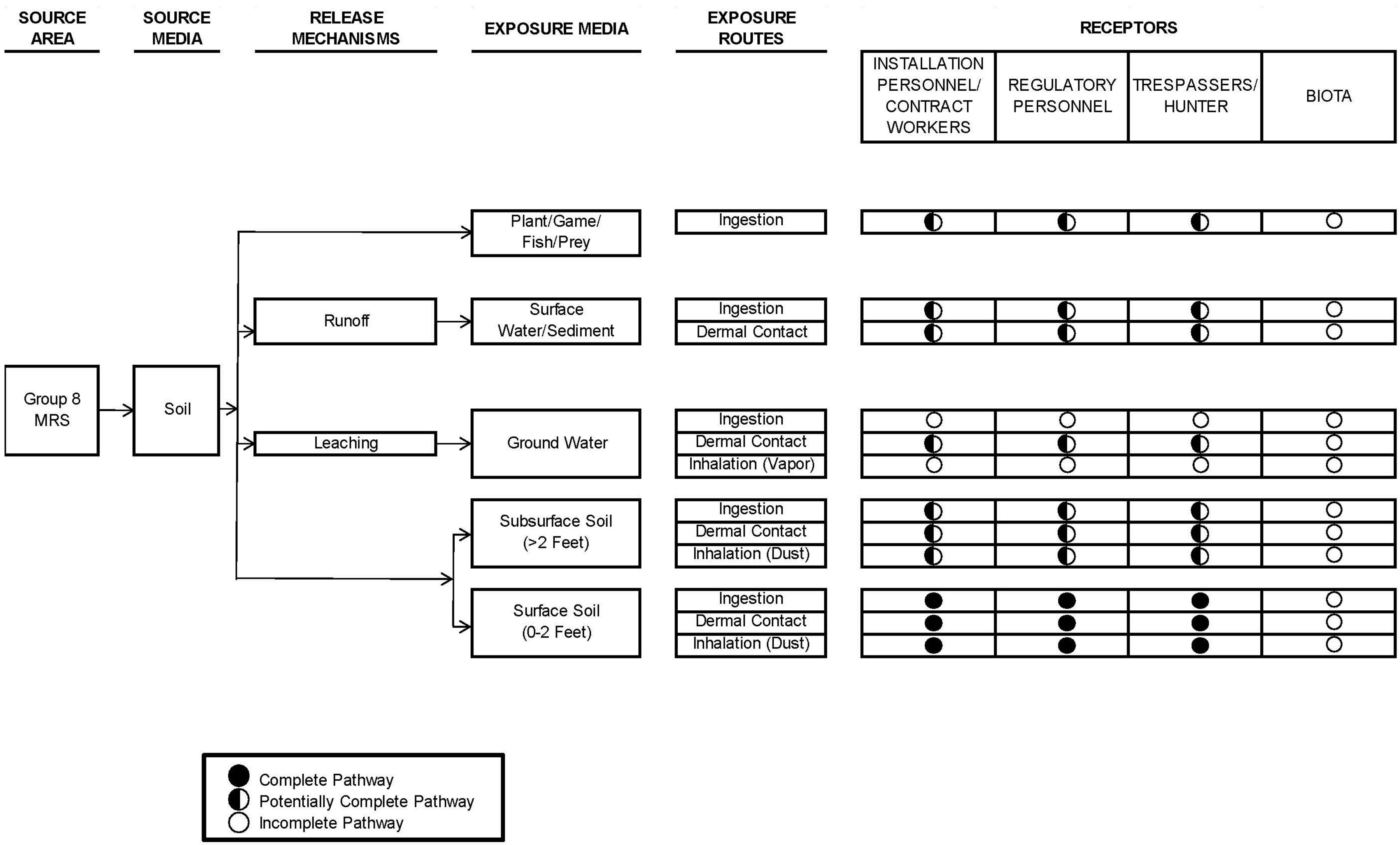

Source: Final Site Inspection Report, Ravenna Army Ammunition Plant, Ohio (e^2M, 2008)

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FIGURE 2-2 PRELIMINARY MC CONCEPTUAL SITE MODEL

followed by compaction of soils, as a result of vehicles moving through the MRS, resulted in the potential for MEC/MD to be present in the surface and subsurface soil at the Group 8 MRS. The source of MC at the MRS also includes the potential residual contamination in soils as a result of the burning activities on the ground surface.

- **Activity—**Human activities considered for the preliminary CSM include maintenance of the grounds and security checks that were being performed on an infrequent basis.
- **Access—**With the exception of the facility perimeter fence, access to the MRS is unrestricted and military vehicles and the identified receptors may drive or walk through/over the MRS to gain access to adjacent storage buildings.
- **Receptors—**At the time of the SI, current and reasonably anticipated receptors included installation personnel, contractors, regulatory personnel, hunters, and trespassers. The SI considered biota to be state-listed species identified as being present at the RVAAP. If present, MEC and/or MD and associated MC on the ground surface and near the surface could have been accessed by receptors.

MEC was observed lying on the ground surface and partially buried at the MRS during the SI field activities. Human exposure pathways were identified as contact with MEC lying on the ground surface and disturbance of shallow subsurface soil. For buried MEC, transport and migration was not considered likely to occur, unless disturbed. MEC lying on the ground surface was considered able to be transported by erosion, surface water flow, and by frost heave. Therefore, the SI Report identified the complete MEC human exposure pathways as handle or tread under foot and disturbance of shallow surface soil (i.e., 0–0.5 feet bgs). The preliminary CSM for MEC at the Group 8 MRS, as presented in the SI Report (e^2M, 2008), is shown in **Figure 2-1**.

During preparation of the SI Report, the surface soil exposure depths for all receptors were defined as 0 to 2 feet bgs and subsurface soil was defined as depths greater than 2 feet. The SI Report predates the *Final Facility-Wide Human Health Cleanup Goals for the RVAAP* (SAIC, 2010), hereafter referred to as the FWCUG Report, and does not reflect the exposure depths for the current and future land use receptors which are defined in later sections of this RI Report. MC consisting of metals (antimony, aluminum, arsenic, cadmium, copper, iron, lead, and manganese) was found to be present at the MRS following the SI field work. Complete pathways were considered to be present for surface soil and potentially complete pathways were considered as present for subsurface soil. The SI Report identified the exposure pathways as dermal contact, ingestion, and inhalation of contaminated soil. Potential transport was considered possible via surface water, erosion of soils, and through a release to groundwater and surface water. The exposure pathways for biota were considered as incomplete since no federally listed species or critical habitats were present at the RVAAP at the time of the SI field activities. The preliminary CSM for MC at the Group 8 MRS, as presented in the SI Report (e^2M, 2008), is shown in **Figure 2-2**.

2.2 Applicable or Relevant and Appropriate Requirements and "To Be Considered" Information

Applicable or relevant and appropriate requirements (ARARs) and "to be considered" (TBC) guidance for future anticipated and reasonable remedial actions at the RVAAP under the MMRP are currently under development. Once ARARs and/or TBC materials have been identified, PRGs, and remedial action objectives will be developed. The identified ARARs, TBC, PRGs, and remedial action objectives will be included in the follow-on documents to this RI Report as required per 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 Addendum (Shaw, 2011). The data needs included characterization for MEC and/or MC associated with the former activities or incidents 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.

2.3.1 Data Quality Objectives

The DQOs were developed for MEC and MC in accordance with the *Facility-Wide Sampling and Analysis Plan for Environmental Investigations at the RVAAP* (SAIC, 2011), hereafter referred to as the FWSAP, and the EPA *Data Quality Objectives Process for Hazardous Waste Site Investigations*, EPA QA/G-4HW (2000). **Table 2-1** identifies the DQO process at the Group 8 MRS as presented in the Work Plan Addendum (Shaw, 2011).

Table 2-1
Data Quality Objectives Process for the Group 8 MRS

Step	Data Quality Objective
1. State the problem.	The Group 8 MRS was used to burn construction debris and rubbish. In 1996, one antipersonnel fragmentation bomb with high explosives verified as MEC and one 175 millimeter projectile considered as MD was observed at the MRS by OHARNG personnel. During the SI, two potential MEC items (partially buried fuzes) were identified in addition to numerous MD items found throughout the MRS. Therefore, there is a potential for MEC/MD associated with potential burning activities on the ground surface and subsurface. In addition, there is a potential for environmental impacts from MC at the MRS.

Step	Data Quality Objective
2. Identify the decision.	The goal of the investigation at the Group 8 MRS is to identify the areas impacted with MEC/MD. In addition, MC sampling will be performed in order to further characterize the type and amount of contamination associated with activities at the MRS. The information obtained during the RI will be used to assess the potential risks and hazards posed to human health and the environment.
3. Identify inputs to the decision.	• Historical information • DGM survey • Intrusive inspection • Incremental environmental media sampling
4. Define the study boundaries.	The RI investigation will be performed in the Group 8 MRS boundaries as defined at the conclusion of the SI Report (e^2M, 2008).
5. Develop a decision rule.	Prior to the MEC investigation at the Group 8 MRS, all construction debris will be removed. Although no formal visual survey transects are planned at the MRS, the presence of surface MEC/MD will be investigated during the DGM survey. 100 percent DGM coverage will be performed in all accessible areas within the MRS boundaries. Since full coverage is proposed at the Group 8 MRS, the number of anomalies investigated will be based on a prioritized ranking system and statistical sampling. The SI recommended additional MC sampling at the Group 8 MRS based on previous surface soil results above screening criteria. Currently, a total of four ISM surface soil samples are proposed at the MRS. Additional soil samples may be collected based on the results of the DGM field activities and target anomaly investigation if MEC/MD is identified. The final location and number of samples will be proposed at the conclusion of the MEC investigation. Collected samples will be analyzed for aluminum, antimony, barium, cadmium, total and hexavalent chromium, copper, iron, lead, strontium, mercury, and zinc; explosives; and semivolatile organic compounds, nitrocellulose, total organic carbon, and pH. The samples will also be analyzed for geochemical metal parameters (calcium, magnesium, and manganese).
6. Specify limits of decision errors.	Quality control procedures are in place so that all fieldwork will be performed in accordance with all applicable standards. Further details on the QC process implemented during the RI are located in Section 4.0 of the Work Plan Addendum (Shaw, 2011).
7. Optimize the design for obtaining data.	The information gathered as part of the field investigation at the Group 8 MRS will be used to determine what potential risks or hazards, if any, are present at the MRS. Shaw will perform a MEC HA to identify the potential MEC hazards. In addition, RVAAP site-specific human health and ecological risk assessments will be performed on the analytical results. If unacceptable potential 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 Responsibility, and Compensation and Liability Act of 1980.
DGM denotes digital geophysical mapping.
HA denotes hazard assessment.
ISM denotes incremental sampling methodology.
MC denotes munitions constituent.
MD denotes munitions debris.
MEC denotes munitions and explosives of concern.
MRS denotes munitions response site.
OHARNG denotes Ohio Army National Guard.
RI denotes remedial investigation.
RVAAP denotes Ravenna Army Ammunition Plant.
SI denotes site inspection.

2.3.2 Data Needs

For MEC, data needs include determining the types, locations, condition, and number of MEC items present at the MRS so that the potential hazard to likely human and environmental receptors can be assessed and remedial decisions can be made. The DQOs were developed in accordance with the FWSAP (SAIC, 2011), the EPA DQO Guidance (2000), and past experience with MRSs containing MEC. These data needs for MEC were evaluated using the most applicable methods and technologies, such as UXO Estimator® (USACE, 2003b), which are discussed in the following chapters.

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 coming into contact with 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 in environmental media at the MRS based on the results of the MEC investigation to include sampling and analysis of surface soil and subsurface soil that potentially pose unacceptable risk to human health 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 levels to support human health and ecological evaluation whenever possible.

2.4 Data Incorporated into the RI

Whenever possible, existing data are incorporated into the RI. The following is a summary of existing data and how they were used:

- **Historical Records Review—**The HRR 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 Installation Restoration Program (IRP) at various MRSs includes analytes considered to be MC associated with previous activities at the MRS, although it should be noted that not all analytes are considered MC. No sampling has been conducted at the

Group 8 MRS under the IRP; therefore, evaluation for the inclusion of IRP data in the RI was not applicable.

- **Site Inspection Data—**The MMRP SI Report (e^2M, 2008) provides reconnaissance data identifying surface MEC and MD that will be used in conjunction with historical data to preliminarily delineate areas with munitions-related activity. MC sampling was conducted during the SI; however, incorporation of the data was not required because sufficient MC samples were collected during the RI field effort along with a more robust suite of analyses. The RI samples are considered representative of current conditions.

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3.0 CHARACTERIZATION OF MEC AND MC

This chapter documents the approaches used to investigate MEC and MC at the Group 8 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 Addendum (Shaw, 2011).

3.1 MEC Characterization

The following section summarizes the geophysical investigation, anomaly reacquisition and subsequent intrusive investigation activities that were performed at the Group 8 MRS during the RI field activities. Based on the documented discoveries of MEC and MD, it was determined in the SI reporting stage that there is a potential for MEC/MD on the ground surface and subsurface at the MRS. The initial step in evaluating for MEC at the Group 8 MRS was to remove from the surface nonmunitions debris consisting of scrap metal, fence materials, and wood scraps. These items were placed at a nearby location off of the MRS to minimize interference from surface metallic items during the digital geophysical mapping (DGM) survey. Visual surveys of surface conditions were performed in conjunction with the geophysical investigation. The results of the DGM survey and intrusive investigation activities are discussed in Section 4.0, "Remedial Investigation Results."

3.1.1 Geophysical Survey Activities

Between October 31, 2011, and November 14, 2011, Shaw performed a DGM investigation to identify potential subsurface areas of MEC at the Group 8 MRS. The approved sampling coverage presented in the Work Plan Addendum (Shaw, 2011) required full coverage DGM data to be collected over the accessible areas of the 2.65-acre MRS. The actual coverage obtained during the DGM survey is discussed and presented in Section 4.1.2, "Geophysical Survey Results." The *Digital Geophysical Mapping Report for the Group 8 MRS (RVAAP-062-R-01)*, hereafter referred to as the DGM Report, is presented in **Appendix A** and provides a comprehensive review of the DGM survey at the MRS with regards to data acquisition, processing and analysis, anomaly reacquire, and results of the DGM quality control (QC) program.

Geophysical instruments used for the DGM survey consisted of an EM61-MK2 time domain electromagnetic instrument and a Leica TPS1200 series robotic total station (RTS) for positioning. The DGM platform consisted of a modified standard wheeled configuration with the lower coil 16 inches above the ground surface. The field team that performed the DGM survey consisted of a geophysicist and a unexploded ordnance (UXO)-qualified assistant.

The DGM system used for the Group 8 MRS investigation and other MRSs at RVAAP was initially validated during the start-up phase of the project at an instrument verification strip (IVS) located near Load Line 7. The results of the initial IVS effort are documented in the *Instrument Verification Strip Technical Memorandum in Support of Digital Geophysical Mapping Activities for Military Munitions Response Program Remedial Investigation Environmental Services*, which is included in the DGM Report (**Appendix A**). A localized IVS at the Group 8 MRS was used to ensure the functionality of the DGM system on a daily basis during DGM activities at the MRS.

A discussion of the MRS preparation activities for the DGM investigation, the data collection process, and summary of the DGM results are presented in the following sections.

3.1.1.1 Survey Controls

A Registered Ohio Land Surveyor established three survey monuments at the Group 8 MRS. Each monument was established with third order horizontal accuracy (residual error less than or equal to 1 part in 10,000). In areas where data could be acquired using the RTS, the survey monuments were used to provide positional data streamed directly to the EM61-MK2. All of the survey data documenting the MRS features and obstructions is referenced to the three established survey monuments.

For QC purposes, the RTS positioning system was used to reacquire a known, fixed location each time the system was set up on one of the two survey monuments. Per the project metrics defined in the Work Plan Addendum (Shaw, 2011), static measurements for the positioning system were required not to exceed 0.5 feet. The RTS system provides centimeter-level accuracy, and 100 percent of location checks satisfied the metric. All mapping was developed in the North American Datum 1983 Universal Transverse Mercator Zone 17 North Coordinate System.

3.1.1.2 Vegetation Clearance and Inaccessible Areas

The Group 8 MRS is an open area and lacks significant vegetative growth. With the exception of sparse grass and shrub groundcover, no vegetation removal was required along transects in order to provide adequate ground clearance for the DGM equipment. Inaccessible areas for the DGM equipment included a small stand of trees and barbed wire fence at the southwest corner of the MRS, utility poles that are spaced approximately 100 feet apart along the northern boundary of the MRS, and lengths of barbed wire fence near the northern MRS boundary. In all, a total of 0.087 acres (or 3.2 percent) of the 2.65-acre MRS were considered inaccessible.

3.1.1.3 Data Collection

Full coverage DGM data were acquired over all accessible areas of the MRS on lines spaced at approximately 2.5-foot intervals, which resulted in a spatial coverage of nearly 97 percent of the 2.65-acre MRS. Within the areas accessible to DGM, 99 percent of the data were acquired at a line spacing of less than 3.5 feet, which meets the metric specified in the Work Plan Addendum (Shaw, 2011). One-dimensional transect survey methodology was employed to collect uniform geophysical data. Along each data acquisition line, positioning system data were recorded at a minimum rate of 1 hertz, and the EM61-MK2 measurements were recorded at a rate of 15 hertz, which translates into a measurement sample density along the ground surface of approximately 0.5 feet. The EM61-MK2 and position data were digitally recorded using the EM61-MK2 software on a Juniper Allegro CX data logger. The general DGM procedures performed for data acquisition at the Group 8 MRS consisted of the following:

- The DGM survey area was reviewed by performing a MRS walkover. Special attention was made to difficult terrain and the presence of obstacles, which created potential safety issues.
- The positioning system was set up at a documented control point of known location or a location was determined by using a minimum of two known control points. The location control was checked by at least one "checkshot" to a different control point of known location.
- DGM system instrument functional checks were performed at the start and end of each day and the results were documented.
- DGM data were collected over the area in a systematic fashion with respect to the terrain, vegetation, and obstacles present. The acquisition protocol used navigation techniques proven at the IVS.
- Field logs were used to document MRS conditions during data collection. The field logs included information and observations regarding the data collection process, weather, field conditions, data acquisition parameters, and quality checks performed. The positioning system was used to document the presence of significant MRS features related to terrain, vegetation, and cultural features so these features could be accounted for during the interpretation of the data.

At the end of each day, the field geophysicist uploaded the DGM data to a computer where the data was archived, backed up, and initially processed and analyzed. The data were also transferred to the Shaw Processing Center in Concord, California on a daily basis for processing and review by the data processor. The raw and final processed data were transferred to USACE at intervals specified in Data Item Description (DID) MMRP-09-004, *Geophysics* (USACE, 2009a).

3.1.1.4 Data Processing and Interpretation

The geophysical data were processed, analyzed, and interpreted using the methods and approach outlined in the Work Plan Addendum (Shaw, 2011). An 8-millivolt (mV) threshold for Channel 2 of the EM61-MK2 was used to initially select the anomalies for potential investigation. From previous RVAAP experience, locations which have signal strength (Channel 2) greater than 8 mV are more likely to be MEC/MD than locations with signal strengths less than 8 mV. Important factors that were considered during the interpretation process included the following:

- Data acquisition methodology (full coverage as is the case for Group 8 MRS)
- Types of MEC most likely present at the MRS based on historical data
- Anomaly shape and signal intensity in relation to the spatial sample density (along track and across track)
- Anomaly time constants
- Local background conditions
- Presence of surrounding anomalies (anomaly density)
- Presence of cultural features and sources of interference
- Anomaly characteristics from the IVS items

Based on the responses, the anomaly locations were evaluated to determine if they were high-density anomalous areas that required excavation using mechanical equipment or were individual target anomalies that could be manually investigated (hand dug). Detailed processing and interpretation procedures are provided in the DGM Report in **Appendix A**.

3.1.1.5 Geophysical Field Quality Control Procedures

The geophysical field QC procedures consisted of tests performed at the start and end of each day along with the MRS specific IVS to ensure the geophysical sensor and positioning equipment were functioning properly and the data was of sufficient quantity and quality to meet the performance metrics defined in the Work Plan Addendum (Shaw, 2011). The performance metrics proposed for the EM61-MK2 sensor was derived from a combination of DID MMRP-09-004, *Geophysics* (USACE, 2009a) and the USACE Table, "*Performance Requirements for RI/FS using DGM Methods*" (Army, 2009). Quality objectives and metrics associated with MRS coverage, signal quality during data acquisition, anomaly reacquire, and the intrusive investigation were also developed from the referenced documents. The

DGM field team and the data processor/analyst reviewed and documented the results of the DGM QC program on a Microsoft© Excel spreadsheet that was updated on a daily basis and delivered to the client for approval. The Microsoft© Excel spreadsheet is part of the geophysics digital data deliverable in the DGM Report (**Appendix A).**

3.1.2 Anomaly Investigation Activities

This section presents a discussion of the target dig list development and the intrusive investigation procedures performed for the evaluation of MEC and MD at the MRS. Following the completion of the DGM survey in November 2011, anomaly selection, reacquisition, and an intrusive investigation was conducted to assess the potential for buried MEC and MD at the Group 8 MRS. Based on the results of the DGM survey, the locations were evaluated to determine if they were high-density anomalous areas that required excavation using mechanical equipment or were individual target anomalies that could be manually investigated (hand dug). All anomaly investigation activities were conducted by UXO-qualified personnel, which included a Senior UXO Supervisor, a UXO QC Specialist (UXOQCS), and at least one Level I or II UXO Technician, in accordance with the Work Plan Addendum (Shaw, 2011). The results of the DGM survey and proposed intrusive investigation locations were submitted to the USACE and Ohio Environmental Protection Agency (Ohio EPA) for review and approval in the *DGM Survey Results and Proposed Dig Locations for the Group 8 MRS (RVAAP-063-R-01)* technical memorandum included as an attachment to the DGM Report in **Appendix A**.

3.1.2.1 Selection of High-Density Anomaly Areas for Intrusive Investigation

Evaluation of the data collected during the DGM survey identified 2,690 anomalies that had signal strength greater than or equal to 8 mV (Channel 2). Three areas were considered to have localized high anomaly densities, which accounted for 1,049 of the 2,690 anomalies. Outside of these high density areas, there were a total of 1,641 anomalies identified for potential investigation as individual target locations.

The data interpreter selected 11 locations for trenches as the primary investigative technique within the three areas with localized high anomaly densities. Three additional exploratory trenches were included, for a total of 14 trenches, based on Ohio EPA’s review and comments of the initial target list presented in the technical memorandum. Once the proposed trench locations were approved by the USACE and the Ohio EPA, they were transferred to a dig sheet and provided to Shaw’s Geographical Information System Department for inclusion in the ShawMEC database for the RVAAP that is used to track the investigation results. The results of the DGM investigation at the proposed trench locations are presented in Section 4.2.1, “Trench Investigations.”

3.1.2.2 Target List Development for Individual Anomalies

To determine the number of individual target anomalies to sample in order to characterize the nature and extent of MEC at the Group 8 MRS, the hypergeometric statistical method was applied to the remaining 1,641 individual target anomalies. Use of such a statistical sampling method is in accordance with guidance provided in EM 1110-1-4009, *Military Munitions Response Actions* (USACE, 2007), which states the following:

> "When there are, on average, more than 50 anomalies per acre then it may be necessary to statistically sample the anomalies. Statistical sampling should be applied such that the results of the sampling will meet the data needs and the DQOs of the characterization project. The method for statistically sampling the anomalies should take into the account the objectives of the characterization effort. Different sampling strategies should be employed if the objective is to confirm the presence of MEC or the number of MEC related items. Furthermore, if the statistical sampling is based on anomaly characteristics (amplitude or size) then some sampling of anomalies which don't meet the criteria should be sampled to validate the selection process."

The hypergeometric method for determining the number of anomalies to sample (n) is based on the following equation:

$$n = Nz^2pq/(E^2(N-1) + z^2pq)$$

Where:

N = population size
z = confidence level
E = allowable error
p = probability
q = 1–p

Using input parameters of 95 percent confidence (z), 5 percent probability (p), and 2.5 percent error limits (E), 248 anomalies, representing nearly 15 percent of the total population of the 1,641 individual target anomalies (N), were selected and met the DQOs. An additional 24 individual anomaly target locations were added based on Ohio EPA's review and comments of the initial target list presented in the technical memorandum. This resulted in a total of 272 targets or 16.6 percent of the total population. The 272 locations were transferred to a dig sheet and provided to Shaw's Geographical Information System Department for inclusion in the ShawMEC database for the RVAAP that is used to track the investigation results. The program used to pick the actual locations of the target anomalies in order to eliminate manually biasing the process was the "RANDBETWEEN" function in Microsoft© Excel.

The Microsoft© Excel "HYPGEOMDIST" function was used as a QC measure to check the results of the approved statistics module following the intrusive investigation. A discussion of the results of the statistical analysis of the intrusive program findings is presented in further detail in Section 4.2.4, "Statistical Analysis of Intrusive Results." The results of DGM investigation and the hypergeometric statics module calculation are discussed in Section 4.1.2.

3.1.2.3 Individual Anomaly Reacquisition and Investigation Procedures

The UXO-qualified personnel used a Schonstedt magnetometer to first reacquire and then investigate ferrous anomalies identified during the DGM survey as individual target anomalies. These personnel used hand tools to unearth an item and as the excavation progressed toward the anomaly source, the UXO Technician continued to use the Schonstedt magnetometer to determine the item location both horizontally and vertically. To locate the ground position of the interpreted anomaly coordinates, the navigational system "Waypoint Location" mode was used for the RTS positioning system. A nonmetallic pin flag, labeled with the unique anomaly identification, was placed in the ground at the interpreted location. Reacquisition of any sampling or dig sheet locations (i.e., interpreted location) was performed to ±0.5 feet of the coordinates specified on the dig sheet.

Once the item was determined not to be MEC or MD, it was temporarily removed from the excavation and the Schonstedt magnetometer was used to confirm no additional ferrous items were located beneath the first item. Nonmunitions-related items were replaced and the soil was returned to the investigation hole in reverse order from which it was excavated. All munitions related items (i.e., MEC/MD) were managed and disposed in accordance with the Work Plan Addendum (Shaw, 2011) and as discussed in Section 4.2.5, "Management and Disposal of Munitions Debris". The UXO-qualified personnel were also conscious of encountering any cultural artifacts associated with historical cultural or archeological resources.

3.1.2.4 High-Density Anomalous Area Reacquisition and Investigation Procedures

Locating the ground position for the high-density areas was similar to the individual target anomalies, except on a larger scale. The navigational system "Waypoint Location" mode was used for the RTS positioning system to locate the coordinates of the trench boundary. Nonmetallic pin flags, labeled with the unique anomaly identification, were placed in the ground at the interpreted location of the trench. As for the individual target anomaly locations, reacquisition of any sampling or dig sheet locations (i.e., interpreted location) was performed to ±0.5 feet of the coordinates specified on the dig sheet.

All trenches were mechanically excavated using an excavator. Each trench started out at approximately 3 feet in width and was continued in depth until the target anomalies were identified; native material was identified and a clear, distinct boundary between the native and fill material was evident; a maximum depth of 10 feet was attained; or the water table was reached. Soil material in each trench was removed in layers at approximately 1-foot intervals.

During the excavation activities, one UXO Technician stood in a safe area at the front of the operation and was responsible for examining the area to be advanced into and to visually observe for the presence of MEC or MD. If an anomaly was uncovered in a trench, the UXO Team worked to identify the anomaly before it was removed. Once the item was determined not to be MEC, it was temporarily removed from the excavation hole and a Schonstedt magnetometer was used to confirm no additional ferrous items were located beneath the first item. The soils that were excavated in 1-foot lifts were spread on 6-mil polyethylene sheeting in an adjacent area where the UXO Technician visually examined it for MEC and/or MD materials. Once confirmed that the source had been identified and no MEC or MD was present, nonmunitions-related items were replaced and the soil was returned to the investigation trench in reverse order from which it was excavated. No soil was segregated for off-site disposal. All munitions related items (i.e., MEC/MD) were managed and disposed in accordance with the Work Plan Addendum (Shaw, 2011) and as discussed in Section 4.2.5, “Management and Disposal of Munitions Debris”.

3.1.2.5 Anomaly Investigation Documentation

All anomalies identified during the reacquisition and intrusive investigation activities were logged and recorded in accordance with DID MMRP-09-004, *Geophysics* (USACE, 2009a). The ShawGeo and/or ShawMEC software was used to record any discrepancies between the dig sheet location and the actual required location and to note any anomalies that could not be investigated. The anomaly reacquisition and investigation results are further discussed in Section 4.2, “Intrusive Investigation Results.”

3.1.2.6 Anomaly Field Quality Control Procedures

Ground-truth excavation data reported on anomaly-specific dig sheets was the primary basis for field QC. The dig sheets documented the item description; location; and approximate weight, shape, orientation, and depth. Dig sheets were reviewed by the field geophysicist on a daily basis to determine whether the excavation data were representative of the mV reading for the selected anomaly. Anomalies that were not representative of the excavation results were revisited by the field geophysicist and the UXOQCS.

3.2 MC Characterization

The following section summarizes the MC characterization activities and decision making process at the Group 8 MRS. The determination as to whether MC characterization was required at the MRS was made based on historical evidence and the results of the MEC investigation. In accordance with the Work Plan Addendum (Shaw, 2011), four ISM surface soil samples were collected from sampling units of the same size for the entire MRS. Additional samples were proposed in areas with concentrated MEC/MD and three additional ISM soil samples were collected from the bottom of the trenches where concentrated buried MD was encountered at the MRS. All MC samples were collected in accordance with the *Final Sampling and Analysis Plan and Quality Assurance Project Plan Addendum* included in Appendix A of the Work Plan Addendum (Shaw, 2011), hereafter referred to as the SAP Addendum. The results of the MC sampling activities are presented in Section 4.4, "Nature and Extent of SRCs."

3.2.1 Sampling Approach

The ISM surface soil samples and ISM trench soil samples were collected at the Group 8 MRS to evaluate for the nature and extent of contamination associated with previous activities at the MRS and to determine whether or not there is unacceptable risk. For the purposes of this RI and the sampling approach discussion, surface soil is considered to be any soil samples collected between 0 to 1 foot bgs and subsurface soil is considered to be samples collected at depths greater than 1 foot bgs. These definitions of soil depths do not take into account the RVAAP's definition of surface and subsurface soil for the receptors that are identified in the FWCUG Report (SAIC, 2010). Discussion regarding the samples collected at depths in relation to the identified RVAAP receptors is discussed in Section 7.0, "Human Health Risk Assessment."

The 2.65-acre MRS is considered the ISM decision unit for surface soil and was split into four predetermined sampling units (approximately 0.67 acres each). The ISM surface soil sampling units are considered areas of equally probably anticipated use by potential receptors to further evaluate the nature and extent of contamination associated with previous activities at the MRS. The MRS was split into equal size sampling units for the RI to provide a more representative comparison of various portions of the MRS than for the five variously sized sample units collected during the SI Report (e^2M, 2008).

The ISM was also used to collect soil samples at the bottoms of three trenches. The trenches were similar in area (40 to 156 square feet) and depth (48 inches), and were considered as separate sampling units. The sample units at the bottoms of the trenches make up the subsurface decision unit for the MRS. Discrete samples were originally proposed at concentrated areas of MEC and MD in the SAP Addendum (Shaw, 2011); however, the ISM approach was considered applicable for sampling the trenches due to the distribution of the buried MD. ISM samples are more suited for providing an estimate of the mean analyte concentration over a sampling unit than are discrete samples collected at individual locations.

The ISM samples collected during the SI were analyzed for limited analytes that included metal, explosives, and propellants. Further review of the OB activities that occurred at the MRS resulted in requiring additional MC analyses for the RI that included semivolatile organic compounds (SVOCs) and polychlorinated biphenyls (PCBs) associated with waste oils and their potential byproducts that may have been used.

Table 3-1 summarizes the sample locations and types of samples collected for the RI and the rationale for the sample strategy.

Table 3-1
Summary and Rationale for Munitions Constituents Sample Collection at the Group 8 MRS

Medium	Sample Type	Sample Depth (feet bgs)	No. of Samples[1]	Rationale
Surface Soil	ISM	0–0.5	4	To characterize for potential MC released during OB activities on the ground surface at the MRS.
Subsurface Soil (Burial Trenches)	ISM	4.0–4.5	3	To characterize for potential MC beneath concentrated MD in burial trenches at the MRS.

[1] Number of samples does not include duplicate or other quality control samples.
bgs denotes below ground surface.
ISM denotes incremental sample methodology.
MC denotes munitions constituent.
MD denotes munitions debris.
MRS denotes munitions response site.
OB denotes open burning.

The methods used for the collection of soil samples during the RI are summarized below. Detailed presentation of the procedures for sample collection is presented in the SAP Addendum (Shaw, 2011). The collection methodology for ISM is presented in the SAP Addendum and is based upon the procedures presented in the *Interim Guidance 09-02, Implementation of Incremental Sampling of Soil for the Military Munitions Response Program* (USACE, 2009b) and the *MMRP Munitions Response Remedial Investigation/Feasibility Study Guidance* (Army, 2009).

3.2.1.1 Surface Soil Sample Collection

The ISM surface soil samples (GR8ss-001M-0001-SO, GR8ss-002M-0001-SO, GR8ss-003M-0001-SO, and GR8ss-004M-0001-SO) were collected on February 8, 2012. Each sample consisted of 30 increments collected at each of the four sampling units at sample depths of 0 to 0.5 feet (0 to 6 inches) bgs. The increments were collected in a systematic random pattern at each designated sampling unit. The four sampling units combined to make up the decision unit for surface soil.

The 0.5-foot (6-inch) bgs sample interval is considered appropriate in accordance with the *MMRP Munitions Response Remedial Investigation/Feasibility Study Guidance* (Army, 2009) and is the maximum depth that MC released from the historical OB activities on the ground surface would be expected to vertically migrate. The entire length of the soil collected at each of the 0- to 0.5-foot increments within a sampling unit was used to make up each of the ISM samples.

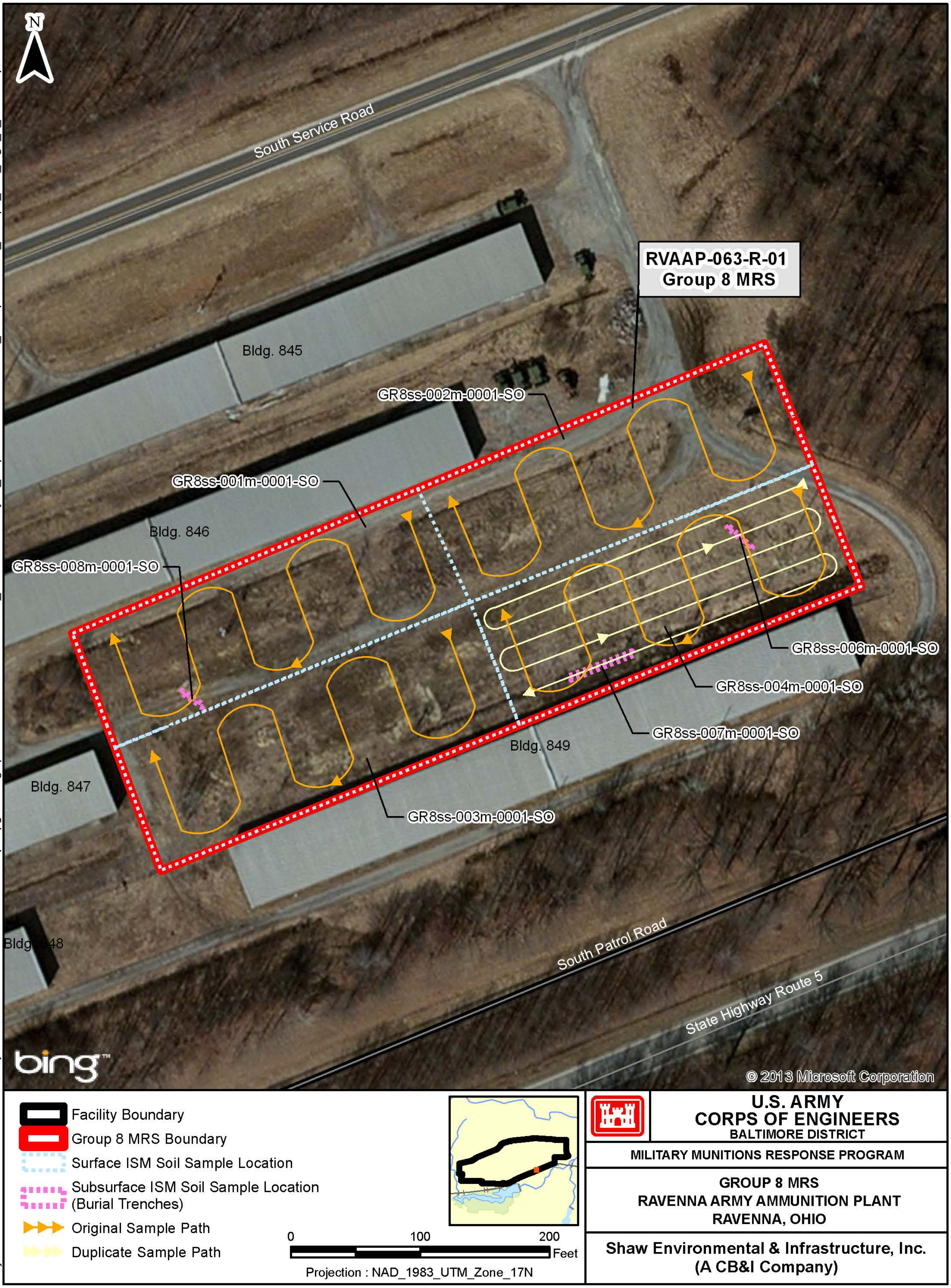
The ISM surface soil samples were collected in accordance with the Work Plan Addendum (Shaw, 2011), and there were no deviations during the RI field activities. The combined proposed sampling units cover the entire MRS that is considered the decision unit.

The key steps for collection of a systematic ISM sample 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 nonmetallic pin flags at the corners of each decision unit. The ISM samples were collected from the predetermined number of increment sample locations using a $^{7}/_{8}$-inch 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 and a 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 increments for the field duplicate were collected at randomly selected locations different from the initial sample increments. The field duplicate was labeled with a different sample number (GR8SS-005M-0001-SO) and submitted to the laboratory for processing as a blind field duplicate. Due to sufficient soil volume, additional collection of soil for the MS/MSD was not required and a sample (GR8SS-004M-0001-SO) was designated as the MS/MSD on the chain of custody prior to shipment.

All data and observations at each sample location were recorded in a sampling field log, which is included in **Appendix B**. **Figure 3-1** presents the MC sample locations at the Group 8 MRS.



Project Number: 136147 Generated By: MM Date: 04/02/13 File Path:\\crpbtrpgi01\arcgisprod3\MAMMS\Ravenna\GIS_Documents\Project_Maps\MMRP\RIFS\RIFS_Group8\RVAAP_Group8_005_Fig3_1_SoilSampleLocs.mxd

U.S. ARMY
CORPS OF ENGINEERS
BALTIMORE DISTRICT

MILITARY MUNITIONS RESPONSE PROGRAM

GROUP 8 MRS
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

FIGURE 3-1 MC SAMPLE LOCATIONS

3.2.1.2 Trench Soil Sample Collection

The ISM trench soil samples (GR8ss-006M-0001-SO, GR8ss-007M-001-SO, and GR8ss-008M-0001-SO) were collected on February 8, 2012, from Trenches 13-1, 11-1, and 14-1, respectively. Each sample consisted of 30 increments collected from the bottom of each of the three trenches that were excavated to 4 feet bgs. Each of the trenches was considered as sampling units that were combined to make up the subsurface decision unit. The ISM increments were collected at sample depths of 0 to 0.5 feet (0 to 6 inches) at the bottoms of the trenches. The increments were collected in a systematic random pattern from each designated sampling unit. The sample depths were 4 to 4.5 feet bgs and, although the soil samples in the trenches were collected at the exposed surface at the bottoms of the trenches, the samples were evaluated as subsurface soil samples due to the sample depths at all three trenches being greater than 1 foot bgs.

The 0.5-foot (6-inch) bgs sample interval at the bottom of each trench is considered appropriate in accordance with the *MMRP Munitions Response Remedial Investigation/Feasibility Study Guidance* (Army, 2009) and is the distance that MC released from buried MEC or MD would be expected to vertically migrate. The entire length of the soil collected at each of the 0- to 0.5-foot increments within a sampling unit (i.e., each trench location) was used to make up each of the ISM samples.

The collection of ISM samples from beneath concentrated areas of MEC/MD is considered a deviation from the Work Plan Addendum (Shaw, 2011) since discrete sample were originally proposed; however, the ISM is considered the more applicable approach for providing an estimate of the mean analyte concentration over a sampling unit when possible. The procedures used to collect the ISM trench soil samples were conducted in accordance with the Work Plan Addendum (Shaw, 2011).

The ISM soil samples from the trenches were collected in the same manner as the surface soil ISM samples. The key steps for collection of a systematic ISM sample were: (1) subdivide the bottom of the trench into a uniform grid (i.e., measure 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 ISM trench soil samples were collected from the predetermined number of increment sample locations using a $^{7}/_{8}$-inch 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.

A QC field duplicate sample was also collected along with one of the original trench samples. Therefore, at the ISM sampling unit (i.e., trench bottom) where the field duplicate QC sample was required, an additional ISM sample was collected in a systematic random pattern consisting of 30 increments of soil. The increments were collected at randomly selected locations different from the initial sample increments. The field duplicate was labeled with a different sample number (GR8ss-009M-0001-SO) and submitted to the laboratory for processing as a blind field duplicate.

All data and observations at each sample location were recorded in sampling field logs, each of which are included in **Appendix B**. The ISM soil samples from the bottoms of trenches where MD was found are presented in **Figure 3-1**.

3.2.2 Sample Analysis

Analytical services for chemical samples were provided by CT Laboratories, Inc. (CT Laboratories) of Baraboo, Wisconsin, which is accredited through the DoD Environmental Laboratory Accreditation Program (ELAP) and the National Environmental Laboratory Accreditation Conference. The selection of chemical analyses for surface and subsurface soil at the Group 8 MRS was based on the types of munitions historically identified for the MRS, the potential MC association with those munitions, and the history of burning debris, rubbish, and potentially munitions items which may have utilized waste oils during the burning operations. To date, the munitions items identified at the Group 8 MRS include the antipersonnel fragmentation bomb with HE, the demilitarized 175 mm projectile, and fuzes of unknown types that were considered as potential MEC; although, any munitions item used at the RVAAP may be present at the MRS. 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:

- Metals (aluminum, antimony, barium, cadmium, chromium [total and hexavalent], copper, iron, lead, mercury, strontium and zinc)—Method EPA SW846 6010C
- Explosives—Method EPA SW846 8330B
- Nitrocellulose—Method EPA SW846 9056 Modified
- SVOCs—Method EPA SW846 8270C
- PCBs—Method EPA SW846 8082B
- Total organic carbon (TOC)—Lloyd Kahn Method
- pH—Method EPA SW846 9045D

In addition to the above analyses, the surface soil and subsurface soil samples were also analyzed for geochemical parameters via EPA Method 6010C in order to potentially evaluate natural high metal concentrations and distinguish them from potential contamination. The geochemical parameters analyzed for the Group 8 MRS include calcium, magnesium, and manganese.

For the ISM surface soil, subsurface soil, and duplicate samples, 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 are necessary to reduce fundamental error. The final reduced portions of the ISM field samples were analyzed for metals, explosives, nitrocellulose, SVOCs, and PCBs. The ISM field samples were analyzed for TOC and pH following processing of the sample and prior to grinding. A summary of the number and types of samples collected are presented in **Table 3-2**.

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

Location	Sample Name	Sample Type	Depth (feet bgs)	Analytical Parameters	No. Samples	Field Duplicate
Surface Soil						
Northwest Quadrant	GR8ss-001M-0001-SO	ISM	0–0.5	Metals[1], Geochemical Metals[2], Explosives, Nitrocellulose, SVOCs, PCBs, TOC, pH	1	
Northeast Quadrant	GR8ss-002M-0001-SO				1	
Southwest Quadrant	GR8ss-003M-0001-SO				1	
Southeast Quadrant	GR8ss-004M-0001-SO				1	1
Subsurface Soil (Burial Trenches)						
Trench 13-1	GR8ss-006M-0001-SO	ISM	4.0–4.5	Metals[1], Geochemical Metals[2], Explosives, Nitrocellulose, SVOCs, PCBs, TOC, pH	1	
Trench 11-1	GR8ss-007M-0001-SO				1	
Trench 14-1	GR8ss-008M-0001-SO				1	1

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

[1] *Metals includes analysis for aluminum, antimony, barium, cadmium, chromium (total), hexavalent chromium, total chromium, copper, iron, lead, strontium, mercury, and zinc.*
[2] *Geochemical metals include analysis for calcium, magnesium, and manganese.*
bgs denotes below ground surface.
ISM denotes incremental sampling methodology.
PCB denotes polychlorinated biphenyl.
SVOC denotes semivolatile organic compound.
TOC denotes total organic carbon.
VOC denotes volatile organic compound.

The samples collected were packaged for shipment and dispatched to the contracted analytical laboratory, CT Laboratories, in accordance with the SAP Addendum (Shaw, 2011). A separate signed custody record listing sample numbers and locations 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 were in compliance with applicable U.S. Department of Transportation regulations for environmental samples.

3.2.3 Laboratory Analysis

The soil samples were collected and analyzed according to the FWSAP (SAIC, 2011) and the SAP Addendum (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 Guidance for the *Data Quality Objectives Process* (EPA, 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. 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 Addendum (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 DoD *Quality Systems Manual (QSM) for Environmental Laboratories* (DoD, 2010), EPA SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Analytical Protocols* (EPA, 2007) or as specified in the FWSAP. SW-846 chemical analytical procedures were followed for the analyses of metals, explosives, nitrocellulose, SVOCs, PCBs, pH. TOC was performed using the Lloyd Kahn Method. 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 blank was submitted for analysis along with the field duplicate samples 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 Group 8 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 and groundwater
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	

Shaw 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 Shaw until they are transferred to USACE, Baltimore District and the RVAAP. 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 Shaw 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 (SOPs) in the SAP Addendum (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 Shaw for data validation. CT Laboratories prepared and retained full analytical and QC documentation for the project in electronic storage media (i.e., compact disk), as directed by the analytical methods employed. CT Laboratories provided the following information to Shaw 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, serial dilutions, sample duplicates, and initial and continuing calibration verifications of standards and blanks, surrogates, method blanks, and LCS information

3.2.4 Data Validation

Following receipt of the analytical data packages, Shaw performed data validation on all surface and subsurface soil samples collected from Group 8 MRS (including field duplicates 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 contaminants of concern and calculating risk.

Analytical results were reported by the laboratory in electronic format and were issued to Shaw on compact disc. Data validation was performed to ensure all requested data were received and complete. Data were validated in accordance with specifications outlined in the SAP Addendum (Shaw, 2011), FWSAP (SAIC, 2011), and the *QSM Version 4.2* (DoD, 2010). 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.
- "UJ"—Not detected. The detection limits and quantitation limits are approximate.
- "J"—The reported result is an estimated value.
- "R"—The reported result is rejected.

In addition to assigning qualifiers, the validation process also selected the appropriate result to use when reanalyses 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 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 C**.

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. QA 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 specifications contained and the data were produced, reviewed, and reported by the laboratory in accordance with specifications outlined in the SAP Addendum (Shaw, 2011), FWSAP (SAIC, 2011), the QSM 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 Addendum (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, and equipment 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 C**.

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. The following data quality indicators were measured and QA reviews were performed:

- **General Review—**The EPA guidance entitled, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part A, Interim Final* (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." All project samples were analyzed in one batch sample delivery group (SDG), 89284. 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 the common condition of reported values being below the certainty range of detection (i.e., either less than the method reporting limit and greater than the MDL, or less than three times the MDL, whichever is greater) as well as analytical column confirmation or accuracy recoveries found outside criteria. The holding time criterion was exceeded for hexavalent chromium for sample GR8-RB-01; therefore, was qualified estimated "J" based upon this outlier. Select surrogates were outside criteria for samples GR8-RB-01, G8SS-001M-0001-SO, G8SS-008M-0001-SO, G8SS-009M-0001-SO resulting in "J" or "UJ" estimations. Target compounds 2,4,6-trichlorophenol, 2,4,5-trichlorophenol, 2,4-dinitrophenol, and 4,6-dinitro-2-methylphenol were qualified rejected "R" for the aqueous rinse blank sample GR8-RB-01 because no aqueous LCS recoveries were found in the associated run batch. The solid LCS passed criteria and the aforementioned associated target compounds were nondetect for all field soil samples collected for this RI; therefore, there were no impacts resultant from these outliers. There were no other data rejections (i.e., R-flagged results) as a result 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 50 percent relative percent difference (RPD) for organic parameters and less than or equal to 25 percent RPD for inorganic parameters. Field duplicate pairs, laboratory duplicate pairs, and/or laboratory MSDs were evaluated for the surface soil samples.

  All laboratory duplicate and/or MSD pairs were within RPD criteria limits; therefore, did not warrant further qualification. Blind field duplicate sample pairs G8SS-004M-0001-SO/G8SS-005M-0001-SO and G8SS-008M-0001-SO/G8SS-009M-0001-SO were collected for all parameter groups. All target analytes were within precision criteria for duplicate pair G8SS-008M-0001-SO/G8SS-009M-0001-SO. For the field duplicate pair G8SS-004M-0001-SO/G8SS-005M-0001-SO, acenaphthene, acenaphthylene, anthracene, antimony, barium, benzo(a)anthracene, bis(2-ethylhexyl)phthalate, cadmium, carbazole, copper, di-n-butyl phthalate, fluoranthene, fluorene, mercury, Aroclor-1254, Aroclor-1260, phenanthrene, and pyrene were outside criteria and were qualified estimated "J" for the duplicate pair based upon these outliers (probably resultant from in-homogeneity or matrix effects). For all other parameter groups, all criteria were met for the field duplicates. 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 C**.

- **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.

  All MS/MSD recoveries were within criteria for all parameters. The aqueous LCS recoveries were outside limits for target compounds 2-chlorophenol, 2-nitrophenol, 2,4-dichlorophenol, 2,4,6-trichlorophenol, 2,4,5-trichlorophenol, 2,4-dinitrophenol, and 4,6-dinitro-2-methylphenol. Associated sample GR8-RB-01 was qualified as estimated "UJ" for compounds 2-chlorophenol, 2-nitrophenol, and rejected "R" for 2,4,6-trichlorophenol, 2,4,5-trichlorophenol, 2,4-dinitrophenol, and 4,6-dinitro-2-methylphenol based upon these outliers. The solid LCS passed criteria and the aforementioned rejected target compounds were nondetect for all field soil samples collected for this RI; therefore, there were no resultant impacts from these outliers.

  Select surrogates were outside criteria for samples GR8-RB-01, G8SS-001M-0001-SO, G8SS-008M-0001-SO, and G8SS-009M-0001-SO. Associated compounds were qualified estimated "J" for detections and "UJ" for nondetections based upon these outliers. The method and laboratory blanks, as well as the LCS, had acceptable surrogate recoveries. All other surrogates were within criteria for the soil samples.

  Although some data results were qualified as estimated or were rejected due to the outliers noted, the estimated data are still considered useable (EPA, 1989) and the rejected data had no direct impact on the field soil samples. Further discussion is presented in the *Data Validation Report* in **Appendix C**.

- **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 "U" and considered nondetect at the limit of detection (LOD) or level of contamination, whichever was greater. From the EPA guidance entitled *Risk Assessment Guidance for Superfund, Volume I,* *Human Health Evaluation Manual (Part A)* (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 10 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 5 times (10 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."

The rinsate blank (GR8-RB-01) was analyzed for all scoped parameters and contained trace levels of naphthalene, bis(2-ethylhexyl)phthalate, benzyl alcohol, HMX, and aluminum at concentrations below the LOD. All other target analytes were nondetect (less than or equal to the limit of detection). No samples required qualification based upon these low concentrations. All calibration blanks (metals) were within criteria (i.e. less than LOD) therefore, no data qualification was required.

For batch SDG 89284, bis(2-ethylhexyl)phthalate was detected below the LOD in the associated method blank (MB). The results for bis(2-ethylhexyl)phthalate in the associated soil samples were either not detected or (if detected) were all greater than 10 times the MB results; therefore, no data qualification was required. For all other analytes, all MB criteria (less than LOD) were met. Further discussion is provided in the *Data Validation Report* in **Appendix C**.

- **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.

For this sampling round, the sample collection was performed using Shaw SOPs and the analytical testing was performed using the EPA methodology with the ELAP-accredited laboratory. Sampling protocols were properly followed to assure that samples collected are representative of the media including the field handling protocols (i.e., storage, handling in the field, and shipping) of the collected samples. Sample identification and integrity were maintained (i.e., chain of custody) during this sampling event as determined during data validation. In review of the analytical data, data validation reports, and field records, no significant nonconformances were noted for holding times, QC blanks, accuracy, precision, and completeness evaluations. All analytical data were deemed representative in accordance with EPA Guidance (1989), with no sample or data rejections for the compounds of concern.

A QC field audit was conducted for field sampling activities at the RVAAP in accordance with the Work Plan Addendum (Shaw, 2011). The audit was activity-based and covered ISM surface soil sample collection conducted at the Group 8 MRS in February 2012. The QC field audit results are presented along with the field documentation in **Appendix B**.

Several nonconformances were observed during the QA audit by the Shaw UXOQCS. The noncomformances included not having the sampling 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. 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 UXOQCS 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 UXOQCS 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 which are judged to be usable. The percent completeness criterion is 90 percent. In this data validation review, three categories of completeness quotients are calculated, including the overall sampling completeness, overall analytical completeness, and 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. Five ISM surface soil samples (including a field duplicate sample) and one rinsate blank were intended to be collected and sent to CT Laboratories for analyses in accordance with the Work Plan Addendum (Shaw, 2011). In addition, four ISM soil samples (including a field duplicate sample) were collected from the bottom of trenches where buried MD was encountered during the RI field activities. Excluding rinsate blanks, the overall sampling completeness was 100 percent (or 9 surface and subsurface soil samples collected divided by 9 planned surface and subsurface 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 and subsurface soil samples, field duplicates, and rinse blank resulted in 1,140 useable data points of possible 1,144 data points, resulting in an overall analytical completeness quotient of 99.7 percent for all parameter groups. The completeness statistics were computed as follows:

  – 1,140 represents the total number of accepted analytes as usable data points (no analytes were rejected).

  – 1,144 represents the number of analyzed inputs, which is equal to the total number of analytes for all field samples.

  The rejected data points applied to select SVOCs that were resultant from very low surrogate recoveries (i.e. less than 10 percent) for the rinse blank sample GR8-RB-01. The SVOC completeness was 666 useable data points of possible

670 data points, resulting in an overall analytical completeness quotient of 99.4 percent. There were no rejected data points for any of the parameters for explosives, metals, hexavalent chromium, trivalent chromium, PCBs, TOC, pH, 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 C**.

- **Comparability—**Comparability is the confidence with which one data set can be compared to another. Comparability was controlled through the use of 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 Addendum (Shaw, 2011) using cited EPA methodology. Where applicable, the EPA-approved methods and QSM, Version 4.2 (DoD, 2010) provided the QC criteria guidelines for the analytical methods and the ELAP accrediting body provided the QA oversight. The laboratory adapted its processes accordingly into an applicable working SOP specific to the laboratory's 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 accreditation 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 Addendum (Shaw, 2011) for the RI program was applied to on-site work during the sampling event at the MRS. The field SOPs were followed, as established in the SAP Addendum (Shaw, 2011) to ensure that protocols meet project DQOs. The recorded field documentation provided verification (i.e., field calibration, etc.) 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, LODs, MRLs, etc.) and analyte detections 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. The screening criteria are presented in *Attachment F–Table 12, "Proposed Human Health and Ecological Screening Level for Ravenna Army Ammunition Plant MRSs"* of the Work Plan Addendum (Shaw, 2011). 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.

The Group 8 (RVAAP-063-R-01) MRS data were determined to be of sufficient quality to make informed decisions for the surface and subsurface soil samples collected. Further discussions of data qualifications are provided in the *Data Validation Report* in **Appendix C**.

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 RVAAP contractors' building. In summary, the decontamination procedures consisted of the following:

- Wet the equipment with 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 is 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." Summary of results of the equipment rinsate sample are presented along with the electronic versions of the laboratory data reports in **Appendix D**.

3.4 Investigation-Derived Waste

The investigation-derived waste (IDW) generated during the field activities at the Group 8 MRS consisted of solid waste that included expendable waste debris (personal protective equipment) and equipment decontamination materials. Due to the minimal number of sampling equipment and in an effort to minimize waste generation, the decontamination liquids were applied using hand-held spray bottles and the residual liquids were 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 Addendum (Shaw, 2011). The expendable waste debris and equipment decontamination materials generated was containerized along with similar materials generated from other MRSs and were staged at Building 1036 in accordance with the FWSAP (Shaw, 2011). IDW management, which describes the waste characterization analyses performed; waste characterization screening; and IDW transport and disposal are presented in **Appendix E**.

4.0 REMEDIAL INVESTIGATION RESULTS

This chapter presents a discussion of the results of the RI data that were collected for MEC and MC at the Group 8 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/or MC and subsequently determine the potential hazards and risks posed to likely human and environment 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 F**.

4.1 MEC Investigation Results

The following subsections 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 Group 8 MRS. These efforts included a combination of surface debris removal, visual and DGM surveys, and intrusive investigations at the Group 8 MRS that were conducted in accordance with the Work Plan Addendum (Shaw, 2011).

4.1.1 Visual Survey Results

While no visual surveys were proposed for the MRS, the potential presence of MEC and/or MD on the ground surface was investigated during the geophysical investigation. Complete (100 percent) surface coverage of the MRS was conducted during the RI field activities and no MEC or MD was identified on the ground surface.

4.1.2 Geophysical Survey Results

A total of 2.563 acres of full coverage DGM data were collected at the Group 8 MRS. Data were acquired in all accessible areas of the MRS on line spacing of approximately 2.5 feet and the area surveyed equates to nearly 97 percent coverage over the 2.65 acre MRS. The remaining 0.087 acres could not be investigated due to obstructions consisting of trees, utility poles, and barbed wire fence. The data were processed and interpreted consistent with the Work Plan Addendum (Shaw, 2011).

Evaluation of the data collected during the DGM survey identified 2,690 anomalies that had signal strength greater than or equal to 8 mV (Channel 2) for an average anomaly density of 1,015 anomalies per acre. Three areas were considered to have localized high anomaly densities, which accounted for 1,049 of the 2,690 anomalies. The majority of the high density areas were located south of the gravel roadway. Outside of these high density areas, there were a total of 1,641 anomalies identified for potential investigation. In general, the geophysical data indicate that the anomaly density at the MRS was high and dispersed throughout the MRS with defined localized areas of higher density than found throughout the other areas at the MRS. **Figure 4-1** illustrates the actual DGM survey transects at the MRS during the RI field activities.

Based on the review of the DGM data, the MRS was divided into two distinct areas for anomaly reacquisition and investigation. **Table 4-1** presents the areas where the anomalies were identified, the suspected distribution of anomalies (i.e., segregated or high-density areas), the rationale for the point source anomaly or combined investigation due to high-density areas, and the method of investigation.

Table 4-1
Summary of Proposed Intrusive Investigation Activities

Area at MRS	Anomalies Identified[1]	Proposed Investigation Areas	Investigation Rationale and Proposed Method
3 areas of relatively high anomaly density of varying shape and size distributed throughout the MRS	1,049 clusters of anomalies that represent aggregates of subsurface metal over 3 well-defined regions	3 high density anomaly regions representing the 1,049 cluster of anomalies	3 high-density anomaly regions to be excavated by 14 trenches[2]
Individual target anomalies throughout the remainder of the MRS	1,641 individual target anomalies	272 individual target anomalies[3]	Hand digging at all 272 individual target anomalies

[1] *Based on response of 8 mV (Channel 2) for the EM61-MK2.*
[2] *All trenches to be excavated mechanically.*
[3] *Based on the hypergeometric statistic method presented in Section 3.1.2.2.*
MRS denotes munitions response site.

Figures 4-2 and **4-3** display the results of the EM61-MK2 DGM survey. **Figure 4-2** provides a sensitive color-scale that highlights all individual target anomalies above a signal threshold of 8 mV, while **Figure 4-3** uses a coarse color-scale to delineate the major aggregates of the localized high density areas with increased definition.

Geophysical Quality Control Results

The DGM data were processed and interpreted consistent with the Work Plan Addendum (Shaw, 2011) and the DGM quality metrics were achieved for all data collected, excepting two occurrences. The first occurrence was the exceedance of the DGM quality metric for platform speed due to adverse surface conditions on November 1, 2011; however, the sampling interval for these data achieved the required metric (98 percent of the data collected were to have a sample to sample interval of less than 0.24 meters). The second occurrence was on November 14, 2011, when low-level external noise was noted by the field crew during the morning static test. The noise was attributed to the intermittent operation of

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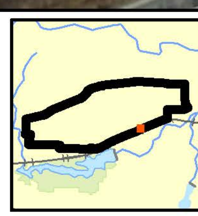
Facility Boundary
Group 8 MRS Boundary
Standing Water Area
DGM Track



0 100 200 Feet

Projection : NAD_1983_UTM_Zone_17N

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FIGURE 4-1 ACTUAL DGM COVERAGE

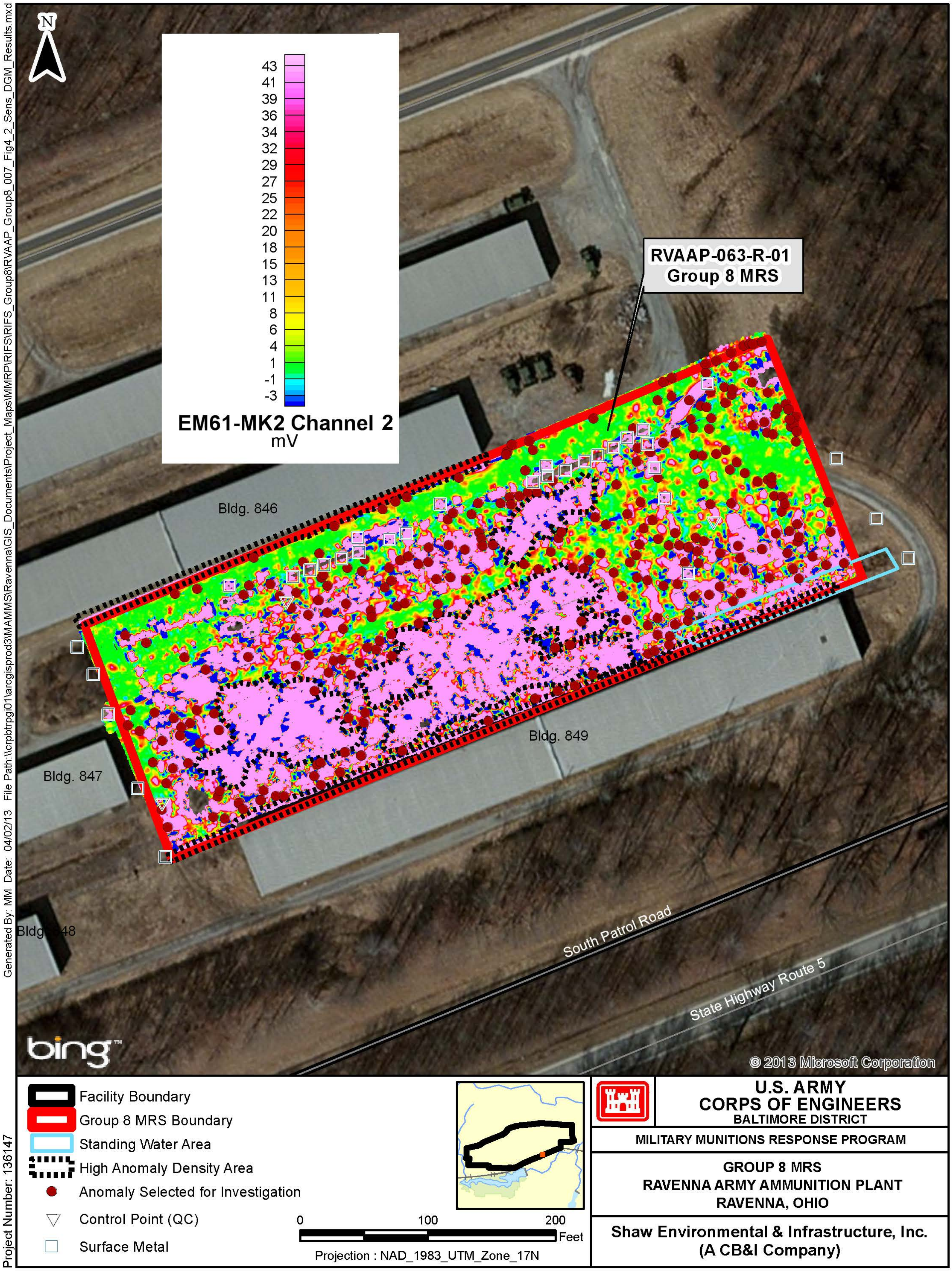
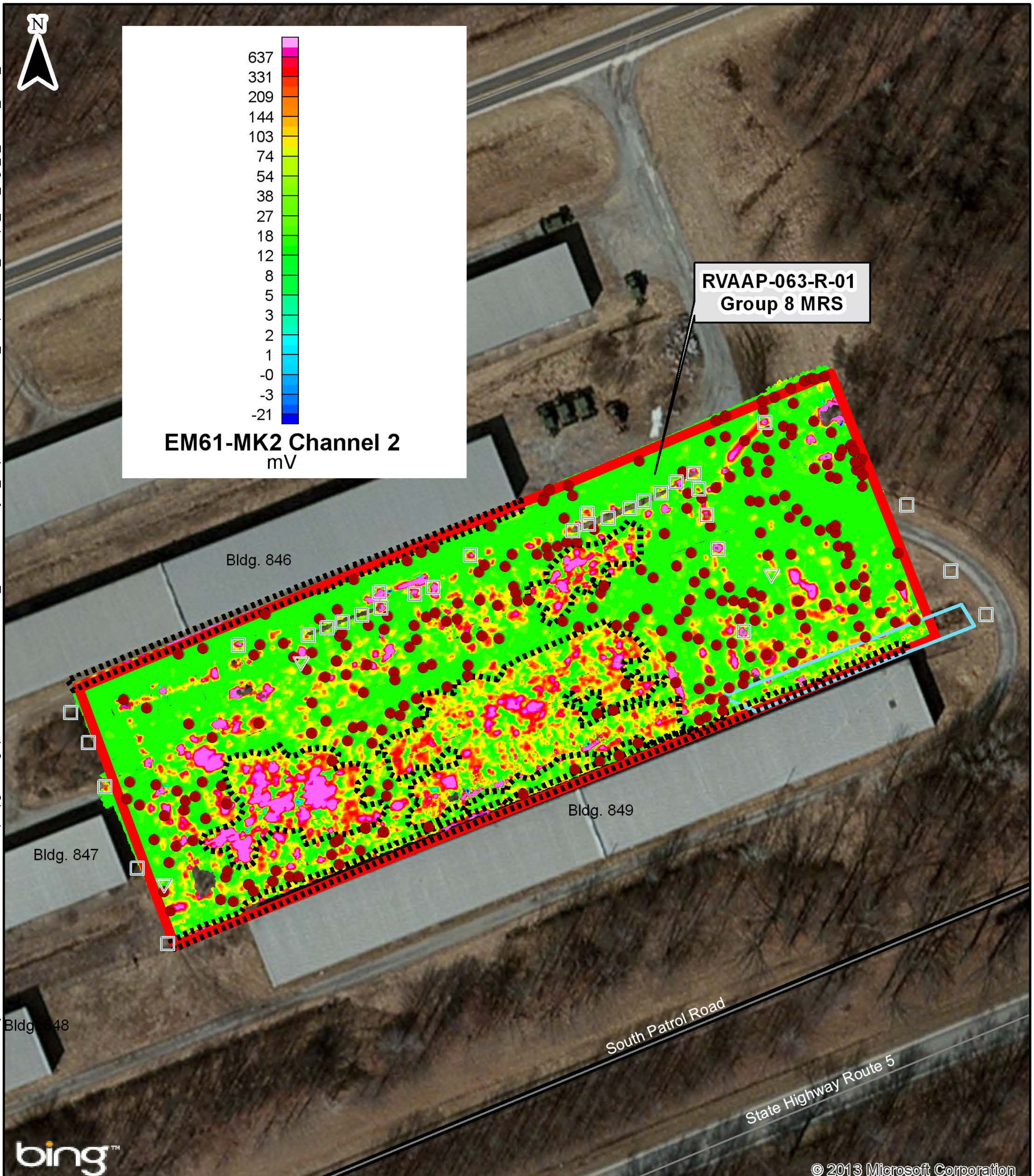


FIGURE 4-2 SENSITIVE COLOR-SCALE DGM RESULTS



Facility Boundary
Group 8 MRS Boundary
Standing Water Area
High Anomaly Density Area
Anomaly Selected for Investigation
Control Point (QC)
Surface Metal

0 100 200 Feet

Projection : NAD_1983_UTM_Zone_17N

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Project Number: 136147

FIGURE 4-3 COARSE COLOR-SCALE DGM RESULTS

electrical equipment in the nearby buildings. The data collected on November 14 represent a very small amount of fill-in data in one of the high anomaly density zones. All the data results were interpreted, including the identified exceptions, and the data quality was considered to be acceptable. Additional discussion regarding the geophysical quality control results is presented in the DGM Report in **Appendix A**.

4.2 Intrusive Investigation Results

This section presents the results of the intrusive investigations performed at the Group 8 MRS based on the DGM survey findings. The individual target anomalies selected for intrusive investigation were excavated by hand. The high-density anomalous areas were investigated using mechanical excavation methods. A summary of the proposed intrusive activities is presented in **Table 4-1**. The results of the intrusive investigation activities are presented in **Figure 4-4**. The investigation results for the intrusive investigation activities are presented in the data sheets in **Appendix G**.

4.2.1 Trench Investigations

No MEC was uncovered during the intrusive activities conducted at the 14 exploratory trench locations. Various types and amounts of MD were uncovered in nine of the trenches at depths ranging from 4 inches to 48 inches bgs. The investigation criteria for trenching were to excavate at a location until the target anomalies were identified; native material was identified and a clear, distinct boundary between the native and fill material was evident; a maximum depth of 10 feet was attained; or the water table was reached. The maximum depth that any of the trenches at the MRS were excavated to was 48 inches bgs, which is the maximum depth that native soils were encountered. Approximately 1,180 pounds (lbs) (277 individual MD items) of MD items were recovered from 9 trenches and 1,281 lbs of “Other Debris” were identified within all 14 trenches. The MD and “Other Debris” quantities were determined by the UXO Teams in the field. All nonmunitions debris was left in place. All MD was managed in accordance with the Work Plan Addendum (Shaw, 2011) and is discussed further in Section 4.2.5. **Table 4-2** summarizes the results at each trench location, the maximum depth attained, a description of MD and “Other Debris” uncovered, and the estimated weight of the debris.

Table 4-2
Trench Investigation Results Summary

Trench Number	Maximum Depth (inches)	Description of MD	Approximate Weight (lbs)	“Other Debris” Description	Approximate Weight (lbs)
01-1	48	NA	0	Scrap metal	350
02-1	48	NA	0	Scrap metal	400

Trench Number	Maximum Depth (inches)	Description of MD	Approximate Weight (lbs)	"Other Debris" Description	Approximate Weight (lbs)
03-1	48	Assorted MD Components	15	Scrap metal	25
04-1	48	Assorted MD Components	8	Scrap metal	25
05-1	12	NA	0	Scrap metal	50
06-1	48	Assorted MD Components	19	Scrap metal	15
07-1	48	¼ of a 40 mm HE M397 series (inert)	1	Scrap metal	50
08-1	48	NA	0	Nails and pipe	65
09-1	12	Assorted fuze adaptors, inert HEAT warhead, expended 60 mm M49 series mortar	29	Scrap metal	51
10-1	12	Expended M84 fuze	1	Scrap metal	100
11-1	48	Assorted MD components, 75 mm M72 series projectile, M532 series fuze, 40 mm cartridge case	1,054.25	NA	0
12-1	48	NA	0	Fence parts and scrap metal	100
13-1	48	Expended M557 series fuze	2	Scrap metal	50
14-1	48	Assorted MD components	50	NA	0
		Total:	**1,179.25**	**---**	**1,281**

HE denotes high explosive.
HEAT denotes high explosive anti-tank.
lbs denotes pounds.
MD denotes munitions debris.
mm denotes millimeter.
NA denotes not applicable.

4.2.2 Individual Target Anomaly Investigations

A total of 272 single point source anomalies were agreed upon for reacquisition as presented in the *DGM Survey Results and Proposed Dig Locations for the Group 8 MRS (RVAAP-063-R-01)* technical memorandum presented as an attachment in **Appendix A**. The dig locations were approved by the USACE Project Geologist and the Ohio EPA Project Manager. Seven of the 272 anomalies could not be reacquired successfully due to significant interference from adjacent buildings. One anomaly (target 1,647) was located beneath a small area of asphalt at the northeast entrance to the MRS and was not intrusively investigated. In all, a

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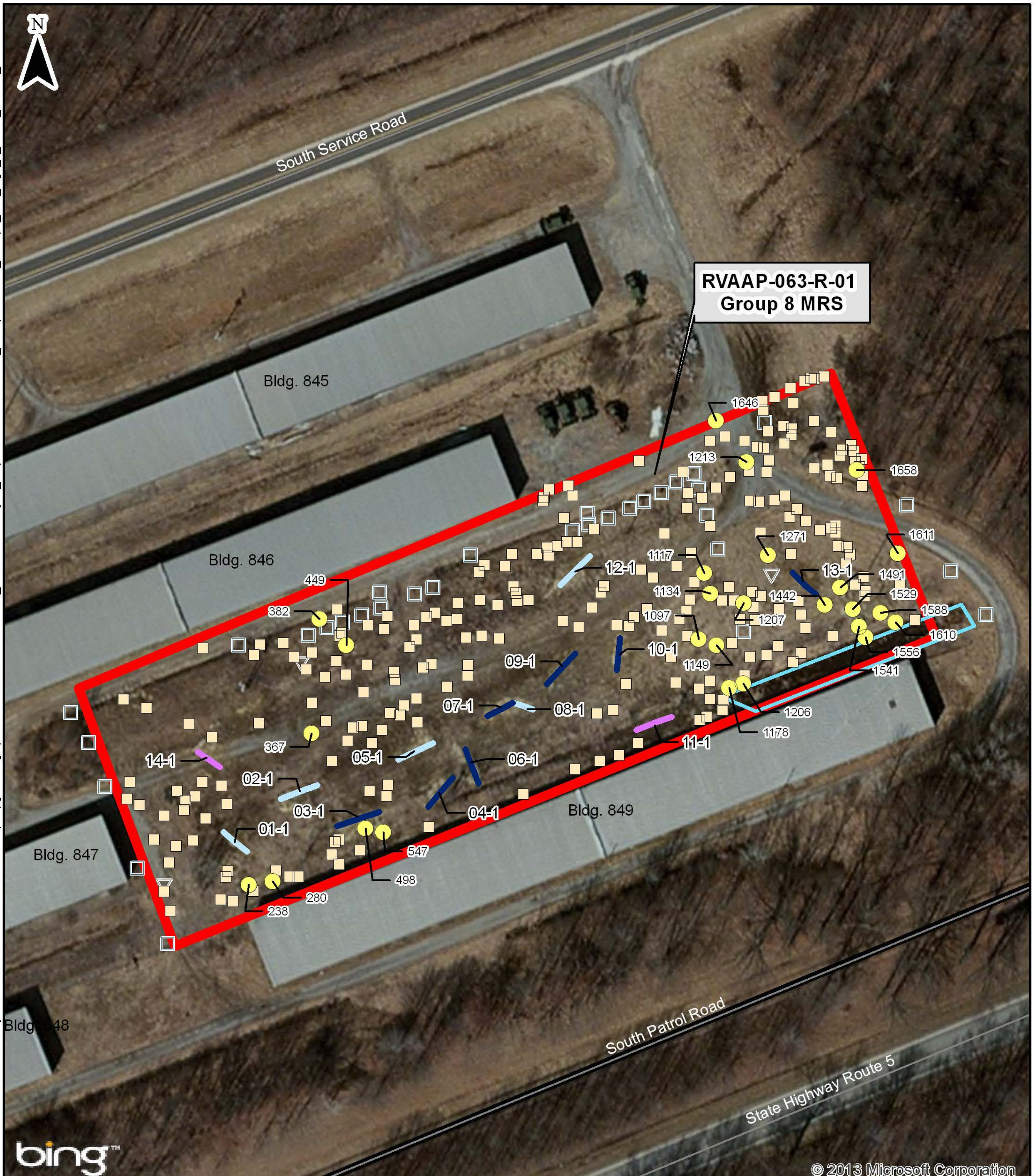

Facility Boundary

Group 8 MRS Boundary

Trench Results: Munitions Debris and Other Debris Identified

Trench Results: Munitions Debris Identified

Trench Results: Other Debris Identified

Standing Water Area

Single Anomaly Results

Munitions Debris

Other Debris

Control Point (QC)

Surface Metal

0 100 200 Feet

Projection : NAD_1983_UTM_Zone_17N

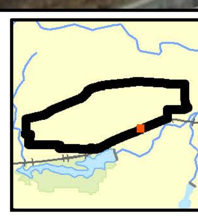

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FIGURE 4-4 SINGLE ANOMALY AND TRENCH INVESTIGATION RESULTS

total of 264 of the 272 proposed anomalies were successfully reacquired during the intrusive investigation.

No MEC was identified at any of the individual anomaly locations. However, 238.5 lbs (82 individual items) of MD were recovered from 26 single point anomaly locations. The depth of the MD encountered at the single point anomaly locations ranged from 1 inch to 36 inches bgs. The MD recovered from the single point anomaly locations was found to be consistent with the types of MD uncovered during the intrusive trench investigation: assorted expended fuzes, 75 mm projectile pieces, 20 mm cartridges, ammunition cans with residue, and miscellaneous unidentified MD components. The remaining 238 single point anomalies were intrusively investigated without an MD discovery. A total of 3,020 lbs of "Other Debris" items were identified during the single point anomaly investigation. All MD was managed in accordance with the Work Plan Addendum (Shaw, 2011) and is discussed further in Section 4.2.5.

Three MD items were encountered along the northeast and east MRS boundaries during the individual target anomaly intrusive investigation activities. Starting at the northernmost anomaly and going clockwise, these items were numbered as targets 1646, 1658, and 1611 and are presented on **Figure 4-4**. In order to evaluate for potential MEC and MD outside of the MRS, step-out, Schonstedt-assisted visual surveys were performed where possible but were not tracked with the global positioning system. Investigation beyond the northeast boundary where target 1646 was found was limited by OHARNG vehicle storage and interference to the Schonstedt magnetometer along the access road due to slag. The step-out surveys along the east boundary were conducted for approximately 50 feet until dense tree and vegetation was encountered. The only anomalies found along the step-outs from the MRS were surface metal debris. No MEC or MD was encountered outside of the MRS boundaries during the Schonstedt-assisted step-out surveys.

4.2.3 Post-Excavation Field Quality Control

A total of 44 anomaly locations were randomly selected for post-excavation QC with the EM61-MK2 following the intrusive investigation in accordance with the Work Plan Addendum (Shaw, 2011). The purpose of the post-excavation QC checks were to perform intrusive anomaly verification to ensure that at a 90 percent confidence, less than 5 percent of the remaining anomalies are "unresolved" (i.e., there is a low probability that a significant item related to MEC is present within the dig locations that were not checked post-excavation). At 42 of the locations, the residual signal from the sensor was less than 4 mV (Channel 2). Two locations (Anomalies 1,550 and 1,556) were classified as trash pits and all of the metal could not be removed. Based on the results of the post-excavation QC, no additional excavation locations were required to be investigated.

4.2.4 Statistical Analysis of Intrusive Results

A statistical approach was used to quantify the intrusive findings of the RI as is discussed in Section 3.1.2.2, "Target List Development for Individual Anomalies." Since no MEC was found during the intrusive investigation and based on the statistical approach used to select the number of anomalies to investigate, there is a 99 percent probability that there is no MEC present in any of remaining 1,369 anomalies that were not investigated during the RI field activities. These results support the DQOs established in the Work Plan Addendum (Shaw, 2011). A summary of the statistical analysis of the intrusive findings is presented in **Appendix H**.

4.2.5 Management and Disposal of Munitions Debris

This section presents the management and disposal practices for the MD items that were encountered during the RI intrusive investigation activities at the Group 8 MRS. In all, a total of 1,418 lbs of MD, as determined by the UXO Team in the field, were recovered during the visual survey and intrusive investigation activities at the MRS. Once items were verified as MD by the UXO Technician, they were placed into 55-gallon steel drums for off-site disposal. The drums were documented as materiel determined as safe and were transported to a designated area, the former Ready Magazine Area (Building 1501) at Open Demolition Area #2 MRS for temporary storage. The drums were labeled as "Scrap Steel" and were shipped off-site for demilitarized disposal at Demil Metals, Inc. in Glencoe, Illinois on May 11, 2012. Waste shipment documentation for MD disposal is presented in **Appendix I** and is inclusive of all MD that was generated by Shaw at the Group 8 MRS and other RVAAP MRSs investigated under the MMRP between September 8, 2011, and May 10, 2012.

4.3 MC Data Evaluation

This section presents the results of the RI data screening process for MC that may be associated with past activities that occurred at the Group 8 MRS and to evaluate the occurrence and distribution of the site-related chemicals (SRCs) in the media sampled. The data evaluated for the Group 8 MRS in this section is inclusive of the results of the RI sampling event only. Analytical data from previous samples collected during the 2007 SI field activities were not included in this evaluation based on the rationale discussed in Section 2.4, "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 MC within the sampled environmental media (surface soil and subsurface soil) established for this RI Report are also presented below. A summary of the complete laboratory analytical results for the RI data and the laboratory data reports are presented in **Appendix D**.

4.3.1 Data Evaluation Method

Data evaluation methods for the Group 8 MRS are consistent with those established in the FWCUG Report (SAIC, 2010). These methods consist of three general steps: (1) define data aggregates; (2) data verification, reduction, and screening; and (3) data presentation.

4.3.1.1 Definition of Aggregates

Samples were grouped (aggregated) at the Group 8 MRS based on the type of environmental sample and consistency in sample type, area, and depth. The data aggregates identified for the MRS included the following:

- **Surface Soil (0 to 0.5 feet bgs)**—This data aggregate consists of four surface soil samples collected using ISM at evenly sized sampling units (0.67 acres each). This medium is evaluated as an MRS-wide aggregate since the surface soil samples cover the entire MRS and the sample units are considered as areas of equally probable anticipated use by likely human and ecological receptors. For consideration of this MC exposure analysis at the Group 8 MRS, the defined exposure unit (EU) for surface soil will be the entire MRS to the 0- to 0.5-foot sample depth.
- **Subsurface Soil (4 to 4.5 feet bgs)—**This data aggregate consists of three subsurface soil samples collected using ISM from the bottom of three trench locations where concentrated areas of MD were encountered during the RI field activities. The three trenches were selected for additional sampling for MC due to the concentrated areas of MD that were encountered, in accordance with the Work Plan Addendum (Shaw, 2011). The trenches were of the approximate same size, with areas ranging from 40 to 156 square feet, and were excavated to similar depths of 48 inches bgs. The trenches were spaced out within the MRS and the medium is evaluated as an MRS-wide aggregate for likely human receptors only since ecological receptors are not typically evaluated for depths greater than 1 foot bgs. For consideration of this MC exposure analysis at the Group 8 MRS, the defined EU for subsurface soil will be to the 4- to 4.5-foot sample depth.

For risk assessment purposes and consideration of MC exposure analysis, 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.” Ecological risk is typically evaluated for samples collected within the 0- to 1-foot surface soil interval; therefore, the subsurface soil aggregate will be used to evaluate for potential risk for human receptors only in Section 7.0.

4.3.1.2 Data Validation

Data validation was performed on all ISM surface and subsurface soil samples collected from the Group 8 MRS (including field duplicates and QC samples) during the RI field activities to ensure 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 data set, as discussed in Section 3.2.4, "Data Validation."

4.3.1.3 Data Reduction and Screening

The data reduction process employed to identify SRCs involves identifying frequency of detection summary statistics, comparison to RVAAP facility-wide background screening values (BSVs) for metals 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 4-5** shows the RVAAP data screening process to identify SRCs and perform selection of 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 four locations (four ISMs) and subsurface soil samples were collected at only three locations (three ISMs), frequency of detection was not utilized for the Group 8 MRS data set.

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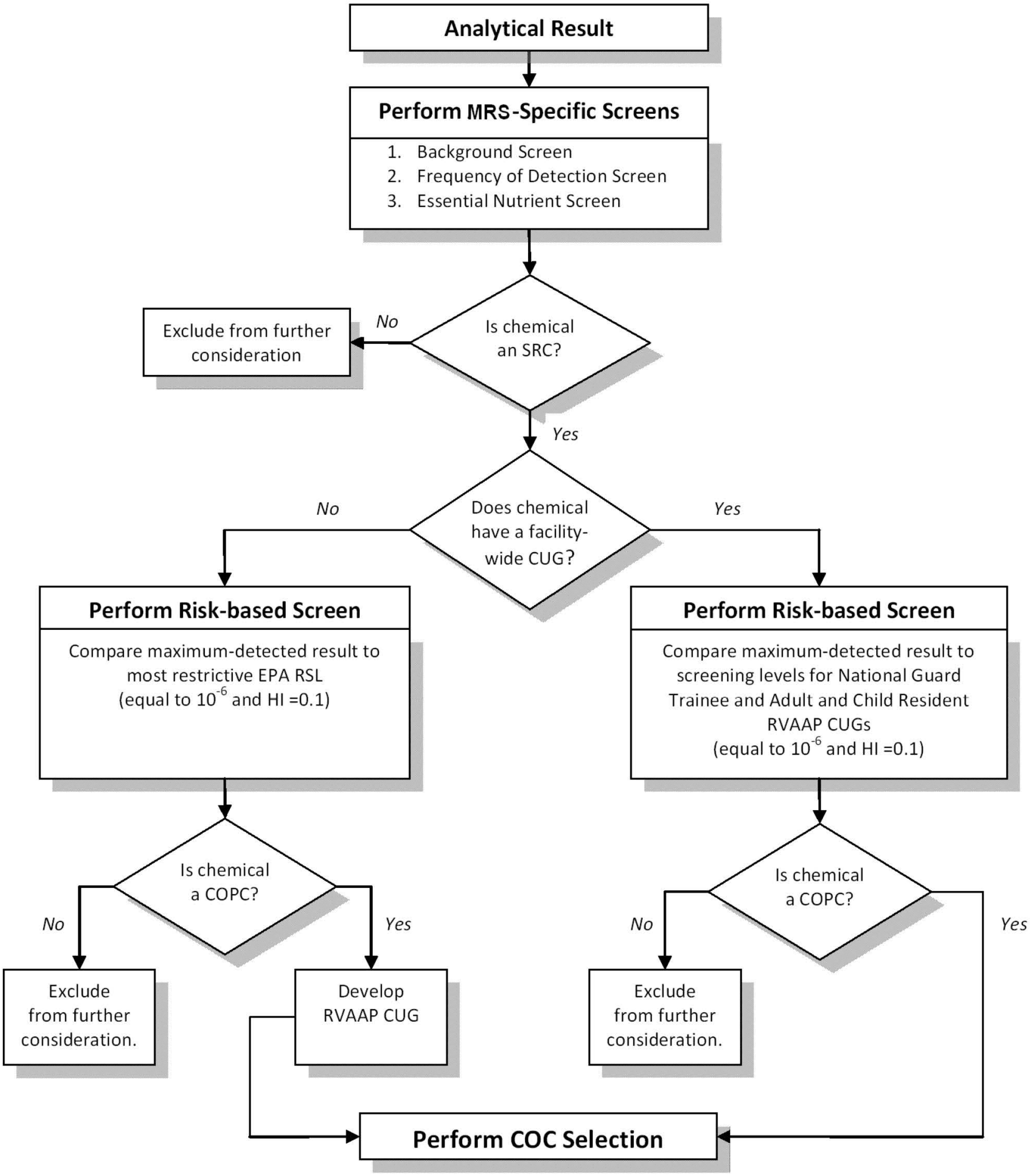

COC = Chemical of Concern
COPC = Chemical of Potential Concern
CUG = Cleanup Goal
EPA = Environmental Protection Agency
HI = Hazard Index
RSL = Regional Screening Level
SRC = Site Related Chemical

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

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FIGURE 4-5 RVAAP DATA SCREENING PROCESS

Facility-Wide Background Screen

For each inorganic constituent, if the maximum detected concentration (MDC) 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 RVAAP MRS being investigated under the MMRP, analyses were conducted for calcium, magnesium, and manganese to be potentially used for geochemical analysis. 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 evaluation is then used to determine if metals are background related or actually developed due to site history. Use of the geochemical evaluation in this manner requires approval from the USACE and the Ohio EPA prior to implementing geochemical evaluation results as a comparison tool for background results. A geochemical analysis was not required for the Group 8 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.

Essential Nutrient Screen

Chemicals that are considered to be 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 site) (USACE, 2005). For the RI field effort, analyses were conducted for calcium, magnesium, and manganese to be used for geochemical analysis, should one be required. These three constituents were eliminated as SRCs in the environmental media since they are not considered as MC associated with the Group 8 MRS. Iron is identified as an MC associated with MEC and MD historically found at the MRS; and therefore, is not eliminated as an essential nutrient.

4.3.1.4 Data Presentation

Data summary statistics for SRCs in surface and subsurface soil collected at the Group 8 MRS are presented for each media evaluated in the following sections. The designated use for Group 8 MRS samples is presented in **Table 4-3**. The SRCs identified for the Group 8 MRS are presented on **Figure 4-6** through **Figure 4-9**, and indicate the extent and magnitude of contamination by highlighting SRCs that exceed the RVAAP BSVs (metals only). The MC identified as SRCs are further evaluated in Section 7.0 and Section 8. The entire analytical data summary for samples collected for the RI is presented in **Appendix D**.

4.3.2 Data Use Evaluation

During the RI field effort surface soil samples were collected at four predetermined ISM sampling units based on the historical information for the Group 8 MRS. Additional subsurface ISM soil samples were collected from trenches where MD was uncovered during the intrusive investigation. 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 contamination, fate and transport, and human and ecological risk assessments. Evaluation of data suitability for use in this RI report involved representativeness with respect to current MRS conditions.

All data from the MRS collected during the 2007 SI were evaluated and it was determined that the samples collected for the RI were more representative of current conditions. Therefore, only the samples collected during the RI field effort were screened for MC considered as SRCs and carried forward into the risk assessment for human health and ecological receptors.

4.4 Nature and Extent of SRCs

This section presents the nature and extent of SRCs within the surface soil and subsurface soil data aggregates evaluated in this RI Report.

4.4.1 Surface Soil

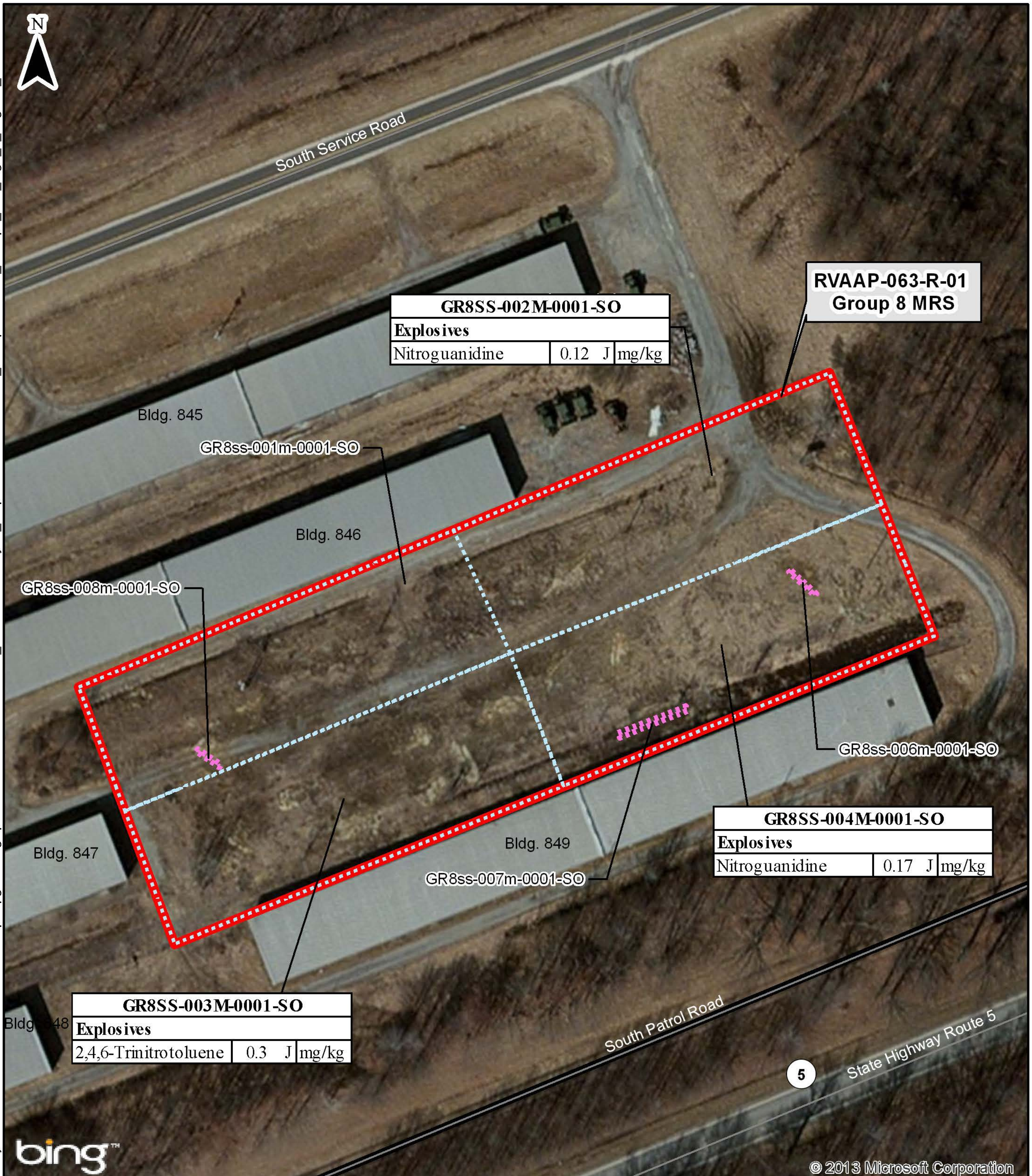
Data from the RI surface soil samples were screened to identify SRCs representing current conditions at the Group 8 MRS. The SRC screening data for surface soil (not including field duplicates or QC samples) included samples G8ss-001M-0001-SO, G8ss-002M-0001-SO, G8ss-003M-0001-SO and G8ss-004M-0001-SO. These samples were collected using the ISM and the sample depth for each increment was from 0 to 0.5 feet bgs.

The ISM samples were collected at grid locations that encompassed the entire MRS and each sample was representative of one quarter of the MRS to characterize the entire MRS for residual MC in surface soils. All ISM surface soil samples collected during the RI sampling event were submitted for laboratory analysis for metals, explosives, nitrocellulose, SVOCs, PCBs, TOC, and pH. Metals analysis consists of inorganic MCs that are attributed to munitions historically used or disposed at an MRS and may be expected to be found at that MRS. For the Group 8 MRS, inorganic MCs identified as metals consist of aluminum,

Table 4-3
Data Use Summary Table for Environmental Samples Collected for the Group 8 MRS

Sample Location ID	Date	Depth (feet bgs)	Sample Type	Data Use Type	Sample Location
Surface Soil					
G8ss-001M-0001-SO	2/8/2012	0–0.5	ISM	N&E, F&T, R	Northwest quadrant of MRS (300- by 95-foot ISM grid)
G8ss-002M-0001-SO	2/8/2012	0–0.5	ISM	N&E, F&T, R	Northeast quadrant of MRS (300- by 95-foot ISM grid)
G8ss-003M-0001-SO	2/8/2012	0–0.5	ISM	N&E, F&T, R	Southwest quadrant (300- by 95-foot ISM grid)
G8ss-004M-0001-SO	2/8/2012	0–0.5	ISM	N&E, F&T, R	Southeast quadrant (300- by 95-foot ISM grid)
Subsurface Soil					
G8ss-006M-0001-SO	2/8/2012	4.0–4.5	ISM	N&E, F&T, R	Trench 13-1, MD uncovered (27- by 2-foot ISM grid)
G8ss-007M-0001-SO	2/8/2012	4.0–4.5	ISM	N&E, F&T, R	Trench 11-1, MD uncovered (52- by 3-foot ISM grid)
G8ss-008M-0001-SO	2/8/2012	4.0–4.5	ISM	N&E, F&T, R	Trench 14-1, MD uncovered (20- by 2-foot ISM grid)

bgs denotes below ground surface.
F&T denotes fate and transport evaluation.
ID denotes identification.
ISM denotes incremental sampling methodology
MD denotes munitions debris.
N&E denotes nature and extent evaluation.
R denotes risk evaluation.



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Facility Boundary
Group 8 MRS Boundary
Surface ISM Soil Sample Location
Subsurface ISM Soil Sample Location

Notes:
1) J = Result is less than reporting limit but greater than or equal to the method detection limit
2) mg/kg = milligrams per kilogram

0 100 200 Feet

Projection : NAD_1983_UTM_Zone_17N

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FIGURE 4-6 MC RESULTS, EXPLOSIVES SRCs

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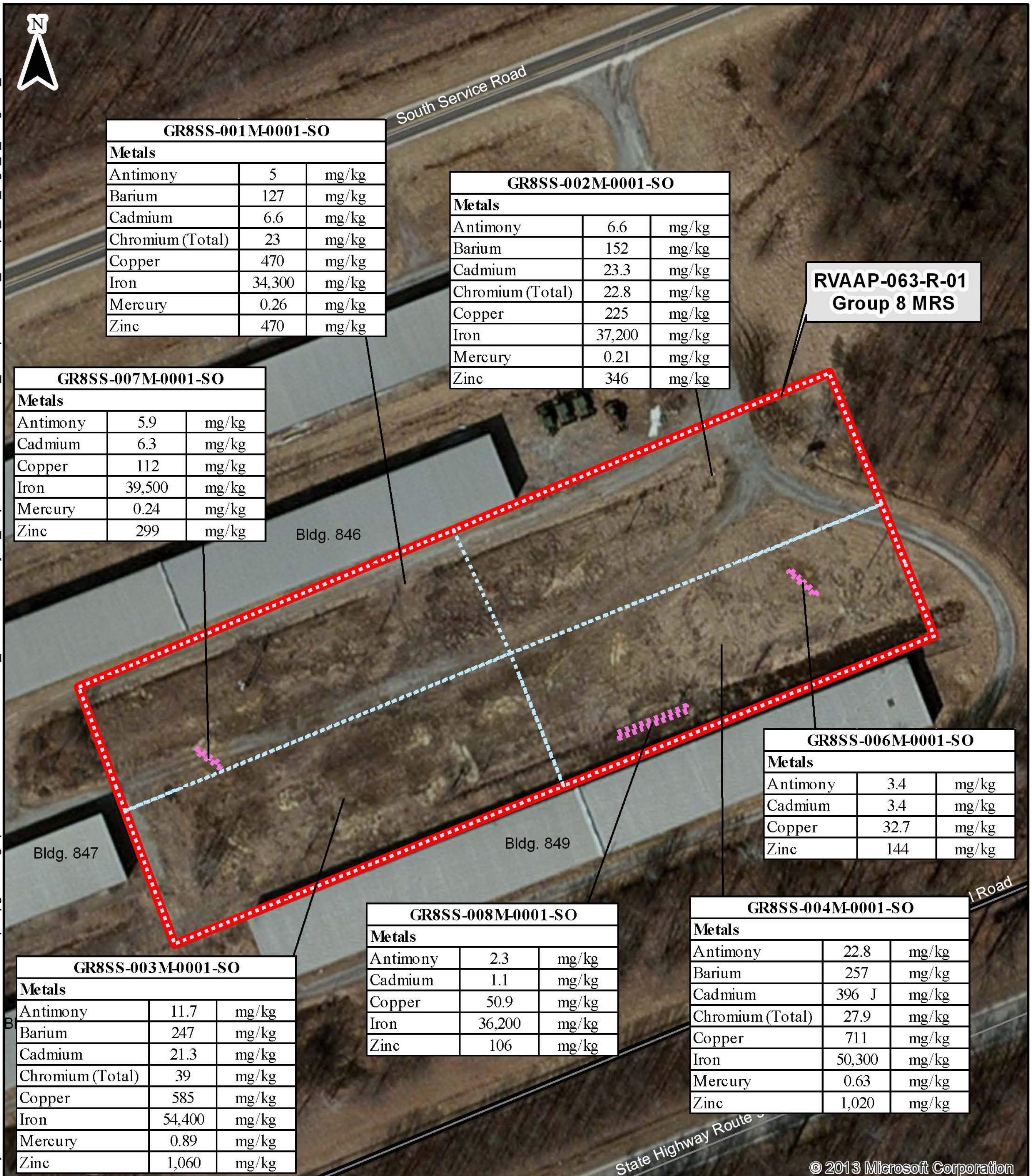


GR8SS-001M-0001-SO		
Metals		
Antimony	5	mg/kg
Barium	127	mg/kg
Cadmium	6.6	mg/kg
Chromium (Total)	23	mg/kg
Copper	470	mg/kg
Iron	34,300	mg/kg
Mercury	0.26	mg/kg
Zinc	470	mg/kg

GR8SS-002M-0001-SO		
Metals		
Antimony	6.6	mg/kg
Barium	152	mg/kg
Cadmium	23.3	mg/kg
Chromium (Total)	22.8	mg/kg
Copper	225	mg/kg
Iron	37,200	mg/kg
Mercury	0.21	mg/kg
Zinc	346	mg/kg

GR8SS-007M-0001-SO		
Metals		
Antimony	5.9	mg/kg
Cadmium	6.3	mg/kg
Copper	112	mg/kg
Iron	39,500	mg/kg
Mercury	0.24	mg/kg
Zinc	299	mg/kg

GR8SS-006M-0001-SO		
Metals		
Antimony	3.4	mg/kg
Cadmium	3.4	mg/kg
Copper	32.7	mg/kg
Zinc	144	mg/kg

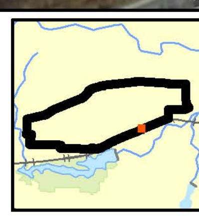
GR8SS-003M-0001-SO		
Metals		
Antimony	11.7	mg/kg
Barium	247	mg/kg
Cadmium	21.3	mg/kg
Chromium (Total)	39	mg/kg
Copper	585	mg/kg
Iron	54,400	mg/kg
Mercury	0.89	mg/kg
Zinc	1,060	mg/kg

GR8SS-008M-0001-SO		
Metals		
Antimony	2.3	mg/kg
Cadmium	1.1	mg/kg
Copper	50.9	mg/kg
Iron	36,200	mg/kg
Zinc	106	mg/kg

GR8SS-004M-0001-SO		
Metals		
Antimony	22.8	mg/kg
Barium	257	mg/kg
Cadmium	396 J	mg/kg
Chromium (Total)	27.9	mg/kg
Copper	711	mg/kg
Iron	50,300	mg/kg
Mercury	0.63	mg/kg
Zinc	1,020	mg/kg

Facility Boundary
Group 8 MRS Boundary
Surface ISM Soil Sample Location
Subsurface ISM Soil Sample Location

Notes:
1) J = Result is less than reporting limit but greater than or equal to the method detection limit
2) mg/kg = milligrams per kilogram



0 100 200 Feet

Projection : NAD_1983_UTM_Zone_17N

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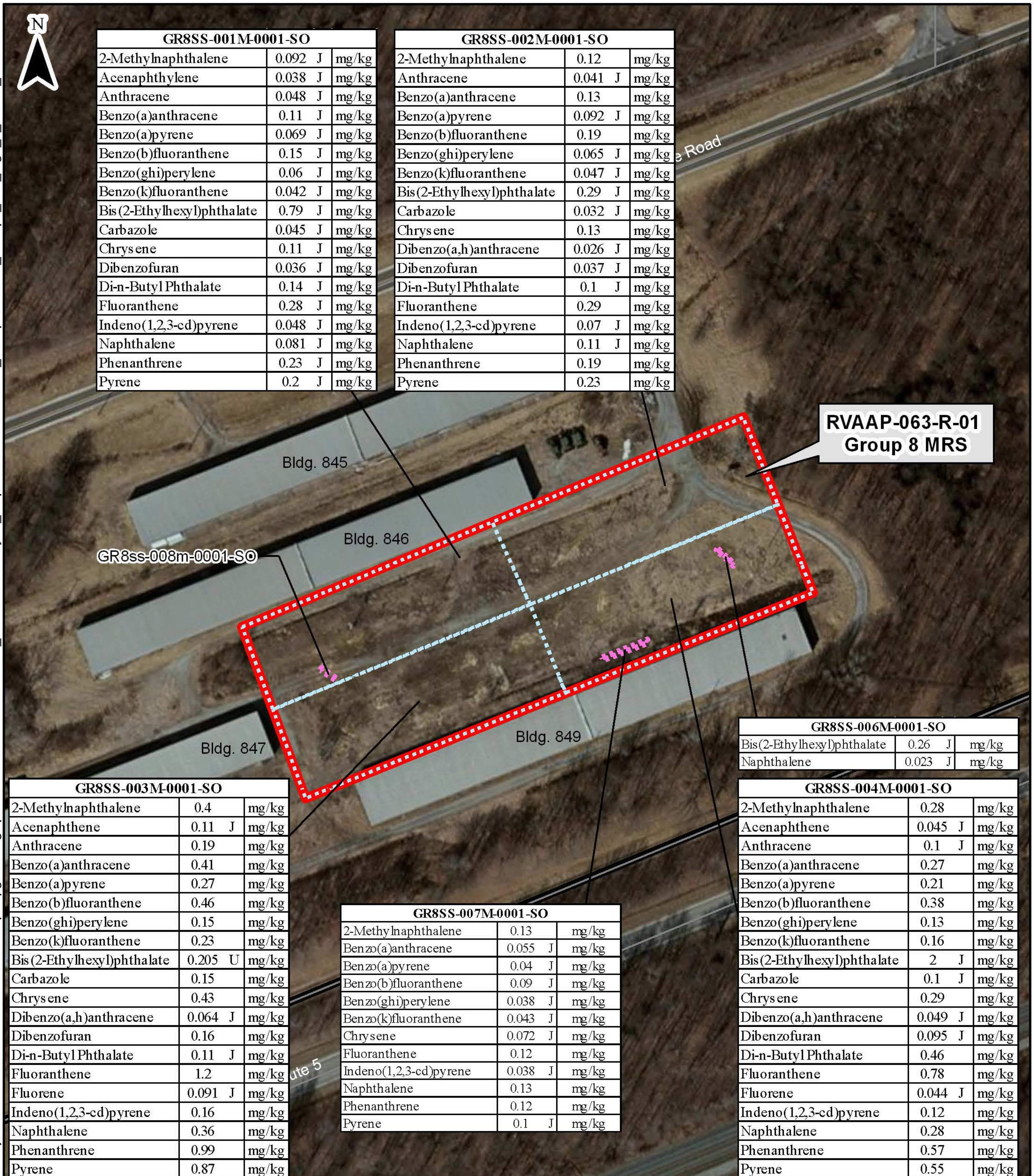
FIGURE 4-7 MC RESULTS, INORGANIC SRCs

Project Number: 136147 Generated By: MM Date: 04/02/13 File Path:\\crpbtrpgi01\arcgisprod3\MAMMS\Ravenna\GIS_Documents\Project_Maps\MMRP\RIFS\RIFS_Group8\RVAAP_Group8_014_Fig4_8_SVOC_Results.mxd



GR8SS-001M-0001-SO			
2-Methylnaphthalene	0.092	J	mg/kg
Acenaphthylene	0.038	J	mg/kg
Anthracene	0.048	J	mg/kg
Benzo(a)anthracene	0.11	J	mg/kg
Benzo(a)pyrene	0.069	J	mg/kg
Benzo(b)fluoranthene	0.15	J	mg/kg
Benzo(ghi)perylene	0.06	J	mg/kg
Benzo(k)fluoranthene	0.042	J	mg/kg
Bis(2-Ethylhexyl)phthalate	0.79	J	mg/kg
Carbazole	0.045	J	mg/kg
Chrysene	0.11	J	mg/kg
Dibenzofuran	0.036	J	mg/kg
Di-n-Butyl Phthalate	0.14	J	mg/kg
Fluoranthene	0.28	J	mg/kg
Indeno(1,2,3-cd)pyrene	0.048	J	mg/kg
Naphthalene	0.081	J	mg/kg
Phenanthrene	0.23	J	mg/kg
Pyrene	0.2	J	mg/kg

GR8SS-002M-0001-SO			
2-Methylnaphthalene	0.12		mg/kg
Anthracene	0.041	J	mg/kg
Benzo(a)anthracene	0.13		mg/kg
Benzo(a)pyrene	0.092	J	mg/kg
Benzo(b)fluoranthene	0.19		mg/kg
Benzo(ghi)perylene	0.065	J	mg/kg
Benzo(k)fluoranthene	0.047	J	mg/kg
Bis(2-Ethylhexyl)phthalate	0.29	J	mg/kg
Carbazole	0.032	J	mg/kg
Chrysene	0.13		mg/kg
Dibenzo(a,h)anthracene	0.026	J	mg/kg
Dibenzofuran	0.037	J	mg/kg
Di-n-Butyl Phthalate	0.1	J	mg/kg
Fluoranthene	0.29		mg/kg
Indeno(1,2,3-cd)pyrene	0.07	J	mg/kg
Naphthalene	0.11	J	mg/kg
Phenanthrene	0.19		mg/kg
Pyrene	0.23		mg/kg

GR8SS-006M-0001-SO			
Bis(2-Ethylhexyl)phthalate	0.26	J	mg/kg
Naphthalene	0.023	J	mg/kg

GR8SS-003M-0001-SO			
2-Methylnaphthalene	0.4		mg/kg
Acenaphthene	0.11	J	mg/kg
Anthracene	0.19		mg/kg
Benzo(a)anthracene	0.41		mg/kg
Benzo(a)pyrene	0.27		mg/kg
Benzo(b)fluoranthene	0.46		mg/kg
Benzo(ghi)perylene	0.15		mg/kg
Benzo(k)fluoranthene	0.23		mg/kg
Bis(2-Ethylhexyl)phthalate	0.205	U	mg/kg
Carbazole	0.15		mg/kg
Chrysene	0.43		mg/kg
Dibenzo(a,h)anthracene	0.064	J	mg/kg
Dibenzofuran	0.16		mg/kg
Di-n-Butyl Phthalate	0.11	J	mg/kg
Fluoranthene	1.2		mg/kg
Fluorene	0.091	J	mg/kg
Indeno(1,2,3-cd)pyrene	0.16		mg/kg
Naphthalene	0.36		mg/kg
Phenanthrene	0.99		mg/kg
Pyrene	0.87		mg/kg

GR8SS-007M-0001-SO			
2-Methylnaphthalene	0.13		mg/kg
Benzo(a)anthracene	0.055	J	mg/kg
Benzo(a)pyrene	0.04	J	mg/kg
Benzo(b)fluoranthene	0.09	J	mg/kg
Benzo(ghi)perylene	0.038	J	mg/kg
Benzo(k)fluoranthene	0.043	J	mg/kg
Chrysene	0.072	J	mg/kg
Fluoranthene	0.12		mg/kg
Indeno(1,2,3-cd)pyrene	0.038	J	mg/kg
Naphthalene	0.13		mg/kg
Phenanthrene	0.12		mg/kg
Pyrene	0.1	J	mg/kg

GR8SS-004M-0001-SO			
2-Methylnaphthalene	0.28		mg/kg
Acenaphthene	0.045	J	mg/kg
Anthracene	0.1	J	mg/kg
Benzo(a)anthracene	0.27		mg/kg
Benzo(a)pyrene	0.21		mg/kg
Benzo(b)fluoranthene	0.38		mg/kg
Benzo(ghi)perylene	0.13		mg/kg
Benzo(k)fluoranthene	0.16		mg/kg
Bis(2-Ethylhexyl)phthalate	2	J	mg/kg
Carbazole	0.1	J	mg/kg
Chrysene	0.29		mg/kg
Dibenzo(a,h)anthracene	0.049	J	mg/kg
Dibenzofuran	0.095	J	mg/kg
Di-n-Butyl Phthalate	0.46		mg/kg
Fluoranthene	0.78		mg/kg
Fluorene	0.044	J	mg/kg
Indeno(1,2,3-cd)pyrene	0.12		mg/kg
Naphthalene	0.28		mg/kg
Phenanthrene	0.57		mg/kg
Pyrene	0.55		mg/kg

Notes:
1) J = Result is less than reporting limit but greater than or equal to the method detection limit
2) U = Not detected or the result is below the detection limit
3) mg/kg = milligrams per kilogram

Projection : NAD_1983_UTM_Zone_17N

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RAVENNA, OHIO

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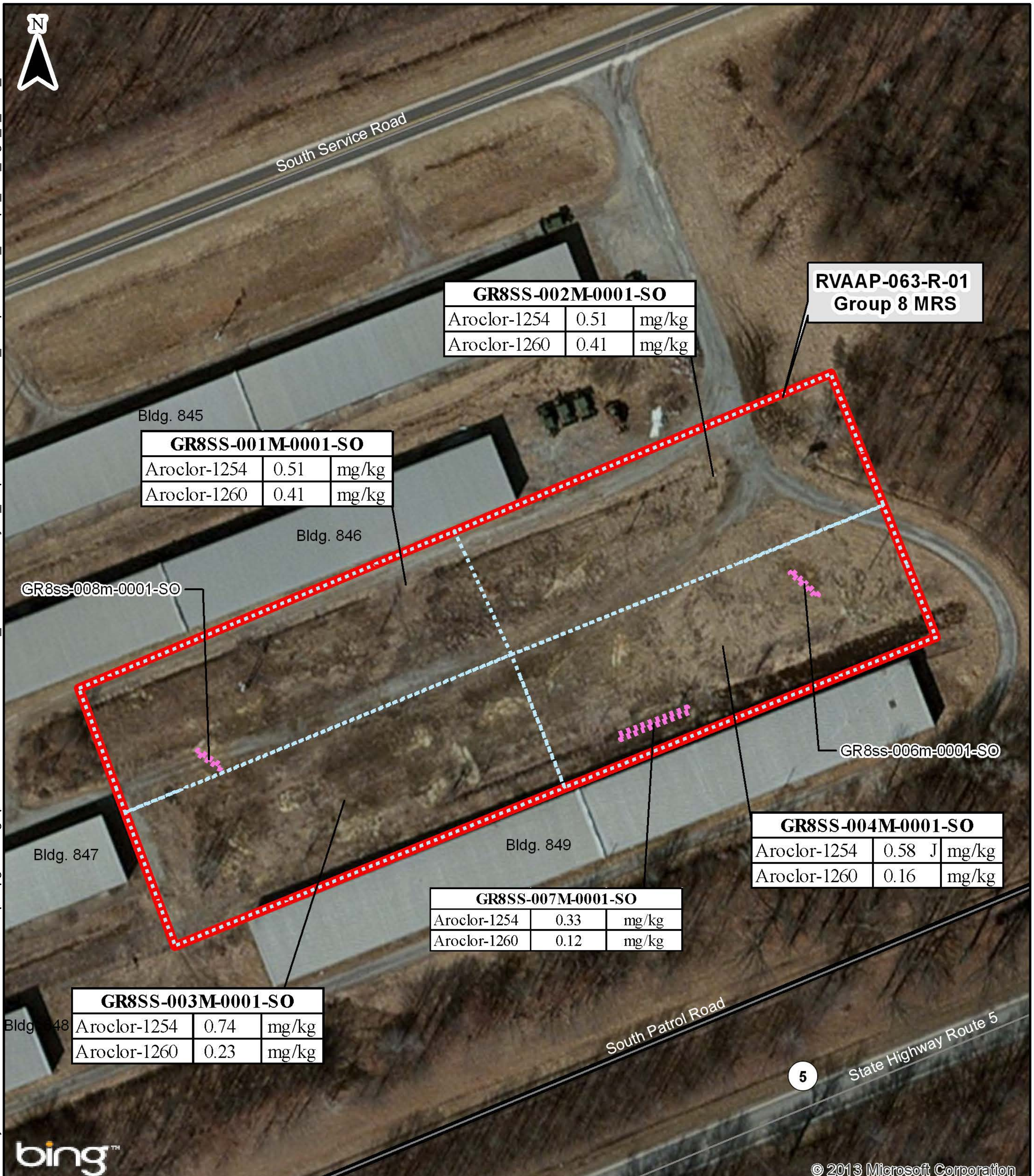
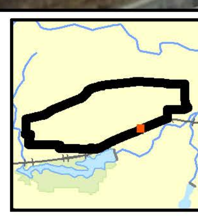
FIGURE 4-8 MC RESULTS, SVOC SRCs



Facility Boundary
Group 8 MRS Boundary
Surface ISM Soil Sample Location
Subsurface ISM Soil Sample Location

Notes:
1) J = Result is less than reporting limit but greater than or equal to the method detection limit
2) mg/kg = milligrams per kilogram



0 100 200 Feet

Projection : NAD_1983_UTM_Zone_17N

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RAVENNA ARMY AMMUNITION PLANT
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Project Number: 136147 Generated By: MM Date: 04/02/13 File Path:\\crpbtrpgi01\arcgisprod3\MAMMS\Ravenna\GIS_Documents\Project_Maps\MMRP\RIFS\RIFS_Group8\RVAAP_Group8_013_Fig4_9_PCB_Results.mxd

FIGURE 4-9 MC RESULTS, PCB SRCs

antimony, barium, cadmium, chromium (total), hexavalent chromium, copper, iron, lead, mercury, strontium, and zinc. Analysis for PCBs and SVOCs, including polycyclic aromatic hydrocarbons (PAHs), were recommended at the Group 8 MRS since these chemicals are potentially associated with waste oils and byproducts may have been used or resulted from the burning operations that occurred at the MRS.

The surface soil samples were also submitted for geochemical parameters that included calcium, magnesium and manganese for the rationale discussed in Section 4.3.1.3, "Data Reduction and Screening." However, since a geochemical analysis was not performed for the MRS, geochemical parameters are not evaluated further in this RI.

Table 4-4 presents the results of the SRC screening for ISM surface soil samples and **Table 4-5** summarizes all of the surface soil sample results. **Figure 4-6** through **Figure 4-9** present the distribution of SRCs in surface soils for the Group 8 MRS. The analytical data summary and laboratory data reports for surface soil are presented in **Appendix D**.

4.4.1.1 Explosives and Propellants

Two explosives, nitroguanidine and TNT, were detected in the ISM surface soil samples. The RVAAP does not have established BSVs for explosives; therefore, both explosives analytes were retained as SRCs in surface soil for the Group 8 MRS. **Figure 4-6** shows the locations where the explosives identified as SRCs were detected at the Group 8 MRS.

Nitroguanidine was detected in two of the ISM surface soil samples, GR8ss-002M-0001-SO and GR8ss-004M-0001-SO, at a maximum concentration of 0.17 J milligrams per kilogram (mg/kg). The "J"-flagged data are considered estimated and are retained as a detected value. The ISM sample GR8ss-002M-0001-SO was collected from the northeast quadrant of the MRS and the ISM sample GR8ss-004M-0001-SO was collected at the southeast quadrant.

The TNT concentration was detected in one ISM surface soil sample, GR8ss-003M-0001-SO, at a concentration of 0.3 J mg/kg. The sample was collected from the southwest quadrant of the MRS.

4.4.1.2 Metals

Ten of the 11 metals considered as MC associated with munitions potentially burned and disposed at the MRS were detected in the ISM surface soil samples. Antimony, barium, chromium, copper, iron, lead, mercury, and zinc were metals with detected concentrations that exceeded the BSVs and are retained as SRCs. Since the analysis results for hexavalent chromium were not detected, the chromium results in surface soil are assumed to consist nearly entirely in its trivalent (Cr^{+3}) form and is compared to the trivalent screening values in the FWCUG Report (SAIC, 2010). Cadmium and strontium were detected and retained as

Table 4-4
SRC Screening Summary for Surface Soil

Analyte	CAS Number	Frequency of Detection	Minimum Detect		Maximum Detect		Mean Result (mg/kg)	BSV[1] (mg/kg)	SRC?	SRC Justification
			Result (mg/kg)	VQ	Result (mg/kg)	VQ				
Metals										
Aluminum	7429-90-5	4/4	11,200		16,300		13,500	*17,700*	No	Below BSV
Antimony	7440-36-0	4/4	5		22.8		11.5	*0.96*	Yes	Above BSV
Barium	7440-39-3	4/4	127		257		196	*88.4*	Yes	Above BSV
Cadmium	7440-43-9	4/4	6.6		396	J	112	*0*	Yes	Above BSV
Chromium (as Cr^{+3})	7440-47-3	4/4	22.8		39		28.2	*17.4*	Yes	Above BSV
Copper	7440-50-8	4/4	225		711		498	*17.7*	Yes	Above BSV
Iron	4739-89-3	4/4	34,300		54,400		44,050	*35,200*	Yes	Above BSV
Lead	7439-92-1	4/4	300		977		664	*26.1*	Yes	Above BSV
Mercury	7439-97-6	4/4	0.21		0.89		0.5	*0.036*	Yes	Above BSV
Strontium	7440-24-6	4/4	48.6		119		92	*0*	Yes	Above BSV
Zinc	7440-66-0	4/4	346		1,060		724	*61.8*	Yes	Above BSV
Explosives and Propellants										
2,4,6-Trinitrotoluene	118-96-7	1/4	0.3	J	0.3	J	0.23	*NA*	Yes	Detected organic
Nitroguanidine	556-88-7	2/4	0.12	J	0.17	J	0.14	*NA*	Yes	Detected organic
Semivolatile Organic Compounds										
2-Methylnaphthalene	91-57-6	4/4	0.092	J	0.40		0.22	*NA*	Yes	Detected organic
Acenaphthene	83-32-9	2/4	0.045		0.11	J	0.07	*NA*	Yes	Detected organic
Acenaphthylene	208-96-8	2/4	0.051		0.051	J	0.051	*NA*	Yes	Detected organic
Anthracene	120-12-7	4/4	0.041	J	0.19		0.09	*NA*	Yes	Detected organic
Benzo(a)anthracene	56-55-3	4/4	0.11	J	0.41		0.23	*NA*	Yes	Detected organic
Benzo(a)pyrene	50-32-8	4/4	0.069	J	0.27		0.16	*NA*	Yes	Detected organic

Analyte	CAS Number	Frequency of Detection	Minimum Detect		Maximum Detect		Mean Result (mg/kg)	BSV[1] (mg/kg)	SRC?	SRC Justification
			Result (mg/kg)	VQ	Result (mg/kg)	VQ				
Benzo(b)fluoranthene	205-99-2	4/4	0.15	J	0.46		0.30	*NA*	Yes	Detected organic
Benzo(ghi)perylene	191-24-2	4/4	0.06	J	0.15		0.06	*NA*	Yes	Detected organic
Benzo(k)fluoranthene	207-08-9	4/4	0.042	J	0.23		0.12	*NA*	Yes	Detected organic
Bis(2-Ethylhexyl)phthalate	117-81-7	3/4	0.29	J	2.0		0.82	*NA*	Yes	Detected organic
Carbazole	86-74-8	4/4	0.032	J	0.15		0.08	*NA*	Yes	Detected organic
Chrysene	218-01-9	4/4	0.11	J	0.43		0.24	*NA*	Yes	Detected organic
Dibenzo(a,h)anthracene	53-70-3	3/4	0.026	J	0.064	J	0.05	*NA*	Yes	Detected organic
Dibenzofuran	132-64-9	4/4	0.036	J	0.16		0.08	*NA*	Yes	Detected organic
Di-n-Butyl Phthalate	84-74-2	4/4	0.10	J	0.46		0.20	*NA*	Yes	Detected organic
Fluoranthene	206-44-0	4/4	0.28	J	1.2		0.64	*NA*	Yes	Detected organic
Fluorene	86-73-7	2/4	0.044	J	0.091	J	0.06	*NA*	Yes	Detected organic
Indeno(1,2,3-cd)pyrene	193-39-5	4/4	0.048	J	0.16		0.10	*NA*	Yes	Detected organic
Naphthalene	91-20-3	4/4	0.081	J	0.36		0.21	*NA*	Yes	Detected organic
Phenanthrene	85-01-8	4/4	0.19		0.99		0.50	*NA*	Yes	Detected organic
Pyrene	129-00-0	4/4	0.20	J	0.87		0.46	*NA*	Yes	Detected organic
Polychlorinated Biphenyls										
Aroclor-1254	11097-69-1	4/4	0.30		0.74		0.53	*NA*	Yes	Detected organic
Aroclor-1260	11096-82-5	4/4	0.15		0.41		0.24	*NA*	Yes	Detected organic

[1] Background values as presented in the Final Facility-Wide Human Health Cleanup Goals at the RVAAP, Ravenna, Ohio (SAIC, 2010).
BSV denotes background screening value.
CAS denotes Chemical Abstracts Service.
Cr^{+3} denotes trivalent chromium.
J denotes that 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.
SRC denotes site-related chemical.
VQ denotes validation qualifier.

Table 4-5
Summary of Surface Soil Results

	Location ID:	GR8SS-001M		GR8SS-002M		GR8SS-003M		GR8SS-004M	
	Sample ID:	GR8SS-001M-001-SO		GR8SS-002M-001-SO		GR8SS-003M-001-SO		GR8SS-004M-001-SO	
	Sample Date:	2/8/12		2/8/12		2/8/12		2/8/12	
	Depth (feet bgs):	0–0.5		0–0.5		0–0.5		0–0.5	
Analyte	BSV[1] (mg/kg)	Result (mg/kg)	VQ	Result (mg/kg)	VQ	Result (mg/kg)	VQ	Result (mg/kg)	VQ
Metals									
Aluminum	*17,700*	11,300		16,300		11,200		15,200	
Antimony	*0.96*	**5**		**6.6**		**11.7**		**22.8**	
Barium	*88.4*	**127**		**152**		**247**		**257**	
Cadmium	*0*	**6.6**		**23.3**		**21.3**		**396**	**J**
Chromium (as Cr^{+3})	*17.4*	**23**		**22.8**		**39**		**27.9**	
Copper	*17.7*	**470**		**225**		**585**		**711**	
Iron	*23,100*	**34,300**		**37,200**		**54,400**		**50,300**	
Lead	*26.1*	**493**		**300**		**977**		**887**	
Mercury	*0.036*	**0.26**		**0.21**		**0.89**		**0.63**	
Strontium	*0*	**48.6**		**75.2**		**119**		**113**	
Zinc	*61.8*	**470**		**346**		**1,060**		**1,020**	
Explosives and Propellants									
1,3,5-Trinitrobenzene	*NA*	<0.25	U	<0.25	U	<0.25	U	<0.25	U
1,3-Dinitrobenzene	*NA*	<0.2	U	<0.2	U	<0.2	U	<0.2	U
2,4,6-Trinitrotoluene	*NA*	<0.2	U	<0.2	U	**0.3**	**J**	<0.2	U
2,4-Dinitrotoluene	*NA*	<0.25	U	<0.25	U	<0.25	U	<0.25	U
2,6-Dinitrotoluene	*NA*	<0.25	U	<0.25	U	<0.25	U	<0.25	U
2-Amino-4,6-Dinitrotoluene	*NA*	<0.2	U	<0.2	U	<0.2	U	<0.2	U

	Location ID:	GR8SS-001M		GR8SS-002M		GR8SS-003M		GR8SS-004M	
	Sample ID:	GR8SS-001M-001-SO		GR8SS-002M-001-SO		GR8SS-003M-001-SO		GR8SS-004M-001-SO	
	Sample Date:	2/8/12		2/8/12		2/8/12		2/8/12	
	Depth (feet bgs):	0–0.5		0–0.5		0–0.5		0–0.5	
Analyte	**BSV[1] (mg/kg)**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**
3,5-Dinitroaniline	*NA*	<0.2	U	<0.2	U	<0.2	U	<0.2	U
4-Amino-2,6-Dinitrotoluene	*NA*	<0.2	U	<0.2	U	<0.2	U	<0.2	U
HMX	*NA*	<0.2	U	<0.2	U	<0.2	U	<0.2	U
m-Nitrotoluene	*NA*	<0.2	U	<0.2	U	<0.2	U	<0.2	U
Nitrobenzene	*NA*	<0.2	U	<0.2	U	<0.2	U	<0.2	U
Nitroglycerin	*NA*	<1	U	<1	U	<1	U	<1	U
Nitroguanidine	*NA*	<0.125	U	**0.12**	**J**	<0.125	U	**0.17**	**J**
o-Nitrotoluene	*NA*	<0.25	U	<0.25	U	<0.25	U	<0.25	U
PETN	*NA*	<1	U	<1	U	<1	U	<1	U
p-Nitrotoluene	*NA*	<0.2	U	<0.2	U	<0.2	U	<0.2	U
RDX	*NA*	<0.25	U	<0.25	U	<0.25	U	<0.25	U
Tetryl	*NA*	<0.2	U	<0.2	U	<0.2	U	<0.2	U
Semivolatile Organic Compounds									
1,2,4-Trichlorobenzene	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U
1,2-Dichlorobenzene	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U
1,3-Dichlorobenzene	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U
1,4-Dichlorobenzene	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U
2,4,5-Trichlorophenol	*NA*	<0.305	U	<0.3	U	<0.305	U	<0.305	U
2,4,6-Trichlorophenol	*NA*	<0.305	U	<0.3	U	<0.305	U	<0.305	U
2,4-Dichlorophenol	*NA*	<0.305	U	<0.3	U	<0.305	U	<0.305	U
2,4-Dimethylphenol	*NA*	<0.305	U	<0.3	U	<0.305	U	<0.305	U

	Location ID:	GR8SS-001M		GR8SS-002M		GR8SS-003M		GR8SS-004M	
	Sample ID:	GR8SS-001M-001-SO		GR8SS-002M-001-SO		GR8SS-003M-001-SO		GR8SS-004M-001-SO	
	Sample Date:	2/8/12		2/8/12		2/8/12		2/8/12	
	Depth (feet bgs):	0–0.5		0–0.5		0–0.5		0–0.5	
Analyte	BSV[1] (mg/kg)	Result (mg/kg)	VQ	Result (mg/kg)	VQ	Result (mg/kg)	VQ	Result (mg/kg)	VQ
2,4-Dinitrophenol	*NA*	<1	U	<1	U	<1	U	<1	U
2-Chloronaphthalene	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U
2-Chlorophenol	*NA*	<1	U	<1	U	<1	U	<1	U
2-Methylnaphthalene	*NA*	**0.092**	**J**	**0.12**		**0.4**		**0.28**	
2-Nitroaniline	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U
2-Nitrophenol	*NA*	<0.5	U	<0.5	U	<0.5	U	<0.5	U
3,3'-Dichlorobenzidine	*NA*	<0.255	UJ	<0.25	U	<0.255	U	<0.255	U
3-Nitroaniline	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U
4,6-Dinitro-2-Methylphenol	*NA*	<0.5	U	<0.5	U	<0.5	U	<0.5	U
4-Bromophenyl Phenyl Ether	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U
4-Chloro-3-Methylphenol	*NA*	<1	U	<1	U	<1	U	<1	U
4-Chloroaniline	*NA*	<0.1	UJ	<0.1	U	<0.1	U	<0.1	U
4-Chlorophenyl Phenyl Ether	*NA*	<0.1	UJ	<0.1	U	<0.1	U	<0.1	U
4-Nitrobenzenamine	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U
4-Nitrophenol	*NA*	<1	U	<1	U	<1	U	<1	U
Acenaphthene	*NA*	<0.06	UJ	<0.06	U	**0.11**	**J**	**0.045**	**J**
Acenaphthylene	*NA*	**0.038**	**J**	<0.06	U	<0.06	U	**0.051**	**J**
Anthracene	*NA*	**0.048**	**J**	**0.041**	**J**	**0.19**		**0.1**	**J**
Benzo(a)anthracene	*NA*	**0.11**	**J**	**0.13**		**0.41**		**0.27**	
Benzo(a)pyrene	*NA*	**0.069**	**J**	**0.092**	**J**	**0.27**		**0.21**	
Benzo(b)fluoranthene	*NA*	**0.15**	**J**	**0.19**		**0.46**		**0.38**	

	Location ID:	GR8SS-001M		GR8SS-002M		GR8SS-003M		GR8SS-004M	
	Sample ID:	GR8SS-001M-001-SO		GR8SS-002M-001-SO		GR8SS-003M-001-SO		GR8SS-004M-001-SO	
	Sample Date:	2/8/12		2/8/12		2/8/12		2/8/12	
	Depth (feet bgs):	0–0.5		0–0.5		0–0.5		0–0.5	
Analyte	BSV[1] (mg/kg)	Result (mg/kg)	VQ	Result (mg/kg)	VQ	Result (mg/kg)	VQ	Result (mg/kg)	VQ
Benzo(ghi)perylene	*NA*	**0.06**	**J**	**0.065**	**J**	**0.15**		**0.13**	
Benzo(k)fluoranthene	*NA*	**0.042**	**J**	**0.047**	**J**	**0.23**		**0.16**	
Benzoic Acid	*NA*	<1.5	U	<1.5	U	<1.5	U	<1.55	U
Benzyl Alcohol	*NA*	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U
Bis(2-Chloroethoxy)methane	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U
Bis(2-Chloroethyl)ether	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U
Bis(2-Chloroisopropyl)ether	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U
Bis(2-Ethylhexyl)phthalate	*NA*	**0.79**	**J**	**0.29**	**J**	<0.205	U	**2**	**J**
Butyl Benzyl Phthalate	*NA*	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U
Carbazole	*NA*	**0.045**	**J**	**0.032**	**J**	**0.15**		**0.1**	**J**
Chrysene	*NA*	**0.11**	**J**	**0.13**		**0.43**		**0.29**	
Cresols (Total)	*NA*	<1.85	U	<1.8	U	<1.8	U	<1.85	U
Dibenzo(a,h)anthracene	*NA*	<0.06	UJ	**0.026**	**J**	**0.064**	**J**	**0.049**	**J**
Dibenzofuran	*NA*	**0.036**	**J**	**0.037**	**J**	**0.16**		**0.095**	**J**
Diethyl Phthalate	*NA*	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U
Dimethyl Phthalate	*NA*	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U
Di-n-Butyl Phthalate	*NA*	**0.14**	**J**	**0.1**	**J**	**0.11**	**J**	**0.46**	
Di-n-Octyl Phthalate	*NA*	<0.1	UJ	<0.1	U	<0.1	U	<0.1	U
Fluoranthene	*NA*	**0.28**	**J**	**0.29**		**1.2**		**0.78**	
Fluorene	*NA*	<0.06	UJ	<0.06	U	**0.091**	**J**	**0.044**	**J**
Hexachlorobenzene	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U

	Location ID:	GR8SS-001M		GR8SS-002M		GR8SS-003M		GR8SS-004M	
	Sample ID:	GR8SS-001M-001-SO		GR8SS-002M-001-SO		GR8SS-003M-001-SO		GR8SS-004M-001-SO	
	Sample Date:	2/8/12		2/8/12		2/8/12		2/8/12	
	Depth (feet bgs):	0–0.5		0–0.5		0–0.5		0–0.5	
Analyte	**BSV[1] (mg/kg)**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**
Hexachlorobutadiene	*NA*	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U
Hexachlorocyclopentadiene	*NA*	<0.1	UJ	<0.1	U	<0.1	U	<0.1	U
Hexachloroethane	*NA*	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U
Indeno(1,2,3-cd)pyrene	*NA*	**0.048**	**J**	**0.07**	**J**	**0.16**		**0.12**	
Isophorone	*NA*	<0.1	UJ	<0.1	U	<0.1	U	<0.1	U
Naphthalene	*NA*	**0.081**	**J**	**0.11**	**J**	**0.36**		**0.28**	
N-Nitroso-di-n-Propylamine	*NA*	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U
N-Nitrosodiphenylamine	*NA*	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U
o-Cresol	*NA*	<1	U	<1	U	<1	U	<1	U
Phenanthrene	*NA*	**0.23**	**J**	**0.19**		**0.99**		**0.57**	
Pyrene	*NA*	**0.2**	**J**	**0.23**		**0.87**		**0.55**	
Polychlorinated Biphenyls									
Aroclor-1016	*NA*	<0.05	U	<0.05	U	<0.1	U	<0.05	U
Aroclor-1221	*NA*	<0.05	U	<0.05	U	<0.1	U	<0.05	U
Aroclor-1232	*NA*	<0.05	U	<0.05	U	<0.1	U	<0.05	U
Aroclor-1242	*NA*	<0.05	U	<0.05	U	<0.1	U	<0.05	U
Aroclor-1248	*NA*	<0.05	U	<0.05	U	<0.1	U	<0.05	U
Aroclor-1254	*NA*	**0.51**		**0.3**		**0.74**		**0.58**	**J**
Aroclor-1260	*NA*	**0.41**		**0.15**		**0.23**		**0.16**	
General Chemistry									
Hexavalent Chromium	*NA*	<4.95	U	<5	U	<5	U	<5	U

	Location ID:	GR8SS-001M		GR8SS-002M		GR8SS-003M		GR8SS-004M	
	Sample ID:	**GR8SS-001M-001-SO**		**GR8SS-002M-001-SO**		**GR8SS-003M-001-SO**		**GR8SS-004M-001-SO**	
	Sample Date:	**2/8/12**		**2/8/12**		**2/8/12**		**2/8/12**	
	Depth (feet bgs):	**0–0.5**		**0–0.5**		**0–0.5**		**0–0.5**	
Analyte	**BSV[1] (mg/kg)**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**
Nitrocellulose	*NA*	<100	U	<100	U	<100	U	<100	U
Total organic carbon	*NA*	47,000		41,000		89,000		64,000	
pH (pH units)	*NA*	7.19		7.92		7.68		8.24	

[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.
Cr^{+3} denotes trivalent chromium.
ID denotes identification.
mg/kg denotes milligrams per kilogram.
NA denotes that a BSV is not available.
TNT denotes 2,4,6-trinitrotolune.
VQ denotes validation qualifier.

Validation Qualifiers:
J denotes the result is less than the reporting limit but greater than or equal to the method detection limit.
UJ denotes result is not detected. The detection limits and quantitation limits are approximate.
U denotes result is not detected or the concentration is below the detection limit.

SRCs since no RVAAP BSV is available for either metal. Concentrations of aluminum were detected in the four surface soil samples but were below the BSV. The distribution of the elevated metal concentrations was uniform across the MRS. All of the identified metal SRCs had detected concentrations that exceeded the BSVs at each of the four ISM surface soil sample locations. **Figure 4-7** shows the locations and distribution of inorganic SRCs detected at the Group 8 MRS.

4.4.1.3 SVOCs

A total of 21 SVOCs, 17 of which are PAHs, were identified as SRCs in the ISM surface soil samples collected at the Group 8 MRS. The sample location with the greatest number of detected SVOCs (21) was in ISM sample GR8ss-004M-0001-SO. This sample was collected at the southeast quadrant of the MRS. The distribution of SVOCs across the MRS was relatively uniform as evidenced by the number of SVOCs that were detected in the other three ISM surface soil samples GR8ss-001M-0001-SO (17 detects), GR8ss-002M-0001-S0 (18 detects), and GR8ss-003M-0001-SO (19 detects). **Figure 4-8** shows the locations where the SVOCs SRCs were detected at the Group 8 MRS.

4.4.1.4 PCBs

Two PCBs consisting of Aroclor-1254 and Aroclor-1260 were detected in all four ISM surface soil samples and were retained as SRCs. The Aroclor-1254 concentrations ranged from 0.3 to 0.74 mg/kg, with the maximum concentration detected at ISM sample location GR8ss-003M-0001M-SO collected at the southwest quadrant of the MRS. The Aroclor-1260 concentrations ranged from 0.15 to 0.41 mg/kg, with the maximum concentration detected at ISM sample location GR8ss-001M-0001-SO that was collected a the northwest quadrant of the MRS. **Figure 4-9** shows the locations where the PCB SRCs were detected at the Group 8 MRS.

4.4.2 Subsurface Soil

Data from the RI subsurface soil samples were screened to identify SRCs representing current conditions at the Group 8 MRS. The SRC screening data for the subsurface soil (not including field duplicates or QC samples) included samples G8ss-006M-0001-SO, G8ss-007M-0001-SO, and G8ss-008M-0001-SO. These samples were collected using the ISM and the sample depth for each increment was from 0 to 0.5 feet at the bottom of trench locations where concentrated MD was encountered during the RI field activities. The total depth beneath the ground surface at which the ISM samples were collected within the trenches was 4 to 4.5 feet bgs and represents the subsurface medium.

The ISM subsurface samples were collected at grid locations that encompassed the entire bottom of each trench that was sampled to characterize the subsurface soils for residual MC associated with the buried MD. All ISM subsurface soil samples collected during the RI sampling event were submitted for the same laboratory analyses as for the ISM surface soil samples that included metals (aluminum, antimony, barium, cadmium, total chromium, hexavalent chromium, copper, iron, lead, mercury, strontium, and zinc), explosives, nitrocellulose, SVOCs, PCBs, TOC, and pH.

The subsurface soil samples were also submitted for geochemical parameters that included calcium, magnesium and manganese for the rationale discussed in Section 4.3.1.3. However, since a geochemical analysis was not performed for the MRS, geochemical parameters are not evaluated further in this RI.

Table 4-6 presents the results of the SRCs screening for subsurface soil samples. **Table 4-7** summarizes the subsurface soil sample results. **Figure 4-7** through **Figure 4-9** present the distribution of SRCs in subsurface soils at the trench locations. The analytical data summary and laboratory data reports for subsurface soil are presented in **Appendix D**.

4.4.2.1 Explosives and Propellants

No explosives or propellants were detected in the subsurface soil samples collected from the bottoms of the trenches where buried MD was encountered during the RI field activities at the Group 8 MRS.

4.4.2.2 Metals

Eight of the 11 metals considered as MC associated with munitions potentially burned and disposed at the MRS were detected in the ISM subsurface soil samples. Antimony, copper, iron, lead, mercury, and zinc were metals with detected concentrations that exceeded the BSVs in the subsurface soil samples and are retained as SRCs. Cadmium and strontium were detected and retained as SRCs since no RVAAP BSV is available for either metal. Concentrations of aluminum, barium, and chromium were detected in all three subsurface soil samples, but were below the BSVs. Since the analysis results for hexavalent chromium were not detected, the chromium results in subsurface soil are assumed to consist nearly entirely in its trivalent (Cr^{+3}) form and is compared to the trivalent screening values in the FWCUG Report (SAIC, 2010). The distribution of the elevated metal concentrations was relatively uniform across the bottoms of the trenches. All of the detected results for antimony, cadmium, copper, lead, strontium, and zinc exceeded the BSVs at each of the three trench locations. Iron concentration exceeded its BSV at two sample locations; ISM sample GR8ss-007M-0001-SO collected at Trench 11-1 and ISM sample GR8ss-008M-0001-SO collected at Trench 14-1. Mercury exceeded its BSV in ISM sample GR8ss-007M-0001-SO only. **Figure 4-7** shows the locations and distribution of inorganic SRCs detected in the trenches at the Group 8 MRS.

Table 4-6
SRC Screening Summary for Subsurface Soil

Analyte	CAS Number	Frequency of Detection	Minimum Detect Result (mg/kg)	Minimum Detect VQ	Maximum Detect Results (mg/kg)	Maximum Detect VQ	Mean Result (mg/kg)	BSV[1] (mg/kg)	SRC?	SRC Justification
Metals										
Aluminum	7429-90-5	3/3	10,900		14,500		12,400	*19,500*	No	Below BSV
Antimony	7440-36-0	3/3	2.3		5.9		3.9	*0.96*	Yes	Above BSV
Barium	7440-39-3	3/3	80		113		93	*124*	No	Below BSV
Cadmium	7440-43-9	3/3	1.1		6.3		3.6	*0*	Yes	Above BSV
Chromium (as Cr^{+3})	7440-47-3	3/3	16.1		22.7		19.6	*27.2*	No	Below BSV
Copper	7440-50-8	3/3	32.7		112		65.2	*32.3*	Yes	Above BSV
Iron	4739-89-3	3/3	31,600		39,500		35,767	*35,200*	Yes	Above BSV
Lead	7439-92-1	3/3	44.3		202		127.8	*19.1*	Yes	Above BSV
Mercury	7439-97-6	3/3	0.018		0.24		0.10	*0.044*	Yes	Above BSV
Strontium	7440-24-6	3/3	27.6		43.1		34.2	*0*	Yes	Above BSV
Zinc	7440-66-0	3/3	106		299		183.0	*93.3*	Yes	Above BSV
Semivolatile Organic Compounds										
2-Methylnaphthalene	91-57-6	1/3	0.13		0.13		0.08	*NA*	Yes	Detected organic
Benzo(a)anthracene	56-55-3	1/3	0.055	J	0.055	J	0.055	*NA*	Yes	Detected organic
Benzo(a)pyrene	50-32-8	1/3	0.04	J	0.04	J	0.05	*NA*	Yes	Detected organic
Benzo(b)fluoranthene	205-99-2	1/3	0.09	J	0.09	J	0.07	*NA*	Yes	Detected organic
Benzo(ghi)perylene	191-24-2	1/3	0.038	J	0.038	J	0.032	*NA*	Yes	Detected organic
Benzo(k)fluoranthene	207-08-9	1/3	0.043	J	0.043	J	0.034	*NA*	Yes	Detected organic
Bis(2-Ethylhexyl)phthalate	117-81-7	1/3	0.26	J	0.26	J	0.22	*NA*	Yes	Detected organic
Chrysene	218-01-9	1/3	0.072	J	0.072	J	0.06	*NA*	Yes	Detected organic
Dibenzofuran	132-64-9	1/3	0.039	J	0.039	J	0.05	*NA*	Yes	Detected organic

Analyte	CAS Number	Frequency of Detection	Minimum Detect		Maximum Detect		Mean Result (mg/kg)	BSV[1] (mg/kg)	SRC?	SRC Justification
			Result (mg/kg)	VQ	Results (mg/kg)	VQ				
Fluoranthene	206-44-0	1/3	0.12		0.12		0.08	*NA*	Yes	Detected organic
Indeno(1,2,3-cd)pyrene	193-39-5	1/3	0.038	J	0.038	J	0.05	*NA*	Yes	Detected organic
Naphthalene	91-20-3	2/3	0.023	J	0.13		0.07	*NA*	Yes	Detected organic
Phenanthrene	85-01-8	1/3	0.12		0.12		0.08	*NA*	Yes	Detected organic
Pyrene	129-00-0	1/3	0.1	J	0.1	J	0.07	*NA*	Yes	Detected organic
Polychlorinated Biphenyls										
Aroclor-1254	11097-69-1	1/3	0.33		0.33		0.14	*NA*	Yes	Detected organic
Aroclor-1260	11096-82-5	1/3	0.12		0.12		0.07	*NA*	Yes	Detected organic

[1] *Background values as presented in the* Final Facility-Wide Human Health Cleanup Goals at the RVAAP, Ravenna, Ohio *(SAIC, 2010).*
BSV denotes background screening value.
CAS denotes Chemical Abstracts Service.
Cr^{+3} denotes trivalent chromium.
J denotes that 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.
SRC denotes site-related chemical.
VQ denotes validation qualifier.

Table 4-7
Summary of Subsurface Soil Results

	Location ID:	GR8SS-006M		GR8SS-007M		GR8SS-008M	
	Sample ID:	GR8SS-006M-001-SO		GR8SS-007M-001-SO		GR8SS-008M-001-SO	
	Sample Date:	2/8/12		2/8/12		2/8/12	
	Depth (feet bgs):	4–4.5		4–4.5		4–4.5	
Analyte	BSV[1] (mg/kg)	Result (mg/kg)	VQ	Result (mg/kg)	VQ	Result (mg/kg)	VQ
Metals							
Aluminum	*19,500*	14,500		10,900		11,800	
Antimony	*0.96*	**3.4**		**5.9**		**2.3**	
Barium	*124*	86.3		113		80	
Cadmium	*0*	**3.4**		**6.3**		**1.1**	
Chromium (as Cr^{+3})	*27.2*	20.1		22.7		16.1	
Copper	*32.3*	**32.7**		**112**		**50.9**	
Iron	*35,200*	31,600		**39,500**		**36,200**	
Lead	*19.1*	**125**		**202**		**44.3**	
Mercury	*0.044*	0.041		**0.24**		0.018	
Strontium	*0*	**43.1**		**38.8**		**27.6**	
Zinc	*93.3*	**144**		**299**		**106**	
Explosives and Propellants							
1,3,5-Trinitrobenzene	*NA*	<0.25	U	<0.25	U	<0.25	U
1,3-Dinitrobenzene	*NA*	<0.2	U	<0.2	U	<0.2	U
2,4,6-Trinitrotoluene	*NA*	<0.2	U	<0.2	U	<0.2	U
2,4-Dinitrotoluene	*NA*	<0.25	U	<0.25	U	<0.25	U
2,6-Dinitrotoluene	*NA*	<0.25	U	<0.25	U	<0.25	U
2-Amino-4,6-Dinitrotoluene	*NA*	<0.2	U	<0.2	U	<0.2	U
3,5-Dinitroaniline	*NA*	<0.2	U	<0.2	U	<0.2	U

	Location ID:	GR8SS-006M		GR8SS-007M		GR8SS-008M	
	Sample ID:	**GR8SS-006M-001-SO**		**GR8SS-007M-001-SO**		**GR8SS-008M-001-SO**	
	Sample Date:	**2/8/12**		**2/8/12**		**2/8/12**	
	Depth (feet bgs):	**4–4.5**		**4–4.5**		**4–4.5**	
Analyte	**BSV[1] (mg/kg)**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**
4-Amino-2,6-Dinitrotoluene	*NA*	<0.2	U	<0.2	U	<0.2	U
HMX	*NA*	<0.2	U	<0.2	U	<0.2	U
m-Nitrotoluene	*NA*	<0.2	U	<0.2	U	<0.2	U
Nitrobenzene	*NA*	<0.2	U	<0.2	U	<0.2	U
Nitroglycerin	*NA*	<1	U	<1	U	<1	U
Nitroguanidine	*NA*	<0.125	U	<0.125	U	<0.125	U
o-Nitrotoluene	*NA*	<0.25	U	<0.25	U	<0.25	U
PETN	*NA*	<1	U	<1	U	<1	U
p-Nitrotoluene	*NA*	<0.2	U	<0.2	U	<0.2	U
RDX	*NA*	<0.25	U	<0.25	U	<0.25	U
Tetryl	*NA*	<0.2	U	<0.2	U	<0.2	U
Semivolatile Organic Compounds							
1,2,4-Trichlorobenzene	*NA*	<0.06	U	<0.06	U	<0.06	U
1,2-Dichlorobenzene	*NA*	<0.06	U	<0.06	U	<0.06	U
1,3-Dichlorobenzene	*NA*	<0.06	U	<0.06	U	<0.06	U
1,4-Dichlorobenzene	*NA*	<0.06	U	<0.06	U	<0.06	U
2,4,5-Trichlorophenol	*NA*	<0.305	U	<0.305	U	<0.305	UJ
2,4,6-Trichlorophenol	*NA*	<0.305	U	<0.305	U	<0.305	UJ
2,4-Dichlorophenol	*NA*	<0.305	U	<0.305	U	<0.305	UJ
2,4-Dimethylphenol	*NA*	<0.305	U	<0.305	U	<0.305	UJ
2,4-Dinitrophenol	*NA*	<1	U	<1	U	<1	UJ

Analyte	Location ID:	GR8SS-006M		GR8SS-007M		GR8SS-008M	
	Sample ID:	GR8SS-006M-001-SO		GR8SS-007M-001-SO		GR8SS-008M-001-SO	
	Sample Date:	2/8/12		2/8/12		2/8/12	
	Depth (feet bgs):	4–4.5		4–4.5		4–4.5	
	BSV[1] (mg/kg)	Result (mg/kg)	VQ	Result (mg/kg)	VQ	Result (mg/kg)	VQ
2-Chloronaphthalene	*NA*	<0.06	U	<0.06	U	<0.06	U
2-Chlorophenol	*NA*	<1	U	<1	U	<1	UJ
2-Methylnaphthalene	*NA*	<0.06	U	**0.13**		<0.06	U
2-Nitroaniline	*NA*	<0.06	U	<0.06	U	<0.06	U
2-Nitrophenol	*NA*	<0.5	U	<0.5	U	<0.5	UJ
3,3'-Dichlorobenzidine	*NA*	<0.255	U	<0.255	U	<0.255	U
3-Nitroaniline	*NA*	<0.06	U	<0.06	U	<0.06	U
4,6-Dinitro-2-Methylphenol	*NA*	<0.5	U	<0.5	U	<0.5	UJ
4-Bromophenyl Phenyl Ether	*NA*	<0.06	U	<0.06	U	<0.06	U
4-Chloro-3-Methylphenol	*NA*	<1	U	<1	U	<1	UJ
4-Chloroaniline	*NA*	<0.1	U	<0.1	U	<0.1	U
4-Chlorophenyl Phenyl Ether	*NA*	<0.1	U	<0.1	U	<0.1	U
4-Nitrobenzenamine	*NA*	<0.06	U	<0.06	U	<0.06	U
4-Nitrophenol	*NA*	<1	U	<1	U	<1	UJ
Acenaphthene	*NA*	<0.06	U	<0.06	U	<0.06	U
Acenaphthylene	*NA*	<0.06	U	<0.06	U	<0.06	U
Anthracene	*NA*	<0.06	U	<0.06	U	<0.06	U
Benzo(a)anthracene	*NA*	<0.06	U	**0.055**	**J**	<0.06	U
Benzo(a)pyrene	*NA*	<0.06	U	**0.04**	**J**	<0.06	U
Benzo(b)fluoranthene	*NA*	<0.06	U	**0.09**	**J**	<0.06	U
Benzo(ghi)perylene	*NA*	<0.06	U	**0.038**	**J**	<0.06	U

	Location ID:	GR8SS-006M		GR8SS-007M		GR8SS-008M	
	Sample ID:	GR8SS-006M-001-SO		GR8SS-007M-001-SO		GR8SS-008M-001-SO	
	Sample Date:	2/8/12		2/8/12		2/8/12	
	Depth (feet bgs):	4–4.5		4–4.5		4–4.5	
Analyte	**BSV[1] (mg/kg)**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**
Benzo(k)fluoranthene	*NA*	<0.06	U	**0.043**	**J**	<0.06	U
Benzoic Acid	*NA*	<1.5	U	<1.5	U	<1.5	UJ
Benzyl Alcohol	*NA*	<0.205	U	<0.2	U	<0.205	U
Bis(2-Chloroethoxy)methane	*NA*	<0.06	U	<0.06	U	<0.06	U
Bis(2-Chloroethyl)ether	*NA*	<0.06	U	<0.06	U	<0.06	U
Bis(2-Chloroisopropyl)ether	*NA*	<0.06	U	<0.06	U	<0.06	U
Bis(2-Ethylhexyl)phthalate	*NA*	**0.26**	**J**	<0.2	U	<0.205	U
Butyl Benzyl Phthalate	*NA*	<0.205	U	<0.2	U	<0.205	U
Carbazole	*NA*	<0.06	U	<0.06	U	<0.06	U
Chrysene	*NA*	<0.06	U	**0.072**	**J**	<0.06	U
Cresols (Total)	*NA*	<1.85	U	<1.8	U	<1.85	U
Dibenzo(a,h)anthracene	*NA*	<0.06	U	<0.06	U	<0.06	U
Dibenzofuran	*NA*	<0.06	U	**0.039**	**J**	<0.06	U
Diethyl Phthalate	*NA*	<0.205	U	<0.2	U	<0.205	U
Dimethyl Phthalate	*NA*	<0.205	U	<0.2	U	<0.205	U
Di-n-Butyl Phthalate	*NA*	<0.205	U	<0.2	U	<0.205	U
Di-n-Octyl Phthalate	*NA*	<0.1	U	<0.1	U	<0.1	U
Fluoranthene	*NA*	<0.06	U	**0.12**		<0.06	U
Fluorene	*NA*	<0.06	U	<0.06	U	<0.06	U
Hexachlorobenzene	*NA*	<0.06	U	<0.06	U	<0.06	U
Hexachlorobutadiene	*NA*	<0.205	U	<0.2	U	<0.205	U

	Location ID:	GR8SS-006M		GR8SS-007M		GR8SS-008M	
	Sample ID:	GR8SS-006M-001-SO		GR8SS-007M-001-SO		GR8SS-008M-001-SO	
	Sample Date:	2/8/12		2/8/12		2/8/12	
	Depth (feet bgs):	4–4.5		4–4.5		4–4.5	
Analyte	**BSV[1] (mg/kg)**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**
Hexachlorocyclopentadiene	*NA*	<0.1	U	<0.1	U	<0.1	U
Hexachloroethane	*NA*	<0.06	U	<0.06	U	<0.06	U
Indeno(1,2,3-cd)pyrene	*NA*	<0.06	U	**0.038**	**J**	<0.06	U
Isophorone	*NA*	<0.1	U	<0.1	U	<0.1	U
Naphthalene	*NA*	**0.023**	**J**	**0.13**		<0.06	U
N-Nitroso-di-n-Propylamine	*NA*	<0.205	U	<0.2	U	<0.205	U
N-Nitrosodiphenylamine	*NA*	<0.205	U	<0.2	U	<0.205	U
o-Cresol	*NA*	<1	U	<1	U	<1	U
Phenanthrene	*NA*	<0.06	U	**0.12**		<0.06	U
Pyrene	*NA*	<0.06	U	**0.1**	**J**	<0.06	U
Diethyl Phthalate	*NA*	<0.06	U	<0.06	U	<0.06	U
Dimethyl Phthalate	*NA*	<0.06	U	<0.06	U	<0.06	U
Di-n-Butyl Phthalate	*NA*	<0.06	U	<0.06	U	<0.06	U
Di-n-Octyl Phthalate	*NA*	<0.06	U	<0.06	U	<0.06	U
Fluoranthene	*NA*	<0.305	U	<0.305	U	<0.305	UJ
Fluorene	*NA*	<0.305	U	<0.305	U	<0.305	UJ
Hexachlorobenzene	*NA*	<0.305	U	<0.305	U	<0.305	UJ
Hexachlorobutadiene	*NA*	<0.305	U	<0.305	U	<0.305	UJ
Hexachlorocyclopentadiene	*NA*	<1	U	<1	U	<1	UJ
Hexachloroethane	*NA*	<0.06	U	<0.06	U	<0.06	U
Indeno(1,2,3-cd)pyrene	*NA*	<1	U	<1	U	<1	UJ

	Location ID:	GR8SS-006M		GR8SS-007M		GR8SS-008M	
	Sample ID:	GR8SS-006M-001-SO		GR8SS-007M-001-SO		GR8SS-008M-001-SO	
	Sample Date:	2/8/12		2/8/12		2/8/12	
	Depth (feet bgs):	4–4.5		4–4.5		4–4.5	
Analyte	**BSV[1] (mg/kg)**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**	**Result (mg/kg)**	**VQ**
Isophorone	*NA*	<0.06	U	**0.13**		<0.06	U
Naphthalene	*NA*	<0.06	U	<0.06	U	<0.06	U
N-Nitroso-di-n-Propylamine	*NA*	<0.5	U	<0.5	U	<0.5	UJ
N-Nitrosodiphenylamine	*NA*	<0.255	U	<0.255	U	<0.255	U
o-Cresol	*NA*	<0.06	U	<0.06	U	<0.06	U
Phenanthrene	*NA*	<0.5	U	<0.5	U	<0.5	UJ
Pyrene	*NA*	<0.06	U	<0.06	U	<0.06	U
Polychlorinated Biphenyls							
Aroclor-1016	*NA*	<0.05	U	<0.05	U	<0.05	U
Aroclor-1221	*NA*	<0.05	U	<0.05	U	<0.05	U
Aroclor-1232	*NA*	<0.05	U	<0.05	U	<0.05	U
Aroclor-1242	*NA*	<0.05	U	<0.05	U	<0.05	U
Aroclor-1248	*NA*	<0.05	U	<0.05	U	<0.05	U
Aroclor-1254	*NA*	<0.05	U	**0.33**		<0.05	U
Aroclor-1260	*NA*	<0.05	U	**0.12**		<0.05	U
General Chemistry							
Hexavalent Chromium	*NA*	<5	U	<5	U	<5	U
Nitrocellulose	*NA*	<100	U	<100	U	<100	U
Total organic carbon	*NA*	9,200		23,000		3,300	
pH (pH units)	*NA*	7.09		7.9		7.64	

[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.
Cr^{+3} denotes trivalent chromium.
ID denotes identification.
mg/kg denotes milligrams per kilogram.
NA denotes that a BSV is not available.
VQ denotes validation qualifier.

Validation Qualifiers:
- *J denotes the result is less than the reporting limit but greater than or equal to the method detection limit.*
- *UJ denotes result is not detected. The detection limits and quantitation limits are approximate.*
- *U denotes result is not detected or the concentration is below the detection limit*

4.4.2.3 SVOCs

A total of 14 SVOCs, 12 of which are PAHs, were identified as SRCs in the ISM subsurface soil samples collected at the Group 8 MRS. The subsurface soil sample location with the greatest number of detected SVOCs (13) was in ISM sample GR8ss-007M-0001-SO collected at the bottom of Trench 11-1. Only two SVOCs, bis(2-ethylhexyl)phthalate and naphthalene, were detected in ISM sample GR8ss-006M-0001-SO that was collected at Trench 13-1. This was the only subsurface sample location that bis(2-ethylhexyl)phthalate was detected. No SVOCs were detected in ISM GR8ss-008M-0001-SO that was collected at Trench 14-1. **Figure 4-8** shows the distribution of the SVOCs identified as SRCs in the burial trenches at the Group 8 MRS.

4.4.2.4 PCBs

Two PCBs consisting of Aroclor-1254 and Aroclor-1260 were detected in the ISM subsurface soil sample GR8ss-007M-0001-SO collected at Trench 11-1 and were retained as SRCs. The detected concentrations for Aroclor-1254 and Aroclor-1260 were 0.33 mg/kg and 0.12 mg/kg, respectively. **Figure 4-9** shows the locations and distribution of where the PCB SRCs were detected in the trenches at the Group 8 MRS.

4.4.3 Summary of Nature and Extent of SRCs

This section presents a summary of the nature and extent of SRCs identified in surface and subsurface soils at the Group 8 MRS following the RVAAP data evaluation process.

4.4.3.1 Surface Soil

In general, the majority of the SRCs identified in the surface soil medium evaluated for the nature and extent of SRCs occurred throughout the MRS. A total of 35 SRCs were identified in surface soil that included 21 SVOCs, 10 metals, 2 explosives, and 2 PCB analytes, considered as MC associated with past activities at the MRS. The SRCs were identified in the four ISM surface soil samples that were collected across the MRS from same sized sampling units (0.67 acres each) at similar depths of 0 to 0.5 feet bgs. The spatial distribution of the SRCs, in particular the types of metals and SVOCs, are consistent between the sampling units that make up the decision unit for surface soil.

4.4.3.2 Subsurface Soil

A total of 24 SRCs were identified in the ISM soil samples collected from the bottom of three trenches (Trenches 11-1, 13-1, and 14-1) where buried MD was encountered during the RI field activities. The ISM samples consisted of 0.5-foot increments collected at the bottom of each of the trenches at similar depths of 4 to 4.5 feet bgs and were evaluated as subsurface soil in accordance with the FWCUG Report (SAIC, 2010). These SRCs consisted of 14 SVOCs, 8 metals, and 2 PCB analytes that are considered as MC associated with past activities at the MRS. The spatial distributions of the various metal SRCs are consistent among the three trenches that make up the decision unit for subsurface soil. The SVOC and PCBs SRCs are primarily prevalent at Trench 11-1, where over 1,000 lbs of assorted MD were removed during the RI field activities.

5.0 FATE AND TRANSPORT

This chapter 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. No MEC was found at the Group 8 MRS during the RI field activities; however, numerous types of MD were found at the MRS. The MD items located at or near the surface appeared to have succumbed to oxidation caused by exposure to water and air, which may have released MC to the environment.

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. 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 an 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 environmental media: terrestrial, aquatic, and 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 media 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 eventually may 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 each of the SRCs that may result from potential contaminant sources in the environmental media at the Group 8 MRS. A summary of the SRCs identified in the data aggregates at the Group 8 MRS is as follows:

- **Surface Soils (0 to 0.5 feet bgs)**—TNT, nitroguanidine, antimony, barium, cadmium, chromium, copper, iron, lead, mercury, strontium, zinc, PAHs, bis(2-ethylhexyl)phthalate, carbazole, dibenzofuran, di-n-buytl phthalate, and PCBs
- **Subsurface Soils (4 to 4.5 feet bgs)—**antimony, cadmium, copper, iron, lead, mercury, strontium, zinc, PAHs, bis(2-ethylhexyl)phthalate, dibenzofuran, and PCBs.

The chemicals analyzed for the MRS were agreed upon in the Work Plan Addendum (Shaw, 2011) and were considered as MC associated with the previous activities at the MRS. The physical and chemical properties and potential release mechanisms and routes of migration for each of the SRCs are discussed in the following sections.

5.2.1.1 Explosives

An explosive compound degradation rate is a function of low-temperature kinetics as well as the influence of light, infrared, ultraviolet (UV) radiation, and microbial action. Degradation products such as nitric oxide, nitrogen dioxide, water, nitrogen, acids, aldehydes, ketones, and large fragments of the parent explosive molecule may be formed. Abiotic and microbial degradation rates are a function of temperature, which varies throughout the year. The fate and transport of the explosives identified at the Group 8 MRS are as follows:

- **TNT**—TNT is a munitions compound currently used for commercial and military purposes. TNT is characterized as being insoluble in water. The vapor pressure of TNT is 1.28×10^{-6} mm of mercury (Hg), which indicates that it will not volatilize to the atmosphere. This is further supported by the Henry's law constant, which for TNT is equal to 1.10×10^{-8} atmospheric cubic meters per mole (atm-m^3/mole). The logarithm (log10) of the organic carbon/water partition coefficient (K_{oc}) is 2.48. This value indicates that TNT will tend to sorb to the organic fraction of soil rather than leaching into groundwater or surface water runoff. TNT can be biotransformed, mineralized, or conjugated into higher molecular weight complex products. It has been shown that a reductive pathway exists for biotransformation of TNT (McCormick et al., 1976; Carpenter et al., 1978; Kaplan and Kaplan 1982a–e, 1985; Greene et al., 1985). This pathway has been observed in a number of systems including aqueous, sewage, soil, and compost. Under anoxic conditions, one or more of the nitro groups is reduced through nitroso and hydroylamino intermediates to form aminodinitrotoluenes (2-amino-4,6-dinitrotolune and 4-amino-2,6-dinitrotolune) and diaminonitrotoluenes (2,4-diamino-6-nitrotoluene and 2,6-diamino-4-nitrotoluene). Biodegradation is the most probable degradative process that may occur for TNT in soil at the Group 8 MRS. Research has shown that TNT can be completely biotransformed through a series of successive denitration steps. Complete degradation of these compounds is anticipated at rates that vary as a function of MRS-specific conditions (Walker and Kaplan, 1992).
- **Nitroguanidine—**Nitroguanidine (also called 1-nitroguanidine) is used as an explosive propellant in munitions. 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} atm-m^3/mole based upon its vapor pressure and water solubility. In

aquatic environments, nitroguanidine is not expected to adsorb to suspended solids or sediment, and 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 particulate phase and to be removed from the atmosphere through either wet or dry deposition. As it absorbs light at approximately 260 nanometers (nm) and above, nitroguanidine is susceptible to direct photolysis (National Institute of Standards and Technology Chemistry WebBook, 2010).

5.2.1.2 Metals

Since most metals are indigenous to the earth, they are usually found at varying concentration levels in most environmental media. Some metals concentrate in animal tissue (example, zinc accumulation in fish) while some metals accumulate in plants (example, vanadium). In soil, metal contaminants are dissolved in the soil pore water, adsorbed or ion-exchanged on the surfaces of inorganic soil constituents, complexed with soluble soil organic matter, and precipitated as pure or mixed solids. Metals dissolved in the soil pore water are subject to movement with water and may be transported through the vadose zone to groundwater, and then either volatilized or consumed by plants and aquatic organisms. Unlike organic constituents, metals cannot be degraded; however, the mobility and toxicity of some metals (i.e., arsenic, chromium and mercury) can be altered due to changes in oxidation states. The fate and transport of the metals identified as SRCs at the Group 8 MRS are as follows:

- **Antimony**—Antimony is naturally occurring in the earth's crust. Antimony is sensitive to oxidation/reduction (redox) conditions, and its ability to bind to soil depends on the nature of the soil and the form of antimony. Some studies suggest that antimony is fairly mobile under diverse environmental conditions (Rai et al., 1984), while others suggest that it is strongly adsorbed to soil (Ainsworth, 1988; Foster, 1989; King, 1988). In water, antimony has the capability to undergo photochemical reactions. However, these reactions do not appear to have a significant effect on its aquatic fate (Callahan et al. 1979).
- **Barium**—Barium is a naturally occurring element that is found in small but widely distributed amounts in the earth's crust, especially in igneous rocks, sandstone, shale, and coal (Kunesh, 1978; Miner, 1969). It is an alkaline earth group element, with chemical behavior similar to calcium. Barium enters the environment naturally through the weathering of rocks and minerals. Anthropogenic releases are primarily associated with industrial processes. The element is soluble in low total dissolved solids (TDSs) water, but it will

precipitate with sulfate or carbonate as the minerals barite ($BaSO_4$) or witherite ($BaCO_3$), respectively if those anions are present. These minerals have low solubilities and frequently control barium mobility, especially in higher TDS groundwater. Barium also has a strong affinity to adsorb on manganese oxides as well as iron oxides and clays to a lesser extent. Barium is not very mobile in most soil systems due to its affinity to adsorb on minerals surfaces and its tendency to precipitate as low-solubility sulfate or carbonate minerals. The element does not form volatile compounds in the aquatic environment; therefore, partitioning from water into the atmosphere doesn't occur (EPA, 1979).

- **Cadmium**—Cadmium is naturally occurring in the earth's crust. Cadmium may travel through soil. However the mobility of cadmium is strongly influenced by the soil pH and amount of organic matter. In general, cadmium tends to bind strongly to organic matter and clay minerals. and can be taken up by plants. However, cadmium may leach into water under acidic conditions where adsorption is minimized (Elinder, 1985; EPA, 1979). Cadmium is considered more mobile than other heavy metals in aquatic environments. Under varying ambient conditions of pH, salinity, and redox potential, cadmium may redissolve from sediments (U.S. Department of the Interior, 1985; EPA, 1979; Feijtel et al., 1988; Muntau and Baudo, 1992). The element does not form volatile compounds in the aquatic environment; therefore, partitioning from water into the atmosphere doesn't occur (EPA, 1979).

- **Chromium**—Chromium exists in two valence states in the environment: trivalent (Cr^{+3}) and hexavalent (Cr^{+6}). Typically, trivalent chromium in an aqueous environment is associated with particles, while hexavalent chromium remains in solution. Trivalent chromium is the most thermodynamically stable form of chromium under common environmental conditions. Trivalent chromium has a low solubility and a strong tendency to adsorb to negatively charged soil clay particles. As a result, trivalent chromium is generally immobile and remains close to the origin of deposition. Hexavalent chromium occurs in the environment as the negatively charged species chromate (CrO_4^{-2}) or dichromate ($Cr_2O_7^{-2}$), which are highly soluble and have a low affinity to adsorb on mineral surfaces. As a result, hexavalent chromium tends to be mobile in the environment. Hexavalent chromium will reduce to the trivalent state if it encounters strongly reducing conditions. This process will immobilize the chromium (EPA, 1998).

- **Copper**—Copper is strongly sorbed by soil particles (i.e., clays, metal oxides, and organic matter). Copper binds to soil much more strongly than other divalent cations, and the distribution of copper in the soil solution is less affected by pH than other metals (Gerritse and Van Driel, 1984). The adsorption of copper generally increases with increasing pH. Like other heavy metals, the movement of copper in soil is also influenced by the permeability of the soil and the amount of clay and iron oxides that are present. These factors tend to attenuate the mobility of copper through adsorption and cation exchange. Volatilization of copper happens to a slight degree, but is insignificant relative to other processes that aid in the reduction of copper concentrations. It sorbs significantly to suspended organic materials and bed sediments, thus reducing its mobility. Much of copper discharged to waterways is in particulate matter and settles out; precipitates out; or adsorbs to organic matter, hydrous iron and manganese oxides, and clay in sediment or in the water column. A significant fraction of the copper is adsorbed within the first hour, and in most cases, equilibrium is obtained with 24 hours (Harrison and Bishop, 1984).

- **Iron**—The redox state of the environment has the greatest influence on the fate and transport of iron. Iron naturally occurs in the environment in two oxidation states: ferrous iron (Fe^{+2}) and ferric iron (Fe^{+3}). Ferric iron is commonly present in oxic soils as iron oxides and hydroxides, which are present as discrete minerals or as coatings on the surfaces of other minerals (Kabata-Pendias, 2001). Iron oxides are relatively insoluble in oxic soils under circumneutral pH conditions and are soluble only under very low pH (below about 4) or high pH (above about 11) (Langmuir et al., 2004). The physical transport of ferric iron occurs mostly due to the erosion of soil material and sediments with the deposition of the minerals occurring at a downgradient point. Under reducing conditions (low redox conditions), ferric iron is reduced to ferrous iron. Free ferrous iron is very soluble and is easily transported under reducing conditions. Precipitation of ferrous iron is possible under strongly reducing conditions in the presence of sulfide (S^{-2}). The precipitation of iron sulfide minerals limits the mobility of ferrous iron; however, if conditions become oxidizing, the precipitated ferrous iron is released to solution and may be subject to reprecipitation (as ferric iron oxides or hydroxides) if oxic conditions are encountered (Kabata-Pendias, 2001).

- **Lead**—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 is either adsorbed on clay surfaces or forms lead carbonate. Lead exhibits a high degree of adsorption in clay-rich soil (Kabata-Pendias, 2001).

- **Mercury**—Mercury is a naturally occurring metal that can exist in several valence states, including +1, +2, and the elemental form. Mercury has a strong tendency to sorb to the organic fractions of soils, which is influenced by the organic matter content of the soils or sediment. In addition, mercury is strongly sorbed to sesquioxides in soil at a pH higher than 4 (Blume and Brummer, 1991) and to the surface layer of peat (Lodenius and Autio, 1989). The transport and partitioning of mercury in surface waters and soils is influenced by the particular form of the compound. It can be microbally transformed to organic forms such as methyl mercury which is mobile and volatile. Volatile forms of mercury are anticipated to evaporate to the atmosphere, whereas dissolved solid forms partition to particulates in the soil or water column and are transported downward in the water column to the sediments (Hurley et al., 1991). Vaporization of methylated and elemental forms of mercury from soil and surface water is be controlled by temperature, with emissions from contaminated soils being greater in warmer weather (Lindberg et al., 1991). Mercury has been shown to volatilize from the surface of more acidic soils (Warren and Dudas, 1992). It should be noted that mercury does not have a tendency to leach into water. However, surface water may cause mercury in particulate form to move from soil to water, especially in soils with high humic content (Meili, 1991).

- **Strontium**—Strontium is a naturally occurring element with typical soil concentrations around 0.2 mg/kg. It is an alkaline earth element with chemical properties similar to calcium and barium. Elevated concentrations of strontium can be attributed to the disposal of coal ash, incinerator ash, and industrial wastes (Agency for Toxic Substances and Disease Registry [ATSDR], 2004). In addition, strontium nitrate is a component of munitions used/produced at RVAAP. In soils and sediments, strontium has moderate mobility and sorbs moderately to metal oxides and clays (Hayes and Traina, 1998). It will also precipitate as carbonate or sulfate minerals in higher TDS groundwater. Strontium can be transported through dry or wet deposition (National Council and Radiation Protection & Measurements, 1984). There is limited information about the bioavailability of strontium from environmental media.

- **Zinc**—Zinc occurs naturally in the earth's crust with an average concentration of about 70 mg/kg (Hazardous Substances Data Bank [HSDB], 2012a). The zinc content of noncontaminated soils ranges between 10 and 300 mg/kg (Efroymson et al., 1997a). Zinc is found virtually in all living organisms as an essential element for life; however, it is toxic particularly to aquatic organisms at elevated concentrations. Zinc is expected to adsorb to suspended particles and sediment in the water column and volatilization is not anticipated to be a primary transport pathway (HSDB, 2012a; Eisler, 1993). Zinc generally demonstrates low mobility in the subsurface environment because it is strongly adsorbed to soil at pH 5 or greater (Evans, 1989; Blume and Brummer, 1991). Mobility is also reduced as permeability decreases, and the amount of clay, lime, anhydrous iron oxides, and other ions such as phosphate increases. Volatilization of zinc from soil or water surfaces is not an important transport process because of the ionic nature of zinc salts (Efroymson et al., 1997a).

5.2.1.3 SVOCs

A total of 21 SVOCs were identified as SRCs at the Group 8 MRS, of which 17 analytes were PAHs. The fate and transport of the SVOCs identified as SRCs at the Group 8 MRS is as follows:

- **PAHs—**A combined group of 17 PAHs [acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorine, indeno(1,2,3-cd)pyrene, naphthalene, 2-methylnaphthalene, phenanthrene, and pyrene] were identified as SRCs in the surface and subsurface soils at the Group 8 MRS. PAHs are a group of more than 100 organic compounds consisting of two or more fused aromatic rings. As a general rule, when PAH compounds grow in molecular weight, their solubility in water decreases, solubility in fat tissues increases, their melting and boiling points increase, and their volatilities decrease. The vapor pressure ranges of the PAHs present indicates that these compounds do not readily volatilize into the atmosphere and is further supported by the Henry's law constant values. The (K_{oc} is a measure of the tendency of a chemical to be sorbed to the organic fraction of soil. The K_{oc} values for the PAHs detected indicate these PAHs have high sorption potentials and will not tend to leach into surface water runoff. This further supported by the octanol/water partition coefficient (K_{ow}) which is an indication of whether a compound will dissolve in a solvent (i.e., n-octanol) or water. The PAHs detected are nonpolar and hydrophobic and, as mentioned above, will tend to sorb to surface soil rather than partition into the polar water phase (Environment Canada, 1998).

- **Phthalates—**Phthalates are a family of SVOC compounds that are various esters of phthalic acid. The compounds bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were identified as SRCs. The most common uses for these two compounds are as plasticizers, which are added to plastic formulations such as polyvinyl chloride to make them more flexible and increase their durability (Montgomery and Welcom, 1989). They are also added to "plastic explosives" (such as C-4) at concentrations up to several weight percent which allows the explosive to be molded into any desired shape. Both of these compounds have fairly low solubilities so they are slowly leached from their source material. Their high K_{oc} values indicate that they will adsorb on soil particles, which will limit their mobility in the soil column. Their volatilities are low so vapor inhalation is not a key exposure pathway (Group, 1986). The aerobic microbial degradation rates in oxic soil and aquatic environments are high, but they may persist under anaerobic conditions as found in organic-rich soil or wetland sediments (Stales et al., 1997).

- **Carbazole—**Carbazole is an aromatic heterocyclic organic compound. It has a tricyclic structure, consisting of two six-membered benzene rings fused on either side of a five-membered nitrogen-containing ring. Carbazole is formed and released to the atmosphere along with PAH compounds during combustion of organic material (Mackay, 2006). It is present in emissions from waste incineration; tobacco smoke; and rubber, petroleum, coal, and wood combustion. If released to the atmosphere, vapor-phase carbazole is rapidly degraded by photochemically produced hydroxyl radicals (estimated half-life of 3 hours). In the particulate phase, the rate of degradation depends upon the adsorbing substrate. Substrates containing carbon (greater than 5 percent) stabilize carbazole and permit long-range atmospheric transport. Physical removal via wet and dry deposition is important. If released to surface soil, the presence of organic carbon materials, such as peat, will adsorb carbazole and may limit or prevent photolysis. Biodegradation in soil should be the dominant fate process providing the presence of specific degrading bacteria in the microbial community (biodegradation half-life of 4.3 minutes to 6.2 hours in screening studies). If released to water, volatilization and bioconcentration in aquatic organisms is not predicted to be important. Biodegradation and photolysis should be the dominant fate processes in aquatic systems providing specific degrading bacteria and sufficient sunlight. However, carbazole may partition from the water column to sediment and suspended matter, thus limiting the rate of photolysis. Human exposure to carbazole occurs through inhalation of contaminated air and consumption of contaminated water (HSDB, 2003).

- **Dibenzofuran—**Dibenzofuran is a heterocyclic aromatic compound that has two benzene rings fused to one furan ring in the middle (Montgomery and Welcom, 1989). Its structure is similar to carbazole except it has oxygen instead of an N-H group on the center ring. Dibenzofuran's presence in coal-tar, as a component of heat-transfer oils, as a carrier for dyeing and printing textiles, as an intermediate for production of dyes, and as an antioxidant in plastics may result in its release to the environment through various waste streams. It also forms along with PAH compounds during combustion of organic materials such as wood, coal, and municipal waste. If released to air, a vapor pressure of 0.00248 mm Hg at 25 degrees Celsius (°C) indicates dibenzofuran will exist solely as a vapor in the ambient atmosphere (National Center for Biotechnology Information [NCBI], 2012). Vapor-phase dibenzofuran will be degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 4 days. Dibenzofuran absorbs little UV light above 300 nm, but UV absorption rises sharply below 300 nm, which indicates the potential for direct photolysis in the environment. If released to soil, dibenzofuran is expected to have limited mobility based upon an estimated K_{oc} of 4,200. Volatilization from moist soil surfaces is expected to be an important fate process based upon an estimated Henry's law constant of 2.1×10^{-4} atm-m^3/mole. However, adsorption to soil is expected to attenuate volatilization. Indigenous soil microorganisms at contaminated sites can degrade dibenzofuran if stimulated. If released into water, dibenzofuran is expected to adsorb to suspended solids and sediment based upon the estimated K_{oc}. Biodegradation screening tests indicate that dibenzofuran is not readily biodegradable. However in laboratory studies, dibenzofuran was degraded in a few days using subsurface materials which had been contaminated by creosote chemicals. Once microbial adaptation had occurred, dibenzofuran rapidly biotransformed under aerobic conditions. Volatilization from water surfaces is expected to be an important fate process based upon the estimated Henry's law constant. Estimated volatilization half-lives for a model river and model lake are 5 hours and 7 days, respectively. However, volatilization from water surfaces is expected to be attenuated by adsorption to suspended solids and sediment. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions. Occupational exposure to dibenzofuran may occur through inhalation and dermal, particularly at sites where coal tar, coal tar derivatives, and creosote is produced or used (i.e., the handling of creosotetreated wood). Monitoring data indicate that the general population may be exposed to dibenzofuran via inhalation of ambient air and dermal contact with wood products containing dibenzofuran (NCBI, 2012).

5.2.1.4 PCBs

PCBs, also known by the Monsanto trade name "Aroclor," were produced by the partial chlorination of biphenyl in the presence of a catalyst. PCBs are distinguished by a four-digit code in which the first two digits indicate the production process and the second two digits indicate the weight percent of chlorine. PCBs as a group are considered to be highly immobile, persistent in the environment, and resistance to oxidation and hydrolysis. In general, the persistence of PCBs increases with an increase in the degree of chlorination (HSDB, 2012b).

- **Aroclor-1254—**Aroclor-1254 is a PCB with an average chlorine content of 54 percent. The vapor pressure of Aroclor-1254 is 7.71×10^{-5} mm of Hg at 25°C and therefore volatilization is not anticipated from dry soils (EPA, 1981). Volatilization from wet soils is possible based on the Henry's law constant of 2.83×10^{-4} atm-m^3/mole (Burkhard et al., 1985). However, the tendency for Aroclor-1254 to adsorb strongly to soils is expected to attenuate volatilization. The log K_{oc} for Aroclor-1254 ranges from 4.6 to 6.1, which indicates that the PCBs will tend to stay bound to the organic fraction of the soil instead of leaching into groundwater or surface water runoff, or volatilizing to the atmosphere (EPA, 1981). Based on the same principle volatilization from surface water to the atmosphere is also not anticipated to occur as the PCB will adsorb to sediment and suspended particles in the water column.

- **Aroclor-1260—**Aroclor-1260 is a PCB with an average chlorine content of 60 percent. The vapor pressure of Aroclor-1260 is 4.05×10^{-5} mm of Hg at 25°C and therefore volatilization is not anticipated from dry soils (EPA, 1981). Volatilization from wet soils is possible based on the Henry's law constant of 3.36×10^{-4} atm-m^3/mole (Burkhard et al., 1985). However, the tendency for Aroclor-1254 to adsorb strongly to soils is expected to attenuate volatilization. The log K_{oc} for Aroclor-1260 ranges from 4.8 to 6.8, which indicates that the PCBs will tend to stay bound to the organic fraction of the soil instead of leaching into groundwater or surface water runoff, or volatilizing to the atmosphere (EPA, 1981). Based on the same principle volatilization from surface water to the atmosphere is also not anticipated to occur as the PCB will adsorb to sediment and suspended particles in the water column.

5.3 Summary of Fate and Transport

During the RI field activities, buried MD was found at a maximum depth of 4 feet bgs, and native soil was not encountered until 4 feet bgs at 11 of the 14 trench locations. Therefore, at a minimum, surface soil conditions at some areas of the MRS have been disturbed or reworked to approximately 4 feet bgs. The average pH of the soils at the MRS is 7.72.

The explosives SRCs, nitroguanidine and TNT, are considered mobile in soil and the impact to subsurface soils beneath potential MD source areas to a maximum depth of 4.5 feet bgs were evaluated for this RI. The concentrations of nitroguanidine and TNT that were detected in the surface soil (0 to 0.5 feet bgs) were low and no concentrations of these explosives were detected in the subsurface soils (4.0 to 4.5 feet bgs). Based on the detected results, significant sources of nitroguanidine and TNT were most likely not released during previous activities at the MRS and the low to medium permeability of the soils at the MRS mitigated any potential migration of residual concentrations to subsurface soils.

The metals SRCs have a tendency to sorb to soil at soil pH of 4 or greater depending on the specific analyte. The MRS-specific pH of 7.72 indicates that metals SRCs would be expected to be found in the top several inches where they were released, with only limited downward migration. The detected PCBs and SVOCs that include PAHs are also anticipated to sorb to soils based on the K_{oc} values (i.e., have the tendency to be sorbed to the organic fraction of soil) and are not expected to leach into surface water runoff or migrate through the soil column.

One of the principle migration pathways at the Group 8 MRS is infiltration through the unsaturated soil to groundwater. The depth to groundwater at the MRS is approximately 15 to 20 feet bgs. Evaluation of the groundwater beneath the Group 8 MRS was not included in the most recent *Final Facility-Wide Groundwater Program, Report on the July 2011 Sampling Event* (EQM, 2012), therefore releases of SRCs to groundwater at the Group 8 MRS have not been investigated.

A distinct boundary between native material and fill material was identified at approximately 4 feet at 11 of the 14 trench locations during the RI field activities. The native material is described primarily as the Mahoning-Urban land complex that is somewhat poorly drained to moderately well-drained (AMEC, 2008). Based on the local topography, some of the precipitation falling as rainfall and snow likely leaves the MRS as surface runoff to the drainage ditch along the southern portion of the MRS. The precipitation that does not leave the MRS as surface runoff infiltrates into the subsurface. Some of the infiltrating water is lost to the atmosphere as evapotranspiration. The remainder of the infiltrating water recharges the groundwater. The rate of infiltration and eventual recharge of the groundwater is controlled by soil cover, ground slope, saturated hydraulic conductivity of the soil, and meteorological conditions throughout the MRS. Based on the aforementioned soil conditions, the low concentrations of explosives, and that metals, SVOCs, and PCBs are expected to remain in the top several inches of soil on the ground surface or in subsurface soils beneath concentrated areas of buried MD where they were deposited, groundwater conditions have most likely not been impacted.

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6.0 MEC HAZARD ASSESSMENT

The chapter presents an evaluation of the MEC hazards that may be associated with the Group 8 MRS in accordance with the *Interim Munitions and Explosives of Concern Hazard Assessment (MEC HA) Methodology* (EPA, 2008a). The MEC HA method was developed to evaluate the potential explosive hazard associated with conventional MEC present at an MRS under a variety of MRS-specific conditions, including various cleanup scenarios and land-use assumptions. The MEC HA addresses human health and safety concern associated with potential exposure to MEC at a MRS but does not address hazards (explosive or toxic) posed by chemical warfare materiel, MEC that is present underwater, nor environmental or ecological hazards that may be associated with MEC.

A MEC HA is performed for an MRS when an explosive safety hazard is identified. In the case for the Group 8 MRS, MEC items were reportedly found on the ground surface at the MRS by OHARNG personnel in the past and during the 2007 SI field activities; however, only MD items were found during complete coverage of the MRS during the RI field activities. Taking into consideration, the amount of buried MD that was removed during the RI field work (1,418 lbs), the various types of MD found, the distribution and depth at which the MD was found, the relatively minimal size of the MRS at 2.65 acres, and that potential MEC items were identified prior to and during the SI field activities, it was determined that a potential explosive safety hazard may be present at the Group 8 MRS and calculation of a MEC HA score was warranted.

The MEC HA is structured into three components consisting of severity, accessibility, and sensitivity. Each of these components requires input factors that have two or more categories. These input factors are assigned a numeric score that is summed to calculate a hazard level. **Table 6-1** presents the four hazard levels and the corresponding minimum and maximum scores for each level of the MEC HA.

Table 6-1
Summary of the MEC HA Hazard Levels

Hazard Level	Maximum MEC HA Score	Minimum MEC HA Score	Description
1	1000	840	Highest potential explosive hazard condition
2	835	725	High potential explosive hazard condition
3	720	530	Moderate potential explosive hazard condition
4	525	125	Low potential explosive hazard condition

MEC HA denotes Munitions and Explosives of Concern Hazard Assessment.

The MEC HA allows a project team to evaluate the potential explosive hazard associated with an MRS given current conditions and under various cleanup, land use activities, and land use control alternatives. It was developed through a collaborative, consensus approach to promote consistent evaluation of potential explosive hazards at MRSs (EPA, 2008a). The MEC HA evaluated in this section is inclusive of the information available for the MRS up to and including the RI field activities and provides a scoring summary for the current and future land use activities, assuming no response actions. The MEC HA in this RI Report does not provide an evaluation of various cleanup and land use control alternatives for the MRS.

The MEC HA workbook prepared for the Group 8 MRS is provided in **Appendix J**. The following sections discuss the components that comprise the MEC HA and provide rationale for the input factors chosen:

6.1 Severity

This component is defined in the MEC HA guidance (EPA, 2008a) as "[t]he potential consequences of the effect (i.e., injury or death) on a human receptor should a MEC item detonate." Two input factors are required to determine this component: (1) *Energetic Material Type* and (2) *Location of Human Receptors*. The first factor describes the hazard associated with MEC known or suspected to be present at the MRS. The second factor accounts for the possibility that secondary receptors could be affected in addition to the receptor that initiated the detonation of a MEC item.

6.1.1 Energetic Material Type

While no MEC items were identified on the surface or during the subsurface intrusive investigation, multiple types of MD were uncovered as discussed in Section 4.2. These MD items consisted of the 40 mm grenade, 20 mm projectile, 60 mm projectile, and 75 mm projectile that were expended. These items were conservatively used as input factors to evaluate for the energetic material type, which was determined to be "High Explosives".

6.1.2 Location of Human Receptors

Unintentional detonation of a MEC item would result not only in injury (or death) to the individual initiating the detonation, but also to other receptors that may be exposed to the overpressure or fragmentation hazards from the MEC detonation. For this factor, a determination is made whether there are places where people congregate that are either within the MRS or within the explosive safety-quantity distance (ESQD). The largest ESQD for the Group 8 MRS was determined to be 1,873 feet and is based on the maximum fragment distance-horizontal for a 75 mm HE MK1 series, which was one of the MD items encountered during the RI intrusive investigation activities. **Figure 6-1** presents the ESQD for the Group 8 MRS.

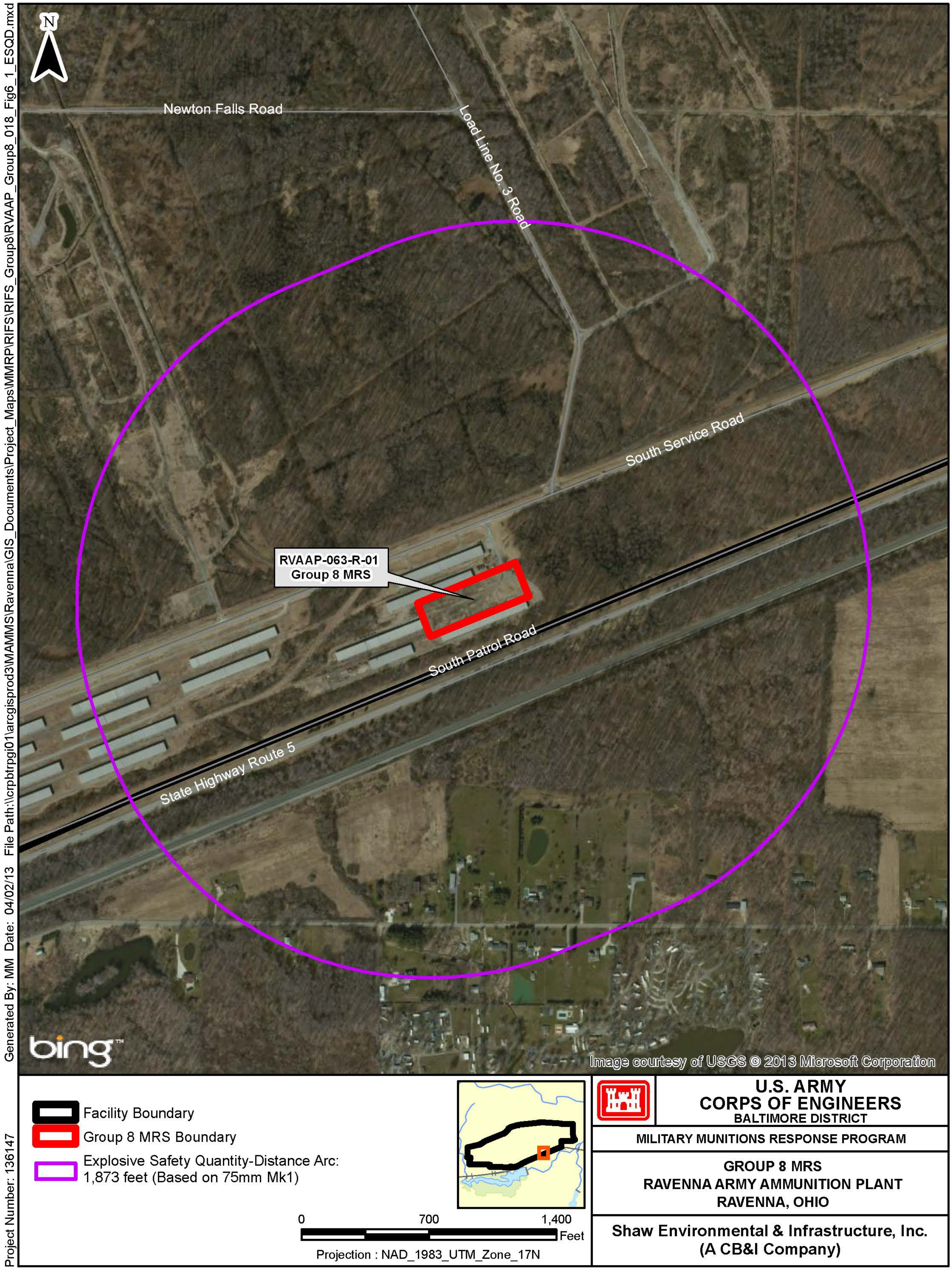

FIGURE 6-1 EXPLOSIVE SAFETY QUANTITY-DISTANCE ARC

There are no specific areas at the RVAAP within the Group 8 MRS ESQD where people consistently congregate. The vicinity of the MRS at the facility includes controlled-humidity preservation buildings that are currently used for the cold storage of OHARNG equipment and vehicles. State Highway Route 5 is located approximately 250 feet south of the MRS and residential properties are located to the south of State Highway Route 5. The buildings, state highway, and several residential properties are located well within the EQSD. Additionally, current activities at the MRS include security patrols, maintenance activities and access to the road network to access the adjacent buildings. Therefore, there is the potential for human receptors to be located within the MRS or the ESQD arc.

Future land use at the Group 8 MRS will be military training. The input factors for *Location of Human Receptors* will not change for the future land use scenario.

6.2 Accessibility

The accessibility component is defined in the MEC HA guidance (EPA, 2008a) as "[t]he likelihood that a human receptor will be able to come into contact with a MEC item." The following five input factors are required to determine this component:

1. *Site Accessibility*, which describes the ease with which people can access the MRS.
2. *Potential Contact Hours*, which is an estimate of the total number of receptor hours per year. Both the number of receptors and the amount of time they spend at the MRS can affect the likelihood of the receptor encountering MEC.
3. *Amount of MEC* that may be present due to past munitions-related activities at the MRS. This input factor is assessed by determining the type of munitions activities that took place at the MRS (some of the categories are target area, open burning/open detonation area, maneuver area, safety buffer area, storage, etc.)
4. *Minimum MEC Depth Relative to the Maximum Receptor Intrusive Depth*, which describes whether MEC items are located where receptor activities take place.
5. *Migration Potential*, which describes the likelihood that MEC items can be moved and potentially exposed by natural processes such as erosion or frost heaving (repeated freeze/thaw cycles).

Details for each of the five input factors are described in the following sections.

6.2.1 Site Accessibility

Site Accessibility describes how receptors access the MRS. The Group 8 MRS is located in the south-central portion of RVAAP and is located within the installation perimeter fence.

Siebert stakes and warning signs are currently present along the boundary of the MRS warning personnel to stay on the road and/or keep out. There are no additional barriers preventing access to the MRS. The input factor for Site Accessibility is determined to be “Full Accessibility,” which indicates that there are no barriers to entry. The anticipated future land use is military training and it is assumed that the current condition at the MRS, which is “Full Accessibility”, is the applicable input factor for future use.

6.2.2 Potential Contact Hours

The input factor for Potential Contact Hours estimates the total number of receptor hours per year. Both the number of receptors and the amount of time they spend at the MRS can affect the likelihood of the receptor encountering MEC. In coordination with the OHARNG and the USACE, the Potential Contact Hours at the Group 8 MRS were developed. The Potential Contact Hours took into consideration the activities performed at the MRS as well as the RVAAP receptor/exposure scenarios that are presented in the FWCUG Report (SAIC, 2010). The following types of activities/receptors/hours were assumed for current use activities at the MRS:

- Security Guard/Maintenance Worker—1 hour per day × 250 days per year = 250 receptor hours per year
- Trespassers—125 people per year × 1 day per person × 2 hours per day = 250 receptor hours per year

Future use activities at the MRS were also calculated, and the following types of activities, receptors, and hours were developed with the USACE and the OHARNG:

- National Guard Trainee—8 people per year × 39 days per person × 24 hours per day = 7,488 receptor hours per year

The receptor hours per year for each activity are then summed and determined to be in one of the following four categories:

1. Many hours (greater than 1,000,000 receptor hours/year)
2. Some hours (100,000 to 999,999 receptor hours/year)
3. Few hours (10,000 to 99,999 receptor hours/year)
4. Very few hours (less than 10,000 receptor hours/year)

Based on the activities that are assumed to be currently taking place, the approximate number of receptor hours per year was determined to be 500 resulting in a category of “very few hours.” Even though the assumptions for calculating this input factor are somewhat idealized, the calculated number of receptor hours per year is less than 10 percent of the number for the next highest category; therefore, even if the usage assumptions are changed slightly, the category does not change. For the future use scenario, the number of receptor hours per year increases to 7,488 but the resulting category would remain “very few hours.”

6.2.3 Amount of MEC

This input factor qualitatively describes the amount of MEC that may be present due to past munitions-related activities at the MRS. This input factor is assessed by determining the type of munitions activities that took place at the MRS (some of the categories are target area, OB/open detonation (OD) area, maneuver area, safety buffer area, storage, etc.). Based on the MRS history and the results of the intrusive investigation activities performed during the RI field activities that encountered MD which had been demilitarized via burning operations, “Open Burn/Open Detonation (OB/OD) Area” was selected as the applicable category.

6.2.4 Minimum MEC Depth Relative to Maximum Receptor Intrusive Depth

The Minimum MEC Depth Relative to Maximum Receptor Intrusive Depth input factor describes whether MEC items are located where receptor activities take place. Results of the RI intrusive investigation did not find any MD on the ground surface. The MD items were found buried in the subsurface only. The Group 8 MRS is surrounded by Seibert stakes and signs to warn unauthorized personnel from entering the area. Intrusive activities are not allow or anticipated for current land uses at the Group 8 MRS; therefore, the input factor for current use activities of “Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth does not overlap with minimum MEC depth” was selected..

The anticipated future land use at the Group 8 MRS is military training with the potential for intrusive activities (USACE, 2005). The input factor for future land use is “Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth overlaps with minimum MEC depth.”

6.2.5 Migration Potential

The Migration Potential input factor describes the likelihood that MEC items can be moved and potentially exposed by natural processes such as erosion or frost heaving (repeated freeze/thaw cycles). The frost line for northeast Ohio is 30 inches. MD was found at the Group 8 MRS at depths between ground surface and 48 inches, indicating that MD and any potentially remaining MEC at the MRS to 30 inches bgs is susceptible to frost heave. Additionally, seasonal heavy rains have the potential to cause frost heave and erosion of soils at the MRS.

In general, the RVAAP has very little difficulty with erosion since slope is typically 5 percent or less (AMEC, 2008). The MRS itself is relatively flat and the soils are compacted due to vehicle traffic and past use of the MRS for equipment storage which has the potential to minimize both frost heave and erosion. Vegetation and small brush provides ground cover for the MRS at areas that are not used for vehicle access to the nearby buildings and is further protection against frost heave and erosion. Based on the current conditions at the MRS, vertical migration of buried MD and any MEC that may be present in soil may occur; however, significant overland migration once exposed on the ground surface is unlikely.

The future land use at the MRS is military training (USACE, 2004) that may expose subsurface MEC/MD; however, the level topography at the MRS and low soil slope makes overland migration unlikely.

6.3 Sensitivity

The Sensitivity component is defined in the MEC HA guidance (EPA, 2008a) as “the likelihood that a MEC item will detonate if a human receptor interacts with it.” Two input factors are required to determine this component: (1) *MEC Classification* (Sensitive UXO, UXO, Fuzed Sensitive Discarded Military Munitions [DMM], Fuzed DMM, Unfuzed DMM, and Bulk Explosives) and (2) *MEC Size*. The *MEC Size* input factor is used to account for the ease with which a MEC item can be moved by a receptor, which increases the likelihood that a receptor will pick it up or otherwise disturb the item. Two categories are used to describe the MEC size: (1) “small” (MEC items that weigh less than 90 lbs) or (2) “large” (MEC items that weigh 90 lbs or more).

6.3.1 MEC Classification

The MEC HA guidance (EPA, 2008a) defines six categories of MEC for the following MEC classification input factors:

1. UXO Special Case
2. UXO
3. Fuzed DMM Special Case
4. Fuzed DMM
5. Unfuzed DMM
6. Bulk Explosives

Based on the MRS classification as an “OB/OD Area,” and the potential for 40 mm projectiles (40 mm grenades) and fuzes to be present, as evidenced from the MD encountered during the RI intrusive investigation activities, the MEC HA selected the MEC classification of UXO Special Case."

6.3.2 MEC Size

The MD items identified at the Group 8 MRS included various expended fuzes and casings of 40 mm grenades, 20 mm projectiles, 60 mm projectiles, and 75 mm projectiles. All of these items individually weighed less than 90 lbs and category selection for MEC size was "small".

6.4 MEC HA Results

The input factors for the components that comprise the MEC HA are discussed in this section and an explosive hazard level determination has been generated for both the current and future land use activities at the Group 8 MRS.

Based on current conditions at the MRS and the current use scenario for security patrols and maintenance activities, the MEC HA methodology resulted in a score of 705. This equates to a Hazard Level of 3 (moderate potential explosive hazard condition).

The future land use at the MRS will be military training with the potential for intrusive activities. The MEC HA methodology resulted in a score of 805, which equates to a Hazard Level of 2 (high potential explosive hazard condition).

7.0 HUMAN HEALTH RISK ASSESSMENT

The purpose of the HHRA is to document whether SRCs are COPCs and COCs that are present at the Group 8 MRS and 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 has been prepared in accordance with the Work Plan Addendum (Shaw, 2011) using the streamlined approach to risk decision-making, as described in the FWCUG Report (SAIC, 2010). In particular, the *Ravenna Army Ammunition Plant Position Paper for the Application and Use of Facility-Wide Cleanup Goals* (USACE, 2012); hereafter referred to as the Position Paper, describes the applicability and use of the final 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) risk value of 0.1 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 Group 8 MRS during the RI field activities.

7.1 Data Used in the HHRA

Although no MEC was found at the Group 8 MRS during the RI intrusive activities, a significant quantity of MD (1,418 lbs) was identified at depths ranging from 1 inch to 4 feet bgs. Based on the MD findings, an MC investigation was performed for the RI to characterize the nature and extent of SRCs associated with previous activities at the MRS. The MC investigation consisted of the collection of four ISM surface soil samples at sampling units that covered the entire MRS and three ISM samples from the bottoms of trenches where concentrated MD was encountered. The increments for the ISM surface soil samples were collected at depths between 0 and 0.5 feet bgs whereas the increments for the ISM soil samples from the trench bottom were collected at 0.5-foot increments as well but at total depths of 4 to 4.5 feet bgs and were evaluated as subsurface soils as part of the RVAAP data evaluation process in Section 4.0.

The Group 8 MRS is considered as a single EU based on the future land use. Although, the MRS is being evaluated as a single EU, the soil data collected within the MRS were aggregated by depth intervals for surface and subsurface soil since different future use receptors with different depths of potential exposure are required to be evaluated. The available data used in this HHRA are presented in **Table 7-1**.

Table 7-1
Human Health Risk Assessment Data Use Summary

<table>
<tr><th>Sample ID</th><th>Sample Date</th><th>Depth (feet bgs)</th><th>Sample Type</th><th>Analysis</th></tr>
<tr><td colspan="4">Surface Soil</td><td rowspan="10">Metals[1],
Explosives,
Nitrocellulose,
SVOCs,
PCBs,
TOC,
pH</td></tr>
<tr><td>GR8SS-001M-0001-SO</td><td rowspan="4">2/8/12</td><td rowspan="4">0 to 0.5</td><td rowspan="4">ISM</td></tr>
<tr><td>GR8SS-002M-0001-SO</td></tr>
<tr><td>GR8SS-003M-0001-SO</td></tr>
<tr><td>GR8SS-004M-0001-SO</td></tr>
<tr><td colspan="4">Subsurface Soil</td></tr>
<tr><td>GR8SS-005M-0001-SO</td><td rowspan="3">2/8/12</td><td rowspan="3">4 to 4.5</td><td rowspan="3">ISM</td></tr>
<tr><td>GR8SS-006M-0001-SO</td></tr>
<tr><td>GR8SS-007M-0001-SO</td></tr>
</table>

[1] Metals includes analysis for aluminum, antimony, barium, cadmium, copper, chromium (total), hexavalent chromium, iron, lead, mercury, strontium, and zinc.
bgs denotes below ground surface.
ID denotes identification.
ISM denotes incremental sampling methodology.
PCB denotes polychlorinated biphenyl
SVOC denotes semivolatile organic compound
TOC denotes total organic carbon.

7.2 Human Receptors

The OHARNG projected future land use for the Group 8 MRS is military training, and the most representative receptor is the National Guard Trainee. This anticipated future land use, in conjunction with the evaluation of agricultural-residential land uses and associated receptors, form the basis for identifying COCs in this RI Report. Residential Land Use, specifically the Residential Farmer (Adult and Child) scenario, is included to evaluate COCs for unrestricted land use at the MRS as required by the CERCLA process and as outlined in the HHRAM (USACE, 2005).

The RVAAP has defined exposure depths scenarios for the identified receptors, which are presented in the FWCUG Report (SAIC, 2010). Surface soil for the residential land use receptors is defined as 0 to 1 foot bgs and surface soil for the military use land use receptors is defined as 0 to 4 feet bgs (i.e., deep surface soil). Subsurface soil for the residential land use receptors is defined as 1 to 13 feet bgs and 4 to 7 feet bgs for the military use land use receptors. 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 sample were collected; however, the data are not intended to evaluate for predefined exposure depth scenarios as is typically performed under the Installation Response Program. 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 ISM surface and subsurface soil samples collected during the RI field activities were all collected at 0- to 0.5-foot (6-inch) increments, since this is the maximum depth that contamination from the presumed burning activities at the MRS, directly beneath MEC or MD on the ground surface, or buried in trenches would be expected to vertically migrate in the soil column. This sampling methodology is consistent with the *MMRP Munitions Response Remedial Investigation/Feasibility Study Guidance* (Army, 2009). Therefore, for the RI, surface and deep surface soil for the residential and military training land use receptors, respectively, is evaluated as 0 to 0.5 feet bgs, the depth at which the ISM surface soil samples were collected. The subsurface soils for the residential and military land use receptors are evaluated at 4 to 4.5 feet bgs, the depths at which the ISM soil samples were collected at the trench locations. The exposure scenarios for the identified receptors based on the RI sample strategy at the Group 8 MRS are summarized as follows:

- Residential Farmer (Adult and Child)—Surface soil at 0 to 0.5 feet bgs
- Residential Farmer (Adult and Child)—Subsurface soil at 4 to 4.5 feet bgs
- National Guard Trainee—Deep surface soil at 0 to 0.5 feet bgs
- National Guard Trainee—Subsurface soil at 4 to 4.5 feet bgs

7.3 COPC Identification

The section presents the evaluation of the MRS data and the identification of COPCs for the intended receptors based on future land use. The data for this RI Report was evaluated in accordance with the initial evaluation step presented in the Position Paper (USACE, 2012) to identify SRCs as presented in Section 4.3, "MC Data Evaluation." The evaluation incorporates the same criteria described in Section 4.3.1.3 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. To establish COPCs, all chemicals that had not been eliminated to this point were evaluated using the following steps.

- The final FWCUGs developed for the Residential Farmer (Adult and Child) and the National Guard Trainee receptors for each chemical were used. If there were no final FWCUGs developed for a particular chemical, then the EPA Regional Screening Levels (RSLs) for the Residential Receptor were used (2012). If neither a final FWCUG nor a RSL was available, then a cleanup goal was developed or another approach was developed in concurrence with USACE and the Ohio EPA. Final FWCUGs or RSLs were available for all chemicals not previously eliminated; therefore, development of a final cleanup goal was not needed.
- 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 was selected.
- A comparison of the selected final FWCUG to the exposure point concentration (EPC) was completed. The EPCs for the Group 8 MRS are the MDCs.
- The chemical was retained as a COPC if the EPC exceeded the most stringent final FWCUG for the Residential Farmer (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 EPC was compared to the RSL if no final FWCUG was available.

The Work Plan Addendum (Shaw, 2011) specifies that in addition to screening the final FWCUGs for the Residential Farmer (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. For the chemicals detected at the Group 8 MRS, the final FWCUGs for the Residential Farmer (Adult and Child) or National Guard Trainee FWCUGs were lower than those for any other OHARNG receptor. As a result, the National Guard Trainee, the most stringent OHARNG receptor, and the Residential Farmer (Adult and Child) receptors were considered for COPC evaluation. The screening values used to evaluate for the identified human receptors are presented in the data summary tables in **Appendix D**.

Tables 7-2 and **7-3** present the screening results for COPCs for the Residential Farmer (Adult and Child) and the National Guard Trainee in accordance with the FWCUG Report (SAIC, 2010). These tables include the final FWCUGs that are based on the lower of the 1 × 10^{-6} (one in a million) excess cancer risk level and an HQ of 0.1 for noncancer effect values. As previously mentioned, if a chemical was detected for which there was no final FWCUG, the EPA RSLs (2012) were used. The RSLs were based on the lower of values derived considering an excess cancer risk of 10^{-6} and noncancer hazard considering a hazard index (HI) of 1. However, the RSLs included in these tables were derived based on noncancer risk that were adjusted to a HI of 0.1 in order to be consistent with the noncancer final FWCUGs. The RSL for lead was not adjusted in this manner since it was not derived using the HI approach. The RSL for lead in soil was based on the value recommended by the EPA as generally safe for residential settings.In some cases, FWCUGs or RSLs were not available for the detected chemical, and values for a closely related compound are used. All such substitutions are noted in the tables.

The COPCs are identified by comparing the MDC to the applicable screening criteria. Substances that are considered SRCs as identified in Section 4.0, and for which the MDC is greater than the lowest final FWCUG, or the RSL if no final FWCUGs are available, are considered COPCs. COPCs identified for the identified residential and National Guard land use receptors are summarized in **Table 7-4**.

7.3.1 COPCs in Surface Soil

In all, 11 COPCs were identified in surface soil (0 to 0.5 feet) for the Residential Farmer (Adult and Child) and 2 COPCs were identified for the National Guard Trainee. The COPCs identified for the land use receptors are as follows:

- **Residential Land Use:** antimony, cadmium, copper, iron, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, Acrolor-1254, and Aroclor-1260
- **Military Training Land Use:** cadmium and lead

Table 7-2 presents the SRC screening process for the COPCs in surface soil. A summary of the COPCs for the residential and military training land use receptors in surface soil is presented in **Table 7-4**.

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

Chemical	Range of Values, mg/kg						Location of MDC	RFA FWCUG[1] (mg/kg)	RFC 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													
Antimony	5		22.8	J	0.81	0.81	GR8ss-004M	13.6	2.82	175		Yes	Above risk screening criteria for RFA and RFC
Barium	127		257	J	0.051	0.25	GR8ss-004M	8,966	1,413	351		No	Below risk screening criteria
Cadmium	6.6		396	J	0.04	0.2	GR8ss-004M	22.3	6.41	10.9		Yes	Above risk screening criteria for RFA, RFC, and NGT
Chromium (as Cr^{+3})	22.8		39		0.14	0.14	GR8ss-003M	19,694	8,147	329,763		No	Below risk screening criteria
Copper	225		711	J	0.4	0.41	GR8ss-004M	2,714	311	25,368		Yes	Above risk screening criteria for RFC
Iron	34300		54,400		9.1	9.1	GR8ss-003M	19,010	2,313	184,370		Yes	Above risk screening criteria for RFA and RFC
Lead	300		977		0.25	0.25	GR8ss-003M	NA	NA	NA	400	Yes	Above risk screening criteria for RSL
Mercury	0.21		0.89		0.0084	0.042	GR8ss-003M	16.5	2.27	172		No	Below risk screening criteria
Strontium	48.3		119		0.081	0.081	GR8ss-004M	NA	NA	NA	4700	No	Below risk screening criteria
Zinc	346		1,060		0.3	0.3	GR8ss-003M	19,659	2,321	187,269		No	Below risk screening criteria
Explosives and Propellants													
2,4,6-Trinitrotoluene	0.3	J	0.3	J	0.4	0.4	GR8ss-003M	21.1	3.65	249		No	Below risk screening criteria
Nitroguanidine	0.12	J	0.17	J	0.25	0.25	GR8ss-004M	NA	NA	NA	610	No	Below risk screening criteria
Semivolatile Organic Compounds													
2-Methylnaphthalene	0.092	J	0.4		0.12	0.12	GR8ss-003M	238	30.6	2,384		No	Below risk screening criteria
Acenaphthene	0.045	J	0.11	J	0.12	0.12	GR8ss-003M	207	122	3,815		No	Below risk screening criteria
Acenaphthylene	0.038	J	0.051	J	0.12	0.12	GR8ss-004M	207	122	3,815		No	Below risk screening criteria
Anthracene	0.041	J	0.19		0.12	0.12	GR8ss-003M	207	122	3,815		No	Below risk screening criteria
Benzo(a)anthracene	0.11	J	0.41		0.12	0.12	GR8ss-003M	0.221	0.65	4.77		Yes	Above risk screening criteria for RFA
Benzo(a)pyrene	0.069	J	0.27		0.12	0.12	GR8ss-003M	0.022	0.065	0.477		Yes	Above risk screening criteria for RFA and RFC
Benzo(b)fluoranthene	0.15	J	0.46		0.12	0.12	GR8ss-003M	0.221	0.65	4.77		Yes	Above risk screening criteria for RFA
Benzo(ghi)perylene	0.06	J	0.15		0.12	0.12	GR8ss-003M	207	122	3,815		No	Below risk screening criteria
Benzo(k)fluoranthene	0.042	J	0.23		0.12	0.12	GR8ss-003M	2.21	6.5	47.7		No	Below risk screening criteria
Bis(2-Ethylhexyl)phthalate	0.29	J	2	J	0.4	0.41	GR8ss-004M	NA	NA	NA	35	No	Below risk screening criteria
Carbazole	0.032	J	0.15		0.12	0.12	GR8ss-003M	69.4	44.6	835		No	Below risk screening criteria
Chrysene	0.11	J	0.43		0.12	0.12	GR8ss-003M	22.1	65	477		No	Below risk screening criteria
Dibenzo(a,h)anthracene	0.026	J	0.064	J	0.12	0.12	GR8ss-003M	0.022	0.065	0.477		Yes	Above risk screening criteria for RFA
Dibenzofuran	0.036	J	0.16		0.12	0.12	GR8ss-003M	119	15.3	1,192		No	Below risk screening criteria
Di-n-Butyl Phthalate	0.1	J	0.46		0.4	0.41	GR8ss-003M	NA	NA	NA	610	No	Below risk screening criteria
Fluoranthene	0.28	J	1.2		0.12	0.12	GR8ss-003M	276	163	5,087		No	Below risk screening criteria
Fluorene	0.044	J	0.091	J	0.12	0.12	GR8ss-003M	737	243	11,458		No	Below risk screening criteria

	Range of Values, mg/kg												
	Detected Concentrations				Reporting Limits								
Chemical	**Minimum**	**VQ**	**Maximum**	**VQ**	**Minimum**	**Maximum**	**Location of MDC**	**RFA FWCUG[1] (mg/kg)**	**RFC FWCUG[1] (mg/kg)**	**NGT FWCUG[1] (mg/kg)**	**RSL[2] (mg/kg)**	**COPC?**	**COPC Justification**
Indeno(1,2,3-cd)pyrene	0.048	J	0.16		0.12	0.12	GR8ss-003M	0.221	0.65	4.77		No	Below risk screening criteria
Naphthalene	0.081	J	0.36		0.12	0.12	GR8ss-003M	368	122	1,541		No	Below risk screening criteria
Phenanthrene	0.19		0.99		0.12	0.12	GR8ss-003M	207	122	3,815		No	Below risk screening criteria
Pyrene	0.2	J	0.87		0.12	0.12	GR8ss-003M	207	122	3,815		No	Below risk screening criteria
Polychlorinated Biphenyls													
Aroclor-1254	0.3		0.74		0.1	0.2	GR8ss-003M	0.203	0.12	3.46		Yes	Above risk screening criteria for RFA and RFC
Aroclor-1260	0.15		0.41		0.1	0.2	GR8ss-001M	0.203	0.349	3.46		Yes	Above risk screening criteria for RFA and RFC

[1] *FWCUG is lower 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.*
COPC denotes chemical of potential concern.
Cr^{+3} denotes trivalent chromium.
FWCUG denotes Facility-Wide Cleanup Goal per the Final Facility-Wide Human Health Cleanup Goals for the RVAAP *(SAIC, 2010).*
FWCUGs for pyrene used for acenaphthene, acenaphthylene, anthracene, benzo(g,h,i) perylene, naphthalene, and phenanthrene.
HQ denotes hazard quotient.
J denotes that the result is less than the reporting limit but greater than or equal to the method detection limit.
MDC denotes maximum detected concentration.
mg/kg denotes milligrams per kilogram.
NA denotes not applicable/available.
NGT denotes National Guard Trainee.
RFA denotes Residential Farmer Adult.
RFC denotes Residential Farmer Child.
RSL denotes residential soil (April 2012). Those based on noncancer risk are adjusted to a HQ of 0.1 (as opposed to published value based on HQ of 1), except lead.
VQ denotes validation qualifier.

Table 7-3
Summary of Screening Results for COPCs in Subsurface Soil (4.0–4.5 feet)

Chemical	Range of Values, mg/kg						Location of MDC	RFA FWCUG[1] (mg/kg)	RFC 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													
Antimony	2.3		5.9		0.81	0.81	GR8SS-007M	13.6	2.82	175		Yes	Above risk screening criteria for RFC
Barium	80		113		0.051	0.051	GR8SS-007M	8,966	1,413	351		No	Below risk screening criteria
Cadmium	1.1		6.3		0.041	0.041	GR8SS-007M	22.3	6.41	10.9		No	Below risk screening criteria
Chromium (as Cr^{+3})	16.1		22.7		0.14	0.14	GR8SS-007M	19,694	8,147	329,763		No	Below risk screening criteria
Copper	32.7		112		0.41	0.41	GR8SS-007M	2,714	311	25,368		No	Below risk screening criteria
Iron	31,600		39,500		9.1	9.1	GR8SS-007M	19,010	2,313	184,370		Yes	Above risk screening criteria for RFA and RFC
Lead	44.3		202		0.25	0.25	GR8SS-007M	NA	NA	NA	400	No	Below risk screening criteria
Mercury	0.018		0.24		0.0084	0.0084	GR8SS-007M	16.5	2.27	172		No	Below risk screening criteria
Strontium	27.6		43.1		0.081	0.081	GR8SS-006M	NA	NA	NA	4,700	No	Below risk screening criteria
Zinc	106		299		0.3	0.3	GR8SS-007M	19,659	2,321	187,269		No	Below risk screening criteria
Semivolatile Organic Compounds													
2-Methylnaphthalene	0.13		0.13		0.12	0.12	GR8SS-007M	238	30.6	2,384		No	Below risk screening criteria
Benzo(a)anthracene	0.055	J	0.055	J	0.12	0.12	GR8SS-007M	0.221	0.65	4.77		No	Below risk screening criteria
Benzo(a)pyrene	0.04	J	0.04	J	0.12	0.12	GR8SS-007M	0.022	0.065	0.477		Yes	Above risk screening criteria for RFA
Benzo(b)fluoranthene	0.09	J	0.09	J	0.12	0.12	GR8SS-007M	0.221	0.65	4.77		No	Below risk screening criteria
Benzo(ghi)perylene	0.038	J	0.038	J	0.12	0.12	GR8SS-007M	207	122	3,815		No	Below risk screening criteria
Benzo(k)fluoranthene	0.043	J	0.043	J	0.12	0.12	GR8SS-007M	2.21	6.5	47.7		No	Below risk screening criteria
Bis(2-Ethylhexyl)phthalate	0.26	J	0.26	J	0.4	0.41	GR8SS-006M	NA	NA	NA	35	No	Below risk screening criteria
Chrysene	0.072	J	0.072	J	0.12	0.12	GR8SS-007M	22.1	65	477		No	Below risk screening criteria
Dibenzofuran	0.039	J	0.039	J	0.12	0.12	GR8SS-007M	119	15.3	1,192		No	Below risk screening criteria
Fluoranthene	0.12		0.12		0.12	0.12	GR8SS-007M	276	163	5,087		No	Below risk screening criteria
Indeno(1,2,3-cd)pyrene	0.038	J	0.038	J	0.12	0.12	GR8SS-007M	0.221	0.65	4.77		No	Below risk screening criteria
Naphthalene	0.023	J	0.13		0.12	0.12	GR8SS-007M	368	122	1,541		No	Below risk screening criteria
Phenanthrene	0.12		0.12		0.12	0.12	GR8SS-007M	207	122	3,815		No	Below risk screening criteria
Pyrene	0.1	J	0.1	J	0.12	0.12	GR8SS-007M	207	122	3,815		No	Below risk screening criteria
Polychlorinated Biphenyls													
Aroclor-1254	0.33		0.33		0.1	0.1	GR8SS-007M	0.203	0.12	3.46		Yes	Above risk screening criteria for RFA and RFC
Aroclor-1260	0.12		0.12		0.1	0.1	GR8SS-007M	0.203	0.349	3.46		No	Below risk screening criteria

Table 7-3 (continued)
Summary of Screening Results for COPCs in Subsurface Soil (4.0–4.5 feet)

1FWCUG is lower noncarcinogenic FWCUG at a hazard index of 0.1 and excess carcinogenic FWCUG risk of 10^{-6}.
2RSL 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
COPC denotes chemical(s) of potential concern
Cr+3 denotes trivalent chromium
FWCUG denotes Facility-Wide Cleanup Goal per the Final Facility-Wide Human Health Cleanup Goals for the RVAAP *(SAIC, 2010).*
FWCUGs for pyrene used for naphthalene and phenanthrene
HQ denotes hazard quotient.
J denotes that the result is less than the reporting limit but greater than or equal to the method detection limit.
MDC denotes maximum detected concentration
mg/kg denotes milligrams per kilogram.
NA denotes not applicable/available.
NGT denotes National Guard Trainee.
RFA denotes Residential Farmer Adult.
RFC denotes Residential Farmer Child.
RSL denotes residential soil Regional Screening Level (April 2012). Those based on noncancer risk are adjusted to a HQ of 0.1 (as opposed to published value based on HQ of 1), except lead.
VQ denotes validation qualifier.

Table 7-4
Summary of COPCs for Residential and Military Training Land Use

Receptor	COPCs Identified[1]
Surface Soil (0 to 0.5 feet bgs)	
Residential Land Use	Antimony
	Cadmium
	Copper
	Iron
	Lead
	Benzo(a)anthracene
	Benzo(a)pyrene
	Benzo(b)fluoranthene
	Dibenzo(a,h)anthracene
	Aroclor-1254
	Aroclor-1260
Military Training Land Use	Cadmium
	Lead
Subsurface Soil (4 to 4.5 feet bgs)	
Residential Land Use	Antimony
	Iron
	Benzo(a)pyrene
	Aroclor-1254

[1] COPCs identified by screening surface and subsurface soil data; see Table 7-2 and Table 7-3 for screening.
bgs denotes below ground surface.
COPC denotes chemical of potential concern.

7.3.2 COPCs in Subsurface Soil

In all, four COPCs were identified in subsurface soil (4 to 4.5 feet) for the Residential Farmer (Adult and Child). Further, no COPCs were identified for the National Guard Trainee in subsurface soil. The COPCs identified for the residential land use receptors in subsurface soil consisted of antimony, iron, benzo(a)pyrene, and Aroclor-1254.

Table 7-2 presents the SRC screening process for the COPCs in subsurface soil. A summary of the COPCs identified for the residential land use receptors in subsurface soil is presented in **Table 7-4**.

7.4 COC Evaluation

This section presents the COC evaluation process for the human health risk receptors. The COCs are identified through additional screening of the COPCs identified in Section 7.2. The determination of COCs for the Group 8 MRS was conducted in accordance with the Position Paper (USACE, 2012) as follows:

- The final FWCUG values for the Residential Farmer (Adult and Child) receptors and the receptor for the planned use by the OHARNG were selected using the 1×10^{-5} carcinogenic value and the noncancer value at an HQ of 1.
- All carcinogenic and noncarcinogenic risk values for all receptors and all critical effects and target organs are reported.
- A comparison of the final FWCUG to the EPC was conducted. The EPC was the MDC due to the small number of samples.
- For carcinogens and noncarcinogens, the EPCs were compared to the target risk final FWCUG using the sum of ratios method presented in the Position Paper (USACE, 2012).
- The chemical was retained as a COC if: (1) the EPC exceeded the most stringent risk value for either the Adult Residential Farmer, Child Residential Farmer, or the military training planned future use receptor, considering the 1×10^{-5} (one in one hundred thousand) carcinogenic value and the noncancer value for an HQ of 1.0, or (2) the sum of ratios for all carcinogens or all noncarcinogens that may affect the same organ was greater than 1 and the chemical contributed at least 5 percent to the sum.

The use of the sum of ratios approach is intended to account for additive effects from exposure to multiple chemicals that can cause the same effect (i.e., cancer) or affect the same target organ. Each of these steps is discussed in more detail below.

7.4.1 Final FWCUG Identification

Final FWCUGS are needed that reflect the planned future use of the Group 8 MRS by the OHARNG. For the planned future use of this area, the military training receptor is the National Guard Trainee. The final FWCUGs used also include those for the Residential Farmer (Adult and Child) receptors to evaluate COCs for future unrestricted land use. The final FWCUGs selected are those based on a 1×10^{-5} (one in one hundred thousand) excess cancer risk for carcinogenic effects and an HQ of 1 for noncarcinogenic effects.

The final FWCUGS for the identification of COCs in surface and subsurface soils for the Residential Farmer (Adult and Child) are provided in **Table 7-5** and **Table 7-6**, respectively. The final FWCUGS for the identification of COCs in surface soil for the National Guard Trainee is provided in **Table 7-5**.

Table 7-5
Summary of COC Evaluation for Noncancer Risk Effects in Surface Soil (0–0.5 feet) for Residential Land Use

Parameter	EPC (mg/kg)	RFC FWCUG[1] (mg/kg)	Target Organ	Ratio of EPC to RFC FWCUG	% Contribution to the Total Sum	COC?	COC Justification
Neurotoxicity							
Lead	977	400	Neurotoxicity, behavioral effects	2.44	100%	Yes	Sum of ratios by target organ > 1
			Sum of Ratios—Neurotoxicity:	**2.4**			
Gastrointestinal Effects							
Copper	711	3,106	Gastrointestinal, hepatic, and renal effects	0.229	9%	No	Contribution to sum > 5%, but ≤ 10% (see text)
Iron	54,400	23,125	Gastrointestinal effects	2.35	91%	Yes	Contribution to sum > 5%
			Sum of Ratios—Gastrointestinal Effects:	**2.6**			
Vascular Effects							
Antimony	22.8	28.2	Longevity, blood glucose, and cholesterol	0.809	100%	No	Sum of ratios by target organ ≤ 1
			Sum of Ratios—Vascular Effects:	**0.81**			
Renal Effects							
Cadmium	396	64.1	Significant proteinuria	6.18	96%	Yes	Contribution to sum > 5%
Copper	711	3,106	Gastrointestinal, hepatic, and renal effects	0.229	4%	No	Contribution to sum ≤ 5%
			Sum of Ratios—Renal Effects:	**6.4**			
Liver Effects							
Copper	711	3,106	Gastrointestinal, hepatic, and renal effects	0.229	100%	No	Sum of ratios by target organ ≤ 1
			Sum of Ratios—Liver Effects:	**0.23**			

Table 7-5 (continued)
Summary of COC Evaluation for Noncancer Risk Effects in Surface Soil (0–0.5 feet) for Residential Land Use

Parameter	EPC (mg/kg)	RFC FWCUG[1] (mg/kg)	Target Organ	Ratio of EPC to RFC FWCUG	% Contribution to the Total Sum	COC?	COC Justification
Skin/Eye Effects							
Aroclor-1254	0.74	1.2	Ocular exudate, inflamed and prominent Meibomian glands	0.617	100%	No	Sum of ratios by target organ ≤ 1
			Sum of Ratios—Skin Effects:	**0.62**			

[1] FWCUG is noncarcinogenic FWCUG at HQ of 1. Only child FWCUG is shown, as this is lower than adult for noncancer effects. Value for lead is residential soil RSL.
COC denotes chemical of concern.
EPC denotes exposure point concentration. EPC is maximum concentration.
FWCUG denotes Facility-Wide Cleanup Goal per the Final Facility-Wide Human Health Cleanup Goals for the RVAAP *(SAIC, 2010).*
HQ denotes hazard quotient.
mg/kg denotes milligrams per kilogram.
RFC denotes Resident Farmer Child.
RSL denotes Regional Screening Value.

Table 7-6
Summary of COC Evaluation for Cancer Risk in Surface Soil (0–0.5 feet) for Residential Land Use

Parameter	EPC (mg/kg)	BSV (mg/kg)	RFA FWCUG[1] (mg/kg)	Ratio of EPC to RFA FWCUG	% Contribution to the Total Sum	COC?	COC Justification
Antimony	22.8	0.96	NA	NA	NA	No	Not carcinogenic
Cadmium	396	ND	12,491	0.0317	1.27%	No	Contribution to sum < 5%
Copper	711	17.7	NA	NA	NA	No	Not carcinogenic
Iron	54,400	23,100	NA	NA	NA	No	Not carcinogenic
Lead	977	26.1	NA	NA	NA	No	Not carcinogenic
Aroclor-1254	0.74	NA	2.03	0.3645	14.56%	Yes	Contribution to sum > 5%
Aroclor-1260	0.41	NA	2.03	0.2020	8.07%	Yes	Contribution to sum > 5%
Benzo(a)anthracene	0.41	NA	2.21	0.1855	7.41%	Yes	Contribution to sum > 5%
Benzo(a)pyrene	0.27	NA	0.221	1.2217	48.81%	Yes	Contribution to sum > 5%
Benzo(b)fluoranthene	0.46	NA	2.21	0.2081	8.32%	Yes	Contribution to sum > 5%
Dibenz(a,h)anthracene	0.064	NA	0.221	0.2896	11.57%	Yes	Contribution to sum > 5%
			Sum of Ratios:	**2.5**			

[1] FWCUG is cancer risk FWCUG at risk of 10^{-5} for adult; values for child are higher.
BSV denotes background screening value.
COC denotes chemical of concern.
EPC denotes exposure point concentration. EPC is maximum concentration.
FWCUG denotes Facility-Wide Cleanup Goal per the Final Facility-Wide Human Health Cleanup Goals for the RVAAP *(SAIC, 2010).*
mg/kg denotes milligrams per kilogram.
NA denotes not applicable.
ND denotes not detected.
RFA denotes Resident Farmer Adult.

7.4.2 EPC Development

The MDCs were used for the COC evaluation due to the small number of samples taken from Group 8 MRS and because all samples were taken using ISM techniques. The EPCs used are provided in **Table 7-5** through **Table 7-7**.

7.4.3 Comparison of EPCs to Final FWCUGs

The EPCs are compared to the final FWCUGs for cancer and noncancerous effects through the development of a ratio (USACE, 2012). These ratios are summed to account for potential cumulative effects. For noncancerous effects, the ratios are summed for target organs, which are shown for each COPC as reported in the FWCUG Report (SAIC, 2010). COCs are identified if one of the following occurs:

- The cancer or noncancer ratio for a given COPC is greater than 1.
- The sum of the ratios for cancer or noncancer effects for any target organ is greater than 1, and the COPC contributes more than 5 percent to the sum.

Table 7-5 through **Table 7-10** evaluate which COPCs have been identified as COCs, and the justification for COPCs that are not considered COCs. The COCs identified for all receptors are summarized in **Table 7-11**.

7.4.4 COCs in Surface Soil

As part of the COC evaluation in surface soils (0 to 0.5 feet), copper was identified as contributing 9 percent to the sum of ratios for gastrointestinal effects (**Table 7-5**). In general, the Position Paper (USACE, 2012) dictates that chemicals contributing greater than 5 percent to the sum of ratios for a given effect be identified as COCs. However, if the contribution is less than 10 percent the chemical can be excluded with justification. In the case of the Group 8 MRS, the concentration of copper was much less than the Residential Farmer Adult final FWCUG at an HQ of 1. Since the contribution of copper to the Sum or Ratios is less than 10 percent, it was excluded as a COC.

COCs were identified in surface soil for both the Residential Farmer (Adult and Child) and the National Guard Trainee. In all, nine COCs, cadmium, iron, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, Aroclor-1254, and Aroclor-1260, were identified in surface soil for the Residential Farmer (Adult and Child). Cadmium and lead were identified as two COCs in surface soil for the National Guard Trainee. **Table 7-11** presents the screening results for the COCs in the surface soil for the unrestricted and military training land use receptors.

Table 7-7
Summary of COC Evaluation for Noncancer Risk Effects in Subsurface Soil (4–4.5 feet) for Residential Land Use

Parameter	EPC (mg/kg)	RFC FWCUG[1] (mg/kg)	Target Organ	Ratio of EPC to RFC FWCUG	% Contribution to the Total Sum	COC?	COC Justification
Gastrointestinal Effects							
Iron	39,500	23,125	Gastrointestinal effects	1.71	100%	Yes	Sum of ratios by target organ > 1
			Sum of Ratios—Gastrointestinal Effects:	**1.7**			
Vascular Effects							
Antimony	5.9	28.2	Longevity, blood glucose, and cholesterol	0.21	100%	No	Sum of ratios by target organ ≤ 1
			Sum of Ratios—Vascular Effects:	**0.21**			
Skin/Eye Effects							
Aroclor-1254	0.33	1.2	Ocular exudate, inflamed and prominent Meibomian glands	0.28	100%	No	Sum of ratios by target organ ≤ 1
			Sum of Ratios—Skin Effects:	**0.28**			

[1] FWCUG is noncarcinogenic FWCUG at HQ of 1. Only child FWCUG is shown, as this is lower than adult for noncancer effects. Value for lead is residential soil RSL.
COC denotes chemical of concern.
EPC denotes exposure point concentration. EPC is maximum concentration.
FWCUG denotes Facility-Wide Cleanup Goal per the Final Facility-Wide Human Health Cleanup Goals for the RVAAP *(SAIC, 2010).*
HQ denotes hazard quotient.
mg/kg denotes milligrams per kilogram.
RFC denotes Resident Farmer Child.
RSL denotes Regional Screening Value.

Table 7-8
Summary of COC Evaluation for Cancer Risk in Subsurface Soil (4–4.5 feet) for Residential Land Use

Parameter	EPC (mg/kg)	BSV (mg/kg)	RFA FWCUG[1] (mg/kg)	Ratio of EPC to RFA FWCUG	% Contribution to the Total Sum	COC?	COC Justification
Antimony	5.90	0.96	NA	NA	NA	No	Not carcinogenic
Iron	22,523	35,200	NA	NA	NA	No	Not carcinogenic
Aroclor-1254	0.33	NA	2.03	0.1626	47.32%	No	Sum of ratios ≤1
Benzo(a)pyrene	0.040	NA	0.221	0.1810	52.68%	No	Sum of ratios ≤1
			Sum of Ratios:	**0.34**			

[1] FWCUG is cancer risk FWCUG at risk of 10^{-5} for adult; values for child are higher.
BSV denotes background screening value.
COC denotes chemical of concern.
EPC denotes exposure point concentration. EPC is maximum concentration.
FWCUG denotes Facility-Wide Cleanup Goal per the Final Facility-Wide Human Health Cleanup Goals for the RVAAP *(SAIC, 2010).*
mg/kg denotes milligrams per kilogram.
NA denotes not applicable.
RFA denotes Resident Farmer Adult.

Table 7-9
Summary of COC Evaluation for Noncancer Risk Effects in Surface Soil (0–0.5 feet) for Military Training Land Use

Parameter	EPC (mg/kg)	NGT FWCUG[1] (mg/kg)	Target Organ	Ratio of EPC to RFC FWCUG	% Contribution to the Total Sum	COC?	COC Justification
Neurotoxicity							
Lead	977	800	Neurotoxicity, behavioral effects	1.22	100%	Yes	Sum of ratios by target organ > 1
			Sum of Ratios—Neurotoxicity:	**1.2**			
Renal Effects							
Cadmium	396	3,292	Significant proteinuria	0.120	100%	No	Sum of ratios by target organ ≤ 1
			Sum or Ratios—Renal Effects:	**0.12**			

[1] FWCUG is noncarcinogenic FWCUG at HQ of 1; value for lead is industrial soil RSL.
COC denotes chemical of concern.
FWCUG denotes Facility-Wide Cleanup Goal per the Final Facility-Wide Human Health Cleanup Goals for the RVAAP *(SAIC, 2010).*
EPC denotes exposure point concentration. EPC is maximum concentration.
HQ denotes hazard index.
mg/kg denotes milligrams per kilogram.
NGT denotes National Guard Trainee.
RFC denotes Residential Farmer Child.
RSL denotes Regional Screening Level (EPA, 2012).

Table 7-10
Summary of COC Evaluation for Cancer Risk in Surface Soil (0–0.5 feet) for Military Training Land Use

Parameter	EPC (mg/kg)	BSV (mg/kg)	NGT FWCUG[1] (mg/kg)	Ratio of EPC to NGT FWCUG	% Contribution to the Total Sum	COC?	COC Justification
Cadmium	396	ND	109	3.63	100%	Yes	Sum of ratios > 1
Lead	977	NA	NA	NA	NA	No	Not carcinogenic
			Sum of Ratios:	**3.6**			

[1] *FWCUG is cancer risk FWCUG at risk of 10^{-5} for adult.*
BSV denotes background screening value.
COC denotes chemical of concern.
EPC denotes exposure point concentration. EPC is maximum concentration.
FWCUG denotes Facility-Wide Cleanup Goal per the Final Facility-Wide Human Health Cleanup Goals for the RVAAP *(SAIC, 2010).*
mg/kg denotes milligrams per kilogram.
NA denotes not applicable.
ND denotes not detected.
NGT denotes National Guard Trainee.

Table 7-11
Summary of COCs for Residential and Military Training Land Use

Receptor	COCs Identified[1]
Surface Soil (0 to 0.5 feet bgs)	
Residential Land Use	Cadmium
	Iron
	Lead
	Benzo(a)anthracene
	Benzo(a)pyrene
	Benzo(b)fluoranthene
	Dibenzo(a,h)anthracene
	Acrolor-1254
	Acrolor-1260
	Iron
Military Training Land Use	Cadmium
	Lead
Subsurface Soil (4 to 4.5 feet bgs)	
Residential Land Use	Iron

[1] COCs are identified by evaluating noncancerous hazard and cancer risk, see Table 7-5 through Table 7-10.
bgs denotes below ground surface.
COC denotes chemical of concern.

7.4.5 COCs in Subsurface Soil

Iron was the only COC identified for the residential land use receptors in subsurface soils (4 to 4.5 feet). No COCs were identified for the National Guard Trainee in subsurface soils. **Table 7-11** presents the screening results for the COCs in the subsurface soil.

7.5 Conclusions of the HHRA

Based on the results of the HHRA, it can be concluded that COCs pose a hazard to both the unrestricted land use and likely military training future land use human receptors in surface soil. Iron was identified as a COC for the unrestricted land use human receptors in subsurface soil only.

Iron was detected above the background screening criteria in two of the three subsurface soil samples (GR8SS-007M-0001-SO and GR8SS-008M-0001-SO). The most stringent FWCUG for iron in subsurface soil is 23,125 mg/kg and is less than its BSV of 35,200 mg/kg. The maximum iron concentration of 39,500 mg/kg is well within an order of magnitude above the BSV for iron and is most likely representative of existing background conditions.

While iron is identified as a COC based on the two ISM subsurface soil sample results above the screening criteria, the consideration of iron as a COC for the FS is not recommended. Although evaluated as an MC associated with the MRS, iron is typically evaluated as an essential nutrient and the EPA does not consider iron to be a concern if it is present at concentrations that are slightly above naturally occurring levels (USACE, 2005). Therefore, the iron concentrations detected are unlikely to pose a hazard to human receptors.

7.6 Uncertainty Assessment

There are various sources of uncertainty in the assessment 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. 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 that were used, including exposure assumptions and toxicity values. These uncertainties are inherent to the use of these values, and will be 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, soil was sampled using ISM techniques. These techniques provide a good representation of average concentrations over the area sampled. While it may not identify discrete locations of greater concentrations, this approach is useful for estimating exposure which is expected to occur over an area.

The identification of COPCs and COCs is based on the identification of SRCs. The identification of SRCs is largely based on RVAAP BSVs for surface and subsurface soils. As shown in **Table 7-4**, several metals were identified as COPCs. This comparison is subject to uncertainties in both the MRS data and background data sets.

The evaluation of chromium in this assessment is based on the final FWCUGs for trivalent chromium (Cr^{+3}). This assumption was made since soil samples were analyzed for hexavalent chromium, and it was not detected in any sample. Therefore, this assumption represents a minor uncertainty to the risk assessment.

A number of substances detected at the MRS have no final FWCUGs. In these cases, the EPA soil RSLs were used as the screening values for all receptors. This provides a conservative evaluation, since RSLs used are based on residential exposure. In some cases, if no final FWCUGs or RSLs were available, screening values for closely related chemicals were used. This assumption represents an uncertainty to the risk assessment, although the frequency of detection and concentrations of most substances without final FWCUGs or

RSLs were quite low. In addition, the chemicals for which there was a final FWCUG available were the ones that had been detected in previously completed investigations on RVAAP. This means that if a chemical lacks a final FWCUG, it is likely not an SRC from a facility-wide perspective.

The selection of the MDC as the EPC provides a conservative evaluation of potential exposures at the Group 8 MRS, and may overestimate exposure and risk for the entire site. The selection of receptors also represents an uncertainty to the risk assessment. However, the Residential Farmer is assumed to be a future receptor in both the COPC and COC evaluations, representing a conservative evaluation of possible future exposures. In addition, the National Guard Trainee is used to evaluate the planned future use. Therefore, risks are not expected to be underestimated for other future uses.

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8.0 ECOLOGICAL RISK ASSESSMENT

The ERA evaluates the potential for adverse effects posed to ecological receptors from potential releases at Group 8 MRS and was prepared in accordance with the Unified Approach to ERAs that was established at sites under environmental investigation at the RVAAP. The ERA is consistent with the process described in the *RVAAP Facility-Wide Ecological Risk Assessment Work Plan* (USACE, 2003c) and the *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE, 2010). Other supporting documents used in the preparation of the ERA include 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; the *Tri-Service Procedural Guidelines for Ecological Risk Assessments* (Wentsel, et al., 1996); and the *Region 5 Biological Technical Assistance Group (BTAG) Ecological Risk Assessment Guidance Bulletin No. 1* (EPA, 1996).

Consistent with the RVAAP Unified Approach for performing ERAs, a screening level ERA (SLERA) was performed on the Group 8 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 under the Unified Approach 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). 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 is to evaluate the potential for adverse ecological effects to ecological receptors from MC at the Group 8 MRS. This objective is 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 addresses the potential for adverse effects to the vegetation, wildlife, threatened and endangered species, and wetlands or other sensitive habitats associated with the MRS.

The objective of the SLERA is to provide an estimate of the potential for adverse ecological effects associated with contamination resulting from former activities at the Group 8 MRS. The results of the SLERA will 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 uses MRS-specific analyte concentration data for surface soil from the Group 8 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 is developed that describes the selection of receptors, exposure pathways, assessment and measurement endpoints, and accounts for cumulative effects.

8.2 Level I Scoping

The scoping step of the SLERA includes 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 is suspected, the SLERA proceeds to Level II.

8.2.1 Site Description and Land Use

The Group 8 MRS is flat and includes gravel roads and grass areas. Buildings near the MRS are currently used to store military equipment. The area is used by vehicles to access the adjacent storage buildings. Both MEC and MC were identified as concerns at the MRS during the 2007 SI field activities and the SI Report recommended that further characterization was necessary to address the MEC and MC concerns (e^2M, 2008).

Current activities at the Group 8 MRS include security patrols, maintenance activities, and access to the road network to access adjacent buildings. The anticipated future land use at the MRS is military training (USACE, 2005).

8.2.2 Ecological Significance

The ecological features of the MRS are presented in this section. The protection of these features from chemical releases, as assessed by the SLERA, is articulated by the RVAAP management goals (Section 8.2.3).

The topography across the MRS is relatively flat and local surface water drainage is toward the drainage ditch along southern MRS boundary. There are no streams or ponds located within the MRS and the MRS is not located within a designated floodplain.

The Group 8 MRS is categorized as “Other Land” in the Anderson Classification of plant communities, which is a category typically used for disturbed and/or paved areas lacking identifiable vegetation communities. The MRS abuts an Oak-Maple Swamp Forest community to its east (AMEC, 2008). Because of its small size, lack of vegetation structure and other habitat features required by most organisms, and human presence, the Group 8 MRS represents a low-quality habitat for most ecological receptors other than ruderal plants and some small-range receptors (i.e., robins, mice, etc.).

8.2.3 Management Goals for the RVAAP

The INRMP (AMEC, 2008) has been developed by the OHARNG as the primary guidance document and tool for managing natural resources at the RVAAP. The management goals presented in the INRMP have relevance to maintaining the ecological resources at the RVAAP and, in some instances, the MRS as well. There are no populations of rare plants, animal species, wildlife resources, wetlands, or surface waters at the MRS. Therefore, the management goals for these natural resources as presented in the INRMP are not applicable. A drainage ditch is present along the southeast corner of the MRS and receives surface water from the surrounding area, and military vehicles drive through the MRS to access nearby buildings. Therefore, the most appropriate management goal for the MRS is to manage soils to maintain productivity and to prevent and repair erosion in accordance with state and federal laws and regulations.

8.2.4 Terrestrial Resources

This section summarizes the terrestrial resources identified for the Group 8 MRS that are evaluated in this SLERA.

8.2.4.1 Special Interest Areas and Important Places and Resources

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 historical ecosystems, or are otherwise noteworthy. No special interest areas on or near the Group 8 MRS have been identified from the natural heritage data searches (AMEC, 2008).

8.2.4.2 Wetlands

Planning level surveys (i.e., desktop review of wetlands data and resources [National Wetlands Inventory maps, aerials etc.]) for wetlands were conducted for the entire facility, including the Group 8 MRS. A jurisdictional wetlands delineation has not been completed at the MRS. No wetlands have been identified at the Group 8 MRS (AMEC, 2008).

8.2.4.3 Animal Populations

The RVAAP 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, open-water ponds and lakes, and semi-improved administration areas (AMEC, 2008).

Vegetation at the RVAAP can be grouped into three categories: (1) herb-dominated, (2) shrub-dominated, and (3) tree-dominated. Approximately 60 percent of the facility is covered by forest or tree-dominated vegetation. The facility has seven forest formations, four shrub formations, eight herbaceous formations, and one nonvegetated formation (AMEC, 2008).

Surface water features within the RVAAP include a variety of streams, ponds, floodplains, and wetlands. Numerous streams drain the facility, including 19 miles of perennial streams. The total combined stream length of streams at the facility is 212 linear miles. Approximately 153 acres of ponds are found on the facility. These ponds generally provide valuable wildlife habitat. The ponds generally support wood ducks, hooded mergansers, mallards, Canada goose, and many other birds and wildlife species. Some ponds have been stocked with fish and are used for fishing and hunting. Wetlands are abundant and prevalent throughout the facility. These wetland areas include seasonal wetlands, wet fields, and forested wetlands. Most of the wetland areas on the facility are the result of natural drainage and beaver activity; however, some wetland areas are associated with anthropogenic settling ponds and drainage areas (AMEC, 2008).

An abundance of wildlife is present at the RVAAP. A total of 35 species of land mammals, 214 species of birds, 41 species of fish, and 34 species of amphibians and reptiles have been identified on the facility (AMEC, 2008). Available habitat at the Group 8 MRS is extremely limited, and consists of a mixture of mowed grass, gravel access roads, and patches of ruderal vegetation. Only species adapted to such impacted environments, such as the

American robin (*Turdus migratorius*) and deer mouse (*Peromyscus maniculatus*), are likely to use the MRS with any regularity. Other birds such as the song sparrow (*Melospiza melodia*), white-tailed deer (*Odocoileus virginianus*), and raccoon (*Procyon lotor*), and woodchuck (*Marmota monax*) are present at the installation (ODNR, 1997) and may use the habitat present at the Group 8 MRS sporadically.

8.2.4.4 Threatened, Endangered, and Other Rare Species Information

The relative isolation and protection of habitat at the RVAAP 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 RVAAP. To date, 77 state-listed species are confirmed to be on the RVAAP property and are listed in **Table 1-3**. The Group 8 MRS has not been specifically surveyed for threatened or endangered species (AMEC, 2008).

8.2.5 Level I Conclusions and Recommendations

Based on the presence of ecological resources at the RVAAP, and the potential presence of detected SRCs associated with historical MRS processes that could adversely affect these resources, proceeding to the 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 CSM

The ecological CSM depicts and describes the known and expected relationships among the stressors, pathways, and assessment endpoints that are considered in the SLERA, 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 Group 8 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 Contamination Source

The contamination source includes potential releases of MC associated with reported OB operations and MD burial activities that occurred at the MRS that may have impacted surface soil.

8.3.1.2 Source Medium

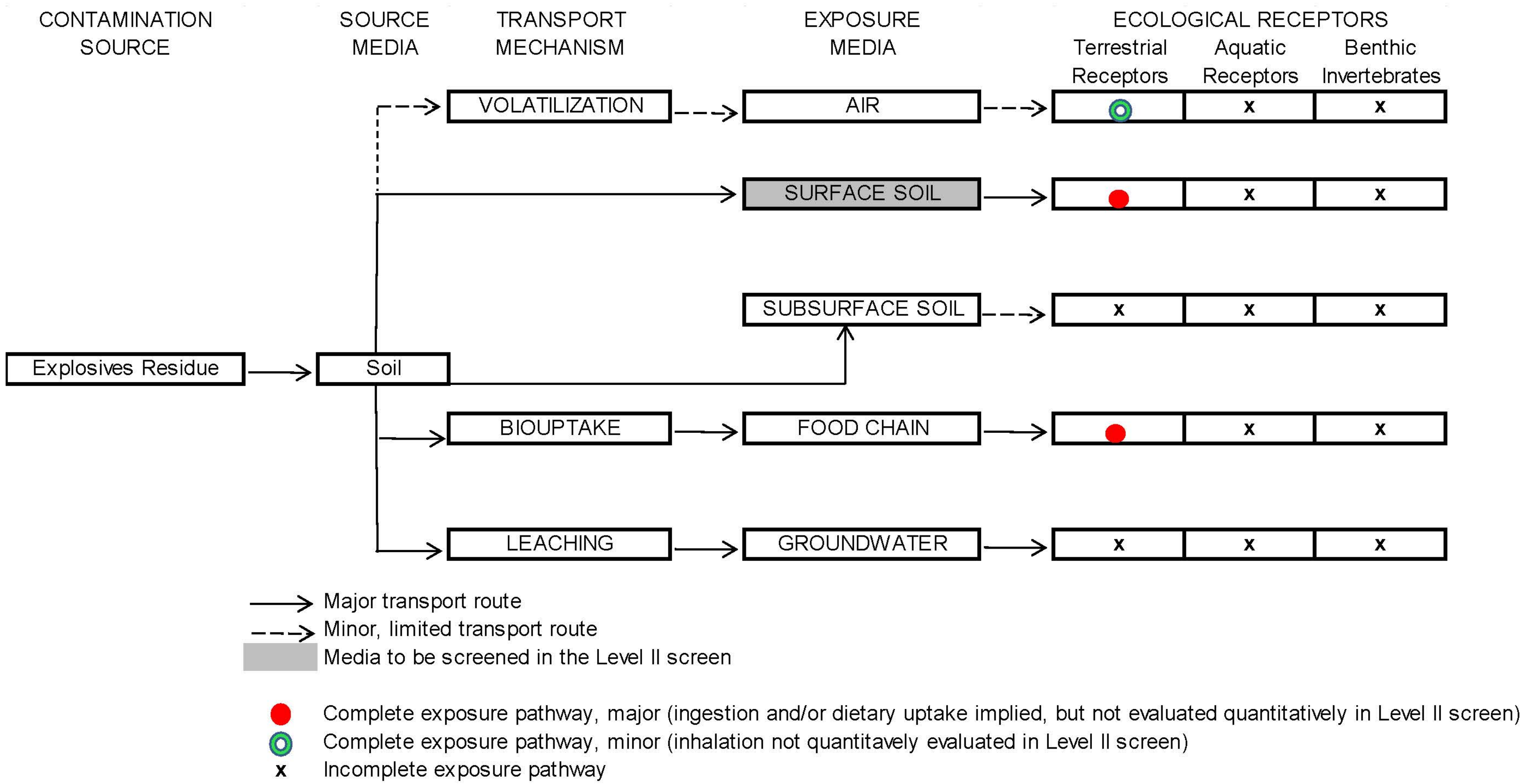
The source media at the Group 8 MRS includes MD and MC in the surface soil. Surface soil for the RVAAP is typically defined as 0 to 1 foot bgs (SAIC, 2010); however, the maximum depth of surface soil sampled for this RI was from 0 to 0.5 feet bgs. This is the anticipated depth interval that MC would be expected to be found, assuming historical OB activities occurred on the ground surface at the MRS and released MC directly into the surrounding soil. Therefore, the applicable surface soil interval for evaluation in this SLERA is between 0 to 0.5 feet bgs.

8.3.1.3 Transport Mechanisms

Potential transport mechanisms at the MRS include volatilization into the air and biota uptake. 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 represent a secondary exposure medium for upper trophic level receptors that prey on the biota.

8.3.1.4 Exposure Media

Sufficient time has elapsed for contaminants in the source medium to have migrated to potential exposure media, resulting in possible exposure of plants and animals that come in 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 RVAAP) was not collected greater than 0.5 feet bgs at the MRS since most MC from OB activities 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), and is not being evaluated at the Group 8 MRS. Groundwater is not considered an exposure medium because ecological receptors are unlikely to contact groundwater. Therefore, soil and biota comprising of prey items for higher trophic level receptors are the two principle exposure media for the Group 8 MRS.



U.S. ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT

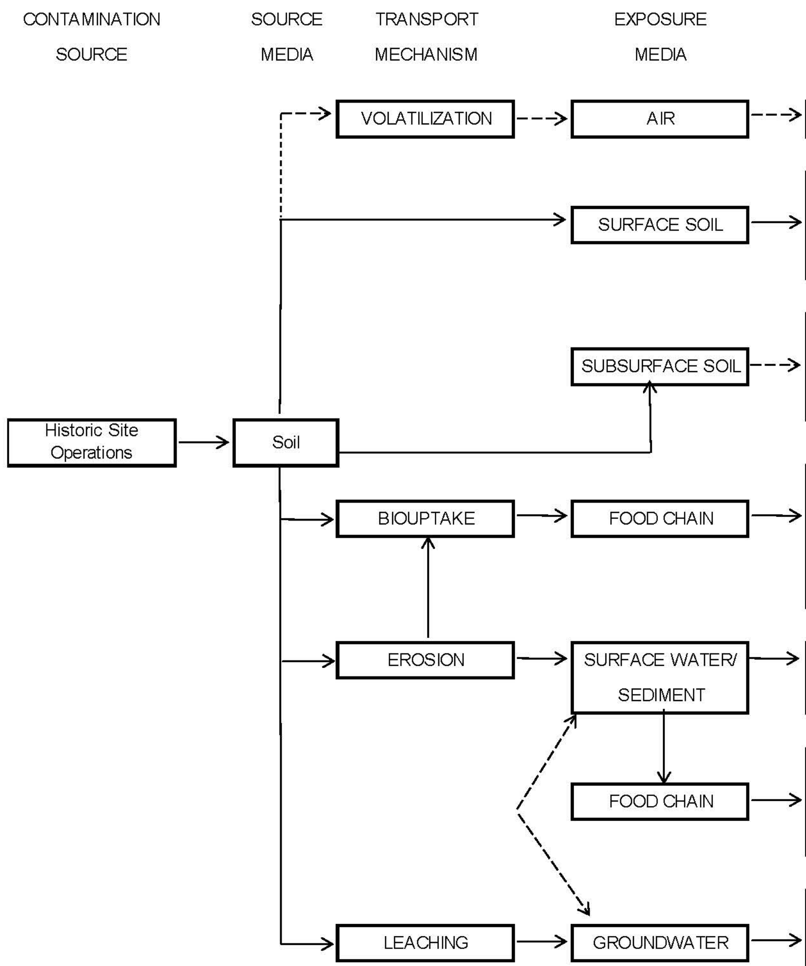
MILITARY MUNITIONS RESPONSE PROGRAM

GROUP 8 MRS
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Project Number: 136147 Generated By: MM Date: 04/02/13 File Path:\\crpbtrpgi01\arcgisprod3\MAMMS\Ravenna\GIS_Documents\Project_Maps\MMRP\RIFS\RIFS_Group8\RVAAP_Group8_019_Fig8_1_LevelII_CSM.mxd

FIGURE 8-1 ECOLOGICAL CSM FOR LEVEL II SCREEN



Exposure Media	Exposure Routes	Terrestrial Plants	Terrestrial Inverts	Rabbit Vole	Shrew Robin	Fox Hawk/Owl	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 or not evaluated

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FIGURE 8-2 PRELIMINARY ECOLOGICAL CSM FOR LEVEL III BASELINE

8.3.1.5 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 sites 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, and whether the organism is mobile or immobile; local or migratory; burrowing or above ground; and plant-eating, animal-eating, or omnivorous.

For the Level II Screening CSM (**Figure 8-1**), specific exposure routes were not identified because the screen is not receptor-specific and only focuses on the comparison of MDCs of chemicals in the exposure media to 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. Ecological receptors are assumed not to come into direct contact with groundwater.

Ecological receptors to be evaluated in the Level II Screening are presented in Section 8.3.1.6. The major exposure routes for chemical toxicity from surface soil to the receptors include ingestion (for terrestrial invertebrates, voles, shrews, robins, foxes, and hawks) and direct contact (for terrestrial plants and invertebrates). The ingestion exposure routes for voles, shrews, robins, foxes, owls, and hawks include soil, as well as plant and/or animal food (i.e., food chain) that was exposed to the surface soil. Minor exposure routes for surface soil include direct contact and inhalation of fugitive dust.

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 part of the surface water medium and would be evaluated as surface water.

8.3.1.6 Ecological Receptors

For the Level II Screening, 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 plants, terrestrial invertebrates (earthworms), voles, shrews, robins, foxes, owls, and hawks. It is noted that due to the small size of the MRS (2.65 acres), the evaluation of some of these receptors that have a home range of many acres (i.e., the raccoon) is highly conservative. These receptors are discussed in more detail in the following sections.

8.3.1.7 Selection of MRS-Specific Ecological Receptor Species

The selection of ecological receptors for the MRS-specific analysis screen was based on plant and animal species that are likely to occur in the terrestrial and aquatic habitats at the MRS. The following three criteria were used to identify the MRS-specific receptors:

1. **Ecological Relevance—**The receptor has or represents a role in an important function such as energy fixation (i.e., plants), 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 site. 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 site, 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 Group 8 MRS, although the small size and low-quality habitat of the MRS would limit the number and types of receptors that regularly use the terrestrial area being evaluated, the following types of ecological receptors may use the MRS to a limited degree and are conservatively included:

- Terrestrial plants
- Terrestrial invertebrates
- Mammalian herbivores such as meadow voles (*Microtus pennsylvanicus*)
- Mammalian and avian insectivores such as short-tailed shrews (*Blarina brevicauda*) and American robins (*Turdus migratoris*)

- Mammalian and avian carnivores such as red foxes (*Vulpes vulpes*) and red-tailed hawks (*Buteo jamaicensis*)

The terrestrial exposures for each of these receptors is described in the following sections and are discussed in greater detail in the *RVAAP Facility-Wide Ecological Risk Assessment Work Plan* (USACE, 2003c).

Terrestrial Vegetation Exposure to Soil

Terrestrial vegetation exposure to soil is applicable to the Group 8 MRS. Terrestrial plants have ecological relevance because they represent the base of the food web and are the primary producers that turn energy from the sun into organic material (plants) that provides food for many animals. There is sufficient habitat present for them at the MRS. In addition, plants are important in providing shelter and nesting materials to many animals, thus, plants are a major component of habitat. Plants provide natural cover and stability to soil and stream banks, thereby reducing soil erosion.

Terrestrial plants are susceptible to toxicity from chemicals. Plants have roots that are in direct contact with surface soil, which provides them with direct exposure to contaminants in the soil. They also can have exposure to contaminants via direct contact on the leaves. There are published toxicity benchmarks for plants (Efroymson et al., 1997b), and there are management goals for plants because of their importance in erosion control. Thus, there is sufficient justification to warrant plants as a candidate receptor for the Group 8 MRS.

Terrestrial Invertebrate Exposure to Soil

Terrestrial invertebrate exposure to soil is applicable to soils for the Group 8 MRS. Earthworms represent the receptor for the terrestrial invertebrate class, and there is sufficient habitat present for them on the MRS. Earthworms have ecological relevance because they are important for decomposition of detritus and for energy and nutrient cycling in soil (Efroymson et al., 1997c), 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., 1997c). Although 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 candidate receptor for the Group 8 MRS.

Mammalian Herbivore Exposure to Soil

Mammalian herbivore exposure to soil is applicable to the Group 8 MRS. Cottontail rabbits and meadow voles represent mammalian herbivore receptors, and although habitat quality is low at this MRS, 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 management goals for rabbits because they are an upland small game species protected under Ohio hunting regulations. There are no specific management goals for meadow voles at the Group 8 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 candidate receptors for the Group 8 MRS.

Insectivorous Mammal and Bird Exposure to Soil

Insectivorous mammal and bird exposure to soil is applicable to the Group 8 MRS. Short-tailed shrews and American robins represent the receptors for the insectivorous mammal and bird terrestrial exposure class, respectively. Although habitat quality is low at this MRS, there is sufficient, suitable habitat present at the MRS for these receptors. Both species have ecological relevance because they help to control above-ground invertebrate community size by consuming large numbers of invertebrates. Shrews and robins are prey items 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 the robin's diet consists of 50 percent 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 sensitivity between mammals and birds exposed to the same contaminants. There are management goals for robins because they are federally protected under the *Migratory Bird Treaty Act of 1993*, as amended. There are no specific management goals for shrews at the MRS. Based on the management goals for robins, plus the susceptibility to contamination and ecological relevance for both species, there is sufficient justification to warrant shrews and robins as candidate receptors for the Group 8 MRS.

Terrestrial Top Predators

Exposure of terrestrial top predators is applicable to the Group 8 MRS. Red foxes, barn owls, and red-tailed hawks represent the mammal and bird receptors for the terrestrial top predator exposure class, and there is a very limited amount of suitable habitat available for them to use 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.

Red foxes, barn owls, 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 site. 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 each taxon (Mammalia and Aves, respectively). Red foxes are primarily carnivorous but consume some plant material. The barn owl and red-tailed hawk consume only animal prey. The fox may incidentally consume soil. There are management goals for all three species. Laws (Ohio trapping season regulations for foxes, and federal protection of raptors under the Migratory Bird Treaty Act) also protect these species. In addition, all three species are susceptible to contamination and have ecological relevance as top predators in the terrestrial ecosystem. Thus, there is sufficient justification to warrant these three species as candidate receptors for the Group 8 MRS.

8.3.1.8 Relevant and Complete Exposure Pathways

Relevant and complete exposure pathways for the ecological receptors at the Group 8 MRS were described in the previous sections. As previously discussed, there are relevant and complete exposure pathways for various ecological receptors including terrestrial vegetation and invertebrates and terrestrial herbivores, insectivores, and carnivores. Thus, these types of receptors could be exposed to COPECs in surface soil at the Group 8 MRS.

8.3.2 Ecological Endpoint (Assessment and Measurement) Identification

The protection of ecological resources, such as habitats and species of plants and animals, is a primary motivation for conducting SLERAs. Key aspects of ecological protection are presented as management goals. These are general 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., the CERCLA, *National Environmental Policy Act*). Other legislation includes the ESA of 1993, as amended (16 USC 1531-1544) and the *Migratory Bird Treaty Act* 1993, as amended (16 USC 703–711). To evaluate whether a management goal has been met, assessment endpoints, measures of effects, and decision rules were formulated. The management goals, assessment endpoints, measures of effects, and decision rules are discussed below.

Because only terrestrial habitat is being evaluated at the Group 8 MRS, there is only one primary management goal for this MRS. However, the assessment endpoints differ between the general screen and the MRS-specific analysis screen. The management goal for the SLERA is to protect terrestrial plant and animal populations from adverse effects due to the release or potential release of chemical substances associated with past MRS activities.

Ecological assessment endpoints are selected to determine whether this 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. Accordingly, assessment endpoints generally refer to characteristics of populations and communities. 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 a threatened and endangered species. Because threatened and endangered species are not a concern at the Group 8 MRS, potential impacts to populations is the appropriate criterion for consideration at the MRS.

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 population, communities, habitats, and sensitive environments (Ohio EPA, 2008). Although the assessment endpoints for the Level II Screening are associated with Management Goal 1, specific receptors are not identified with the assessment endpoints.

Table 8-1 shows the management goals for terrestrial resources, associated assessment endpoints, measures of effect, and decision rules by assessment endpoint number.

Furthermore, the table provides definitions of assessment endpoints 1 through 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 more than 1. If the HQ is greater than 1, the scientific management decision point options from Ohio EPA/Army Guidance 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 management goal. Assessment endpoints 1 through 4 entail the growth, survival, and reproduction of terrestrial receptors such as vegetation and 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 Management Goal 1, protection of terrestrial populations and communities.

The assessment endpoints are evaluated through the use of 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. 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 MDCs of each contaminant in soil to ESV benchmarks. Measurement endpoints for the Level II Baseline include the comparison of estimated doses of chemicals in various receptor animals such as voles, shrews, and robins to toxicity reference values.

In the Level II Screening, MDCs in soil were used as the EPC for comparison to generic soil screening values that are expected not to cause harm to ecological populations. Any COPECs retained following the Level II Screening 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.

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

Management Goals	Assessment Endpoint	Measures of Effect	Decision Rule
Management Goal 1: The protection of terrestrial populations, communities, and ecosystems	Assessment Endpoint 1: Growth, survival, and reproduction of plant and soil invertebrate communities and tissue concentrations of contaminants low enough such that higher trophic levels that consume them are not at risk Receptors: plants and earthworms	Measures of Effect 1: Plant and 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 plants and soil invertebrates, are less than or equal to 1, then Assessment Endpoint 1 has been met and plants and soil-dwelling invertebrates are not at risk. If the HQs are >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 >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.

Table 8-1 (continued)
Management Goals, Ecological Assessment Endpoints, Measures of Effect, and Decision Rules Identified for a Level II Screening

Management Goals	Assessment Endpoint	Measures of Effect	Decision Rule
Management Goal 1: The protection of terrestrial populations, communities, and ecosystems (continued)	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 >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 4: Growth, survival, and reproduction of carnivorous mammal and bird populations Receptors: barn owl, 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 >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.

Table 8-1 (continued)
Management Goals, Ecological Assessment Endpoints, Measures of Effect, and Decision Rules Identified for a Level II Screening

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

For the Level III Baseline, decision rules for COPECs were obtained from the Ohio EPA Guidance (2008) for chemicals. Briefly, for COPECs, the first decision rule is based on the ratio (or the 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 toxicity reference value (TRV; denominator) of the same chemical. A ratio of 1 or less means that ecological risk is negligible, while a ratio of greater than 1 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 HI 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: (1) no significant risks to endpoint species so no further analysis is needed, (2) field baseline assessment conducted 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 (3) 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 Group 8 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 four ISM surface soil samples collected as part of the RI field effort to characterize the nature and extent of SRCs associated with previous activities at the MRS. ISM samples were collected at the MRS during the 2007 SI, but was not included in this SLERA based on the rationale discussed in Section 2.4.

The ISM samples were collected from nonoverlapping spatial areas that covered the entire MRS. Only surface soil (typically defined as 0 to 1 foot bgs, but represented by ISM samples collected from the 0- to 0.5-foot-bgs soil interval) samples were used in the SLERA because most ecological exposure occurs within the top 1 foot of soil. Also, as an MRS, it is expected that much of the native soil has been reworked, removed, or used as cover material, which would likely decrease the attractiveness to burrowing receptors. Therefore, the 0- to 0.5-foot-bgs interval is assumed to represent the zone of maximum exposure for most ecological receptors. Samples included in the ecological risk assessment data set are identified in **Table 8-2**.

Table 8-2
Ecological Risk Assessment Data Use Summary

Sample ID	Sample Date	Depth (feet bgs)	Sample Type	Analysis
Surface Soil				
GR8SS-001M-0001-SO	2/8/12	0 to 0.5	ISM	Metals[1], Explosives, Nitrocellulose, SVOCs, PCBs, TOC, pH
GR8SS-002M-0001-SO				
GR8SS-003M-0001-SO				
GR8SS-004M-0001-SO				

[1] Metals includes analysis for aluminum, antimony, barium, cadmium, copper, chromium (total), hexavalent chromium, iron, lead, zinc, mercury, strontium, and zinc.
bgs denotes below ground surface.
ID denotes identification.
ISM denotes incremental sampling methodology.
PCB denotes polychlorinated biphenyl.
SVOC denotes semivolatile organic compound.
TOC denotes total organic carbon.

The MC analytical data were reviewed and evaluated for quality, usefulness, and uncertainty, as described in Section 4.3. From the MC chemical results of samples described above, a COPEC selection process was performed to develop a subset of chemicals that are identified as COPECs.

8.3.3.2 COPEC Selection Criteria

The section describes the selection criteria used to identify COPECs in the SLERA. The screen incorporates the same criteria described in Section 4.3.1.3 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-related contaminants at the MRS. With the exceptions of these chemicals, all detected chemicals considered as SRCs associated with the munitions that may been burned or buried at the Group 8 MRS and are included in the COPEC screening step. The SRCs identified for the surface soil sampled during the RI field activities are presented in Section 4.4.1 and evaluated in **Table 8-3**.

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

	Range of Values, mg/kg											
	Detected Concentrations				Reporting Limits		BSV[1] (mg/kg)	ESV[1] (mg/kg)	Below ESV?	HQ	PBT?[1]	COPEC?[3]
Chemical	Minimum	VQ	Maximum	VQ	Minimum	Maximum						
Metals												
Antimony	5		22.8	J	0.81	0.81	0.96	0.27	No	84.4	No	Yes
Barium	127		257	J	0.051	0.051	88.4	330	Yes	0.8	No	No (b)
Cadmium	6.6		396	J	0.04	0.04	0	0.36	No	1,100	Yes	Yes
Chromium (as Cr^{+3})	22.8		39		0.14	0.14	17.4	26	No	1.5	No	Yes
Copper	225		711	J	0.4	0.4	17.7	28	No	25	Yes	Yes
Iron	34,300		54,400		9.1	9.1	23,100	NA	NA	NA	No	Yes
Lead	300		977		0.25	0.25	26.1	11	No	88.8	Yes	Yes
Mercury	0.21		0.89		0.0084	0.0084	0.036	0.00051	No	1,745	Yes	Yes
Strontium	48.3		119		0.081	0.081	0	96	No	1.2	No	Yes
Zinc	346		1,060		0.3	0.3	61.8	46	No	23	Yes	Yes
Explosives and Propellants												
2,4,6-Trinitrotoluene	0.3	J	0.3	J	0.4	0.4	NA	6.4	Yes	0.05	No	No (b)
Nitroguanidine	0.12	J	0.17	J	0.25	0.25	NA	NA	NA	NA	No	Yes
Semivolatile Organic Compounds												
2-Methylnaphthalene	0.092	J	0.04		0.12	0.12	NA	3.24	Yes	0.1	Yes	No (b)
Acenaphthene	0.045	J	0.11	J	0.12	0.12	NA	29	Yes	0.004	No	No (b)
Acenaphthylene	0.038	J	0.051	J	0.12	0.12	NA	29	Yes	0.002	No	No (b)
Anthracene	0.041	J	0.19		0.12	0.12	NA	29	Yes	0.007	No	No (b)
Benzo(a)anthracene	0.11	J	0.41		0.12	0.12	NA	1.1	Yes	0.4	No	No (b)
Benzo(a)pyrene	0.069	J	0.27		0.12	0.12	NA	1.1	Yes	0.2	No	No (b)
Benzo(b)fluoranthene	0.15	J	0.46		0.12	0.12	NA	1.1	Yes	0.4	No	No (b)
Benzo(ghi)perylene	0.06	J	0.15		0.12	0.12	NA	1.1	Yes	0.14	No	No (b)
Benzo(k)fluoranthene	0.042	J	0.23		0.12	0.12	NA	1.1	Yes	0.2	No	No (b)
Bis(2-Ethylhexyl)phthalate	0.29	J	2	J	0.4	0.4	NA	0.925	No	2.2	Yes	Yes
Carbazole	0.032	J	0.15		0.12	0.12	NA	0.00008	No	1,875	No	Yes
Chrysene	0.11	J	0.43		0.12	0.12	NA	1.1	Yes	0.4	No	No (b)
Dibenzo(a,h)anthracene	0.026	J	0.064	J	0.12	0.12	NA	1.1	Yes	0.1	No	No (b)
Dibenzofuran	0.036	J	0.16		0.12	0.12	NA	6.1	Yes	0.03	Yes	No (b)
Di-n-Butyl Phthalate	0.1	J	0.46		0.4	0.4	NA	200	Yes	0.002	Yes	Yes
Fluoranthene	0.28	J	1.2		0.12	0.12	NA	29	Yes	0.04	No	No (b)
Fluorene	0.044	J	0.091	J	0.12	0.12	NA	29	Yes	0.003	No	No (b)

	Range of Values, mg/kg											
	Detected Concentrations				Reporting Limits		BSV[1] (mg/kg)	ESV[1] (mg/kg)	Below ESV?	HQ	PBT?[1]	COPEC?[3]
Chemical	Minimum	VQ	Maximum	VQ	Minimum	Maximum						
Indeno(1,2,3-cd)pyrene	0.048	J	0.16		0.12	0.12	NA	1.1	Yes	0.1	No	No (b)
Naphthalene	0.081	J	0.36		0.12	0.12	NA	29	Yes	0.01	No	No (b)
Phenanthrene	0.19		0.99		0.12	0.12	NA	29	Yes	0.03	No	No (b)
Pyrene	0.2	J	0.87		0.12	0.12	NA	1.1	Yes	0.8	No	No (b)
Polychlorinated Biphenyls												
Aroclor-1254	0.3		7.0.74		0.1	0.2	NA	0.371	No	2.0	Yes	Yes
Aroclor-1260	0.15		0.41		0.1	0.2	NA	0.371	No	1.1	Yes	Yes

[1] See screening values in Appendix K.
[2] Chemicals with MDCs lower than the BSV are not considered as SRCs.
[3] Selection of COPECs:
Yes = COPEC exceeds the ESV and BSV, or is a PBT pollutant whose ESV is not protective of food chain effects.
No(a) = Chemical is not site-related (MDC is less than the BSV).
No(b) = The MDC is less than the ESV and the chemical is either not a PBT or is a PBT chemical but the ESV is protective of food chain effects.
bgs denotes below ground surface.
BSV denotes background value.
COPEC denotes chemical of potential ecological concern.
Cr^{+3} denotes trivalent chromium.
ESV denotes ecological screening value.
HQ denotes hazard quotient.
J denotes that the result is less than the reporting limit but greater than or equal to the method detection limit.
MDC denotes maximum detected concentration.
mg/kg denotes milligrams per kilogram.
NA denotes not applicable/available.
PBT denotes persistent, bioaccumulative, and toxic.
VQ denotes validation qualifier.

Comparison to Ecological Screening Values

The MDCs of chemicals detected in the surface soil samples were compared with ESVs used as ecological endpoints following recommendations in the Ohio EPA Guidance (2008), and consistent with the Unified Approach for performing ERAs at the RVAAP. The SRCs that exceed the ESVs, or for which no ESVs are available, were retained as COPECs. Chemicals that were considered as a 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 the 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 following ESV hierarchy was used for the ecological evaluation of soil:

- *Ecological Soil Screening Levels* (EPA, 2010), with online updates from <http://www.epa.gov/ecotox/ecossl/>
- Preliminary Remediation Goals for Ecological Endpoints (Efroymson et al., 1997b)
- Region 5 Resource Conservation and Recovery Act Ecological Screening Levels (ESLs) (EPA, 2003)
- *EcoRisk Database*, Release 2.5 (Los Alamos National Laboratory, 2010)
- *Nitroaromatic Munitions Compounds: Environmental Effects and Screening Values* (Talmage et al., 1999)

The ESVs used for the SLERA were approved in the Work Plan Addendum (Shaw, 2011) and are presented in **Appendix K**.

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. For this MRS, iron is considered to be an MC, and cannot be eliminated as an essential nutrient. Calcium, magnesium, and manganese were the only other essential nutrients analyzed. These analytes are not considered an MC and were analyzed for potential use in a geochemical evaluation of background concentrations. Evaluation for calcium, magnesium, and manganese was not carried through in the SLERA since a geochemical evaluation was not prepared for the RI.

8.3.4 Summary of COPEC Selection

The results of the COPEC screening for surface soil samples evaluated in the SLERA are presented in **Table 8-3**. The tables present the following information for each medium:

- Identified SRC
- Range of detected concentrations
- Range of detection limits
- Mean concentration (for media with more than one sample)
- BSV
- ESV
- HQ
- Determination as to whether the chemical is a PBT compound (soil and sediment only)
- 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 exists. 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 ESV is not protective of food chain effects. A description and summary of the COPECs identified in the media at the Group 8 MRS is presented in the following sections.

8.3.4.1 Soil COPEC Selection

For the ISM surface soil samples, a total of 35 chemicals were detected and evaluated as SRCs that include 14 metals, 2 explosives compounds, 2 PCBs, and 21 SVOCs (**Table 8-3**). One metal, one explosives compound, and 18 SVOCs were eliminated because their MDCs were lower than their ESVs and either they are not PBT compounds, or they are classified as a PBT compound but their ESV is protective of food chain effects. Following the screen, one explosives compound (nitroguanidine), nine metals (antimony, cadmium, chromium, copper, iron, lead, mercury, strontium, and zinc), three SVOCs [bis(2-ethylhexyl) phthalate, carbazole, and di-n-butyl phthalate], and two PCBs (Aroclor-1254 and Aroclor-1260) and were identified as COPECs.

8.3.5 Refinement of COPECs (Step 3a)

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). 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 the MRS. This portion of the Level II Screening represents the Step 3a COPEC refinement, where additional factors are considered that offer more information as to whether a chemical selected as a COPEC during the conservative screening step truly represents an unacceptable risk for ecological receptors. The additional factors to be considered are presented in the Unified Approach list of possible evaluation and refinement factors. Some of these factors are discussed in the following paragraphs.

Due to the highly conservative nature of the Level II Screening, the identification of initial COPECs does not necessarily indicate that the potential for adverse effects is realistic. Although any chemical with an HQ greater than 1 must be identified as a COPEC and is recognized as being a potential concern, if exceedances are low, and other corroborating information suggests that the potential for ecological impacts is minimal, then a recommendation for no additional investigation may be warranted (Ohio EPA, 2008).

As a general consideration, it should be noted that HQs are not measures of risk, are not population-based statistics, and are not linearly scaled statistics. Therefore, an HQ above 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). As a general guideline, HQs less than 10 are considered to represent a low potential for environmental effects, HQs from 10 up to 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 Screening are discussed in additional detail in this section to support final recommendations for this stage of the ERA process.

8.3.6 Weight of Evidence Discussion for Surface Soil

Fifteen COPECs were identified in discrete soil samples, including one explosives compound (nitroguanidine), nine metals (antimony, cadmium, chromium, copper, iron, lead, mercury, strontium, and zinc), three SVOCs [bis(2-ethylhexyl)phthalate, carbazole, and di-n-butyl phthalate], and two PCBs (Aroclor-1254 and Aroclor-1260). It is noted that chromium was also analyzed for as hexavalent chromium, and all results for this analysis were nondetect; therefore, chromium is assumed to consist nearly entirely of its trivalent (Cr^{+3}) form, and is compared to trivalent screening values in this SLERA. **Table 8-4** presents the concentrations of all COPECs by ISM sample, and **Table 8-5** presents the HQs associated with each

COPEC in the individual samples. Additional discussion of some of the COPECs is provided in the following paragraphs.

Iron is a commonly occurring metallic element, comprising nearly 5 percent of igneous and sedimentary rocks. It is also essential for plant growth, and is generally considered to be a micronutrient. Iron was selected as a COPEC because it lacks an ESV. An ESV is not available for iron because iron's bioavailability to plants and associated toxicity are dependent upon MRS-specific soil conditions, especially pH. In soils with pH between 5 and 8, the iron demand of plants is higher than the amount available, and toxicity is not expected. Therefore, EPA recommends no further action for iron in soils with a pH of 5 or greater (EPA, 2008b). The pH data for the four ISM surface soil samples (plus the one field duplicate sample) collected at the Group 8 MRS ranged from 7.19 to 8.24. Therefore, iron is not expected to pose a threat to ecological receptors at this MRS, and is not considered further.

Chromium, strontium, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, and the 2 PCBs had HQs below 10 (**Table 8-2**). The HQs for strontium and Aroclor-1260 did not exceed 1 when rounded. Strontium also lacked a BSV; therefore, its detected concentrations may fall within the range that is naturally occurring. Chromium (HQ = 1.5) and strontium (HQ = 1.2) had HQs that approximated 1, neither metal is bioaccumulative (hexavalent chromium, which is considered bioaccumulative, was determined not to comprise any significant proportion of the total chromium detected at this MRS), and strontium may be background-related. Therefore, further evaluation of these two metals is not recommended. The HQs for bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, and the two PCBs are also very low. In fact, di-n-butyl phthalate had an HQ three orders of magnitude below 1, and was only retained as a COPEC because it is a PBT chemical, and its ESV may not be protective of food chain effects. Because these four chemicals are bioaccumulative and may represent more significant hazards to receptors at higher trophic levels, they are initially retained as COPECs for further evaluation.

Antimony, copper, lead, and zinc had HQs in the 10 to 100 range (**Table 8-2**). For these four metals, elevated concentrations resulting in HQs greater than 10 were detected in all four ISM units for antimony and lead, and in three of the four ISM units for copper and zinc (**Table 8-5**). Copper, lead, and zinc are PBT chemicals. All four of these metals are retained initially as COPECs for further evaluation.

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

			Sample Location:	**GR8SS-001M**		**GR8SS-002M**		**GR8SS-003M**		**GR8SS-004M**	
			Sample Number:	**GR8SS-001M-0001-SO**		**GR8SS-002M-0001-SO**		**GR8SS-003M-0001-SO**		**GR8SS-004M-0001-SO**	
			Sample Date:	**2/8/12**		**2/8/12**		**2/8/12**		**2/8/12**	
			Sample Depth (feet bgs):	**0–0.5**		**0–0.5**		**0–0.5**		**0–0.5**	
COPEC	**BSV**	**ESV**	**Units**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**
Metals											
Antimony	0.96	0.27	mg/kg	***5***		***6.6***		***11.7***		***22.8***	***J***
Cadmium	0	0.36	mg/kg	***6.6***		***23.3***		***21.3***		***396***	***J***
Chromium (as Cr^{+3})	17.4	26	mg/kg	*23*		*22.8*		***39***		***27.9***	***J***
Copper	17.7	28	mg/kg	***470***		***225***		***585***		***711***	***J***
Iron	23100	NA	mg/kg	***34300***		***37200***		***54400***		***50300***	***J***
Lead	26.1	11	mg/kg	***493***		***300***		***977***		***887***	***J***
Mercury	0.036	0.00051	mg/kg	***0.26***		***0.21***		***0.89***		***0.63***	
Strontium	0	96	mg/kg	*48.3*		***103***		*75.2*		***119***	
Zinc	61.8	46	mg/kg	***470***		***346***		***1060***		***1020***	***J***
Explosives and Propellants											
Nitroguanidine	NA	NA	mg/kg	ND		0.12	J	ND		0.17	J
Semivolatile Organic Compounds											
Bis(2-Ethylhexyl)phthalate	NA	0.925	mg/kg	0.79	J	0.29	J	ND		**2**	**J**
Carbazole	NA	0.00008	mg/kg	**0.045**	**J**	**0.032**	**J**	**0.15**		**0.1**	**J**
Di-n-Butyl Phthalate	NA	200	mg/kg	0.14		0.1		0.11		0.46	
Polychlorinated Biphenyl											
Aroclor-1254	NA	0.371	mg/kg	**0.51**		0.3		**0.74**		**0.58**	
Aroclor-1260	NA	0.371	mg/kg	**0.41**		0.15		0.23		0.16	

Detects in bold exceed the ESV; detects in italics exceed the BSV or indicate that a BSV is not available (metals only).
bgs denotes below ground surface.
BSV denotes background screening value.
COPEC denotes chemical of potential ecological concern.
Cr^{+3} denotes trivalent chromium.
ESV denotes ecological screening value.
J denotes that 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 not applicable; a screening value was not available for this chemical.
ND denotes not detected.
VQ denotes validation qualifier.

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

Sample Location:	**GR8SS-001M**	**GR8SS-002M**	**GR8SS-003M**	**GR8SS-004M**
Sample Number:	**GR8SS-001M-0001-SO**	**GR8SS-002M-0001-SO**	**GR8SS-003M-0001-SO**	**GR8SS-004M-0001-SO**
Sample Date:	**2/8/12**	**2/8/12**	**2/8/12**	**2/8/12**
Sample Depth (feet bgs):	**0–0.5**	**0–0.5**	**0–0.5**	**0–0.5**
COPEC	**HQ**	**HQ**	**HQ**	**HQ**
Metals				
Antimony	**18.5**	**24.4**	**43.3**	**84.4**
Cadmium	**18.3**	**64.7**	**59.2**	**1,100**
Chromium (as Cr^{+3})			1.5	1.1
Copper	**16.8**	8.0	**20.9**	**25.4**
Lead	**44.8**	**27.3**	**88.8**	**80.6**
Mercury	**510**	**412**	**1,745**	**1,235**
Strontium		1.1		1.2
Zinc	**10.2**	7.5	**23.0**	**22.2**
Explosives				
Nitroguanidine	NA	NA	NA	NA
Semivolatile Organic Compounds				
Bis(2-Ethylhexyl)phthalate				
Carbazole	**563**	**400**	**1,875**	**1,250**
Di-n-Butyl Phthalate				
Polychlorinated Biphenyls				
Aroclor 1254	1.4		2.0	1.6
Aroclor 1260	1.1			

Cells in bold exceed an HQ of 10.
Shaded cells exceed and HQ of 100.
Only results that exceed the background and ecological screening values in Table 8-4 are present.
bgs denotes below ground surface.
COPEC denotes chemical of potential ecological concern.
Cr^{+3} denotes trivalent chromium.
HQ denotes hazard quotient.
NA denotes not applicable; a screening value was not available for this chemical.

The HQs for cadmium (HQ = 1,100), mercury (HQ = 1,235) and carbazole (HQ = 1,250) were highly elevated, and exceeded an HQ of 100. Cadmium exceeded an HQ of 100 only at surface sample location GR8ss-004M (**Table 8-5**), but exceeded an HQ of 10 at the other three ISM units (although it should be noted that cadmium lacks a BSV, and it is unknown to what degree cadmium exceeds naturally occurring concentrations). The MDC for mercury of 0.89 mg/kg was slightly more than an order of magnitude greater than its BSV of 0.036 mg/kg, and only the sample at location GR8ss-003M had a detected concentration that exceeded both its BSV and ESV. The reason for mercury's elevated HQ values in spite of being present at concentrations approximating background is that the extremely low ESV of 0.00051 mg/kg likely exaggerates predicted hazard associated with this metal, particularly in terrestrial systems. The mercury ESV was calculated using the toxicity properties of methylmercury (Efroymson et al., 1997a), which may not be appropriate for a soil benchmark value. Methylmercury is a highly toxic, organometallic form of mercury that forms naturally in water from the bioconversion of inorganic forms of mercury (HSDB, 2012c). Inorganic mercury compounds can be methylated by microorganisms indigenous to soil under both aerobic and anaerobic conditions; however, the methylation rate is generally considered to be quite low (EPA, 2005) and the process is balanced by microbial processes that reduce inorganic cationic mercury and methylmercury to elemental mercury, which is free to volatilize from soil. Therefore, methylmercury is not the dominant form of mercury in terrestrial systems. The EPA (2005) assumes that 98 percent of the mercury in soil exists as cationic compounds and that 2 percent exists as methylmercury, except in wetland areas. Thus, the use of methylmercury toxicity values to calculate an ESV protective of soil receptors is highly conservative at a site such as the Group 8 MRS that lacks wetland areas. It is noted that alternate mercury ESVs available for the RVAAP are approximately three orders of magnitude greater than the selected ESV, likely because they were based on less toxic forms of mercury that are more common in terrestrial systems (**Appendix K)**. If the EPA Region 5 (EPA, 2003) alternate ESV of 0.1 mg/kg is used, mercury in ISM soil samples at the Group 8 MRS would have an HQ of less than 10 (HQ = 8.9). Cadmium and mercury are retained as COPECs for additional analysis.

The final COPEC with highly elevated HQs is carbazole. Carbazole, is a heterocycle, which is a PAH in which one of the carbons within the aromatic structure is substituted by a nitrogen atom. Carbazole occurs as a natural constituent of creosote and coal tar (ATSDR, 2002) and is often collocated with PAHs in the environment. Carbazole was detected in all four ISM surface soil samples at concentrations ranging from 0.032 to 0.15 mg/kg, which is consistent with other PAHs detected in surface soil (**Table 8-2**). Unlike the PAHs, carbazole had very high HQs (maximum HQ = 1,875) in many sampling units (**Table 8-5**) owing to its very low ESV of 0.00008 mg/kg, which is approximately five orders of magnitude lower than the ESVs for PAHs such as benzo(a)pyrene (ESV of 1.1 mg/kg). Given the structural similarity of carbazole to PAHs, the appropriateness of using such a conservative ESV is highly questionable, particularly in light of the fact that soil toxicity studies have shown carbazole exhibits similar toxic responses as PAHs in soil invertebrates (Wassenberg et al., 2005; Sverdrup et al., 2001, 2002a, and 2002b). Therefore, the presence of carbazole represents a slight uncertainty at the MRS, but further investigation of this chemical in soil is not recommended for ecological purposes.

The one explosive and propellant compound selected as a COPEC, nitroguanidine, could not be evaluated in the initial Level II Screening because no ESV was identified for this compound. The compound was detected in two out of four samples at concentrations below its reporting limit (**Table 8-2**). Explosive and propellant compounds typically are not bioaccumulative, and this chemical is not 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, and is not recommended for further evaluation.

8.3.7 Level II Screening Conclusions and Recommendations

Several chemicals detected in surface soil samples collected at the Group 8 MRS were at elevated concentrations in multiple ISM sampling units. Furthermore, nine of the COPECs identified in the ISM samples are considered PBT chemicals that may bioaccumulate in the food chain at the Group 8 MRS. Because multiple chemicals were present at elevated concentrations in a relatively widespread area (particularly as demonstrated by elevated concentrations detected in multiple ISM sampling units), and because several of these chemicals are bioaccumulative, a Level III Baseline is recommended for COPECs in the Group 8 MRS soil to estimate ecological hazards to specific target receptors. The Level III Baseline more accurately refines hazard estimates for various ecological receptor guilds likely to be present at the site. A few chemicals that were identified as COPECs in ISM soil samples are not recommended for further evaluation in the Level III Baseline, for reasons stated in Section 8.3.6, including chromium, iron, strontium, nitroguanidine, and carbazole. The remaining COPECs [i.e., antimony, cadmium, copper, lead, mercury, zinc, bis(2-ethyhexyl)phthalate, di-n-butyl phthalate, Aroclor-1254, and Aroclor-1260] are evaluated further in the Level III Baseline.

8.4 Level III Baseline Evaluation

The objective of a Level III Baseline evaluation is to estimate hazards to representative endpoint species using a deterministic risk assessment approach (Ohio EPA, 2008). This evaluation is performed in accordance with the ecological CSM presented during the Level II Screening (Section 8.3), modified based on recommendations from the Level II Screening. According to the recommendations from the Level II Screening, the scope of the Level III evaluation is limited to only evaluating the COPECs identified in the ISM surface soil samples for food chain effects in soil, with the exception of iron, which was not carried forward to the Level III Baseline. A revised Level III CSM reflecting this scope is presented in **Figure 8-3**.

8.4.1 Exposure Assessment

An estimate of the nature, extent, and magnitude of potential exposure of assessment receptors to COPECs that are present at or migrating from the MRS is presented in this section, considering both current and reasonably plausible future use of the MRS. Exposure characterization is critical in further evaluating the risk of chemicals identified as COPECs during the screening process. The exposure assessment has been conducted by linking the magnitude (concentration) and distribution (locations) of the contaminants detected in the media sampled during the investigation, evaluating pathways by which chemicals may be transported through the environment, and determining the points at which organisms found in the study area may contact contaminants.

8.4.1.1 Exposure Analysis

An exposure analysis was performed that combines the spatial and temporal distribution of the ecological receptors with those of the COPECs to evaluate exposure. The exposure analysis focuses on the bioavailable chemicals and the means by which the ecological receptors are exposed (i.e., exposure pathways). The focus of the analysis is dependent on the assessment receptors being evaluated as well as the assessment and measurement endpoints.

Exposure pathways consist of four primary components: (1) source and mechanism of contaminant release, (2) transport medium, (3) potential receptors, and (4) exposure route. A chemical may also be transferred between several intermediate media before reaching the potential receptor. All of these components are described in the ecological CSM (Section 8.3.1). If any of these components is not complete, then contaminants in the affected media do not constitute an environmental risk at the MRS. The major fate and transport properties associated with typical MRS contaminants are described in subsequent sections. These properties directly affect a contaminant's behavior in each of the exposure pathway components.

Ecological routes of exposure for biota may be direct (bioconcentration) or through the food web via the consumption of contaminated organisms (biomagnification). Direct exposure routes include dermal contact, absorption, inhalation, and ingestion. Examples of direct exposure include animals incidentally ingesting contaminated soil or sediment (i.e., during burrowing or dust-bathing activities), animals ingesting surface water, plants absorbing contaminants by uptake from contaminated sediment or soil, and the dermal contact of aquatic organisms with contaminated surface water or sediment. Given the scarcity of

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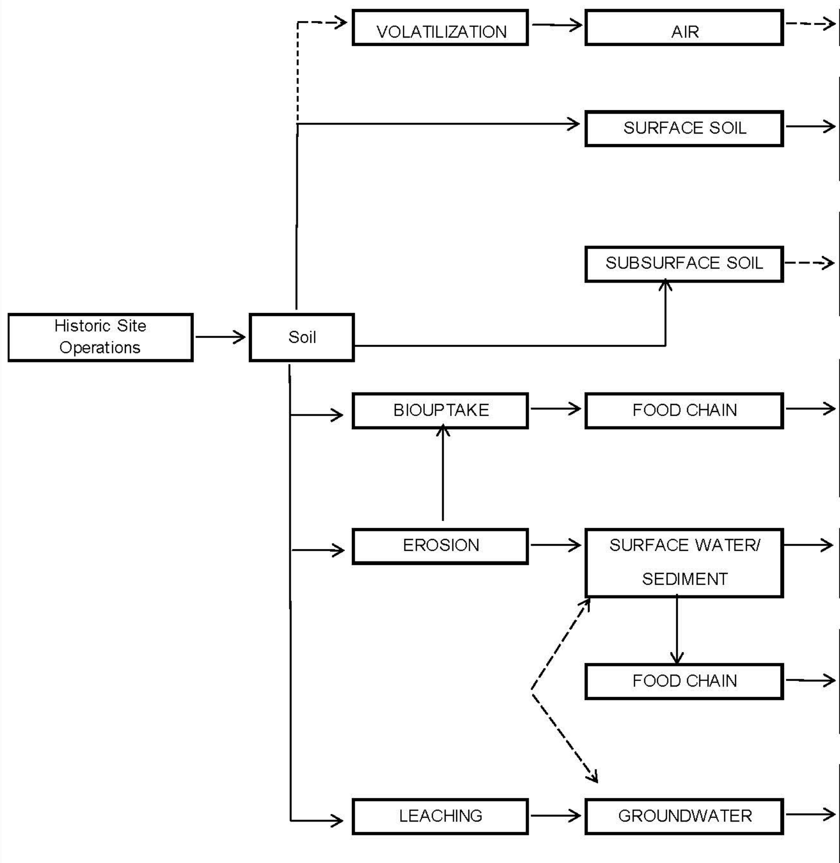

EXPOSURE MEDIA	EXPOSURE ROUTES	Terrestrial Plants	Terrestrial Inverts	Rabbit Vole	Shrew Robin	Fox Hawk/Owl	Aquatic biota	Muskrat Duck	Mink Heron	Benthic Inverts
AIR	INHALATION (VAPORS)	x	x	◎	◎	◎	x	◎	◎	x
SURFACE SOIL	INGESTION	x	●	●	●	●	x	x	x	x
	DIRECT/DERMAL CONTACT	●	●	◎	◎	◎	x	x	x	x
	INHALATION (FUGITIVE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

ECOLOGICAL RECEPTORS

→ Major route
- - → Minor route

● Complete exposure pathway, major
◎ Complete exposure pathway, minor
x Incomplete exposure pathway or not evaluated
Eliminated as a receptor or exposure pathway for Level III

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FIGURE 8-3 REFINED ECOLOGICAL CSM FOR LEVEL III BASELINE

available data for wildlife dermal and inhalation exposure pathways, potential risk from these pathways is not estimated in this SLERA. In addition, these pathways are generally considered to be incidental for most species, with the possible exceptions of burrowing animals and dust-bathing birds.

Food web exposure can occur when terrestrial or aquatic fauna consume contaminated biota. Examples of food web exposure include animals at higher trophic levels consuming plants or animals that bioaccumulate contaminants.

Bioavailability is an important contaminant characteristic that influences the degree of chemical-receptor interaction. The bioavailability of a chemical refers to the degree to which a receptor is able to absorb a chemical from the environmental medium. A chemical's bioavailability is a function of several physical and chemical factors such as grain size, organic carbon content, water hardness, and pH. Unless MRS-specific data are available, bioavailability is conservatively assumed to be 100 percent.

Daily doses of COPECs for vertebrate receptors were calculated using standard exposure algorithms. These algorithms incorporate species-specific natural history parameters (i.e., feeding rates, water ingestion rates, dietary composition, etc.) and also use MRS-specific area use factors, as follows:

Equation 8.1:

$$Total\ Daily\ Dose = \left(\frac{\left(\left[Soil_j * IR_{soil} \right] + \left[Water_j * IR_{water} \right] + \left[\sum_{i=1}^{N} B_{ji} * P_i * IR_{food} \right] \right)}{Body\ Weight} \right) * AUF$$

Where:

$Soil_j$ = Concentration of COPEC "j" in soil
$Water_j$ = Concentration of COPEC "j" in surface water
B_{ji} = Concentration of COPEC "j" in food type "i"
IR_{soil} = Soil ingestion rate
IR_{water} = Surface water ingestion rate
IR_{food} = Food ingestion rate
P_i = Proportion of food type in receptor diet
AUF = Area use factor (equal to area of exposure unit/home range of receptor)
Body Weight = Body weight of receptor

If sediment was a medium of concern, sediment could be evaluated by replacing soil in Equation 8.1 for aquatic or semiaquatic receptors. Because soil is the only medium of concern for this MRS, the exposure equation for terrestrial organisms is as follows:

$$\textit{Total average daily dose} = ADD_P + ADD_A + ADD_S \times AUF \times TUF$$

Where:

ADD_P = Average daily dose by ingestion of plant matter (mg/kg body wt/d)
ADD_A = Average daily dose by ingestion of animal matter (mg/kg body wt/d)
ADD_S = Average daily dose by ingestion of soil (mg/kg body wt/d)
AUF = Area use factor (unitless)
TUF = Temporal use factor (unitless)

Feeding and drinking rates for MRS receptors have been established and are described in the *RVAAP Facility-Wide Ecological Risk Assessment Work Plan* (USACE, 2003c). To estimate dose associated with ingested food items, concentrations of COPECs in the vegetation or prey in the species' diet is estimated using bioaccumulation factors (BAFs) (sometimes referred to as bioconcentration factors [BCFs]). BAFs are based on regression models or scalar variables that reflect the potential for the COPECs to be present in food items at concentrations different from (usually greater than) the ambient environment. Differences in concentration are due to chemical-specific properties of the COPEC that affect its tendency to bioaccumulate in tissue, balanced by the innate ability of the species to regulate body burden levels of the chemical via metabolic and excretory processes.

Selection of appropriate BAFs is a critical component to food chain modeling. General approaches for BAF selection have been discussed in Sample and Suter (1994), EPA (1999a), U.S. Army Environmental Center (2005), and EPA (2008b). An approach that is consistent with these sources was followed in the selection of BAFs for RVAAP. The general hierarchy for selection of BAFs based on types of sources is as follows:

1. Use of regression equations derived from paired field- or laboratory-based measurements
2. Ratio-derived BAFs developed based on paired data of tissue concentrations compared to media concentrations where the BAF is equal to the tissue concentration divided by the concentration in the abiotic medium
3. Modeled equilibrium partitioning-derived BAFs based on physical or chemical characteristics
4. Assumptions based on values common to chemical class

Both U.S. Army Environmental Center (2005) and EPA (1999a) support the use of ratio BAFs in preference to equilibrium partitioning-based BAFs, which are typically calculated based on factors such as log K_{ow} values, fraction of organic carbon in soil, or percent of lipids in invertebrates. Other general recommendations provided in EPA (2008) were also followed, including the following:

- For selection of ratio-based BAFs, median values are selected over maximum or other high-end BAFs.
- BAFs for PAH accumulation into mammalian prey are assumed to equal zero due to the high metabolic breakdown of PAHs in mammals.

Regression equations used to calculate prey tissue concentrations of a specific chemical typically take the following general equation form:

Equation 8.2:

$$Ln\ (C_{food}) = slope\ value \times ln\ (C_{abiotic\_media}) + intercept\ value$$

Where:

C_{food} = Concentration of chemical in food type

$C_{abiotic\_media}$ = Concentration of chemical in abiotic media

Ratio BAFs can be generally presented as follows:

Equation 8.3:

$$C_{food} = BAF \times (C_{abiotic\_media})$$

Where:

C_{food} = Concentration of chemical in food type
$C_{abiotic\_media}$ = Concentration of chemical in abiotic media
BAF = Bioaccumulation factor

BAFs calculated based on equilibrium partitioning typically use a physical constant of a chemical to generate a BAF. A generalized form for this calculation would be as follows:

Equation 8.4:

$$Log\ (BAF) = slope\ value \times Log\ (K_{ow}) + intercept\ value$$

Where:

Log (BAF) = Log of the BAF for chemical in food type
K_{ow} = Octanol/water partition coefficient

BAFs calculated based on equilibrium partitioning are applied in the same fashion as ratio-based BAFs to generate a tissue concentration value. K_{ow} values needed for BAFs based on equilibrium partitioning are obtained using the K_{ow} WIN application in EPA's Estimation Programs Interface Suite software (http://www.epa.gov/oppt/exposure/pubs/episuite.htm).

Finally, where ratio-based BAFs are missing and where no equilibrium partitioning method has been developed for calculating BAFs, other methods, such as using BAFs for chemicals in the same class as surrogates, may be presented for establishing ratio-based BAFs. The hierarchies used to select BAFs specific to the various types of biota are presented below.

Soil-to-plants BAFs are also used to evaluate sediment-to-plant uptake at RVAAP. Soil-to-plants BAFs are selected using the following specific hierarchy of sources:

1. EPA (2008b) selected regressions
2. Efroymson, et al. (2001) regressions
3. EPA (2008b) recommended nonregression BAFs
4. International Atomic Energy Agency (IAEA) (1994) BAFs
5. Baes et al. (1984) BAFs (these values were often updated in the more recent IAEA [1994] publication).

Soil-to-invertebrates BAFs are selected using the following hierarchy of sources:

1. EPA (2008b) selected regressions
2. Sample, et al. (1998a) regressions
3. Sample, et al. (1998a) median BAFs
4. Equilibrium BAF calculation method in EPA (2008b) based on Jager (1998)

Soil-to-mammals BAFs are selected using the following hierarchy or sources:

1. EPA (2008b) or Sample (1998b) selected regressions
2. EPA (2008b) referenced BAFs (Note: Per EPA [2008b], a BAF of zero is used for all PAHs, TNT, and research department explosives.)
3. Sample, et al. (1998b) median BAFs
4. IAEA (1994) BAFs
5. Baes, et al. (1984) BAFs (these values were often updated in the newer IAEA [1994] publication)
6. EPA (1999b) maximum calculated BAFs/BCFs for feeding guilds

The BAFs used for the soil COPECs are presented in **Table 8-6**.

8.4.1.2 Exposure Point Concentrations

Ideally, the mean concentration that a receptor is exposed to on a daily basis would be used to calculate the intake dose that receptor is exposed to for a given chemical. Because of the uncertainty associated with characterizing contamination in environmental media, a reasonable maximum exposure concentration is appropriately used as the EPC. The 95 percent upper confidence limit (UCL) of the mean serves as the reasonable maximum exposure EPC in this Level III Baseline when data sets comprised of discrete samples are being evaluated. However, because ISM samples represent average concentrations over a single decision unit, calculation of a 95 percent UCL for ISM samples is not appropriate. Therefore, the MDCs for COPECs identified in the ISM soil samples were conservatively used as the EPCs for the Level III Baseline to provide an initial indication as to whether any ISM sampling unit exceeds criteria for each COPEC.

8.4.1.3 Terrestrial Ecological Receptor Species

The exposed ecological receptors for the Level III Baseline were identified in the *RVAAP Facility-Wide Ecological Risk Assessment Work Plan* (USACE, 2003c) based on three criteria, including their ecological relevance, susceptibility to the contaminants likely to be found at the MRS, and consistency with management goals, including protection of threatened and endangered species. Based on these criteria, the following terrestrial receptors were selected for evaluation, representing specific taxonomic and foraging guilds likely to be found at the MRS:

- Vegetation
  - Variety of grasses, forbs, and trees
- Soil-dwelling invertebrates
  - Earthworms
- Mammalian herbivores
  - Meadow vole
- Worm-eating and/or insectivorous mammals and birds
  - Short-tailed shrew
  - American robin
- Terrestrial top predators
  - Red-tailed hawk
  - Red fox

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Table 8-6
Bioaccumulation Factors or Regression Equations Used to Model Uptake

COPEC in Soil	Soil-to-Plant BAF	Source	Soil-to-Earthworm BAF	Source	Soil-to-Mammal BAF	Source
Metals						
Antimony	ln (AGP)=0.938(ln[soil])-3.233	EPA, 2008b	ln (EW)=0.706(ln[soil])-1.421	EPA, 2008b	0.05	EPA, 2008b
Cadmium	ln (AGP)=0.546(ln[soil])-0.475	EPA, 2008b	ln (EW)=0.795(ln[soil])+2.114	EPA, 2008b	ln (M)=0.4723(ln[soil]) -1.2571	EPA, 2008b
Copper	ln (AGP)=0.394(ln[soil])+0.668	EPA, 2008b	ln (EW)=0.24(ln[soil])+1.8	EPA, 2008b	ln (M)=0.1444(ln[soil]) +2.042	EPA, 2008b
Lead	ln (AGP)=0.561(ln[soil])-1.328	EPA, 2008b	ln (EW)=0.807(ln[soil])-0.218	EPA, 2008b	ln (M)=0.4422(ln[soil]) +0.0761	EPA, 2008b
Mercury	ln (AGP)=0.54(ln[soil])-1.00	Efroymson et al., 2001[1]	ln (EW)=0.33(ln[soil])+0.078	Sample et al., 1998a	0.192	Sample et al., 1998b
Zinc	ln (AGP)=0.554(ln[soil])+1.575	EPA, 2008b	ln (EW)=0.328(ln[soil])+4.449	EPA, 2008b	ln (M)=0.0706(ln[soil]) + 4.3632	EPA, 2008b
Semivolatile Organic Compounds						
Bis(2-Ethylhexyl)phthalate	0.00055	Travis and Arms (1988) K_{ow} Regression Equation	17.3	See Footnote 1	0.000132	EPA (1999b), maximum for any taxa in Table D-3
Di-n-Butyl Phthalate	0.276	Travis and Arms (1988) K_{ow} Regression Equation	15	See Footnote 1	0.000132	Bis(2-Ethylhexyl)phthalate used as surrogate
Polychlorinated Biphenyls						
Aroclor-1254	0.0036	Travis and Arms (1988) K_{ow} Regression Equation	16.4	See Footnote 1	0.00132	EPA (1999b), maximum for any taxa in Table D-3
Aroclor-1260	0.00064	Travis and Arms (1988) K_{ow} Regression Equation	17.3	See Footnote 1	0.00132	EPA (1999b), maximum for any taxa in Table D-3

[1] *For Organics:* Ecological Soil Screening Level (SSL) Guidance *(EPA, 2008b), Section 3.2.2 in Appendix 4-1, given MRS-specific soil total organic carbon (TOC).*
The biota/soil water partitioning coefficient of $10^{(logKow-0.6)}$ was replaced with Equation 3 from Jager (1998) of $F_{lipid} \times K_{ow}$. The F_{water} variable of Equation 3 was not included, since it only improves the model fit for extremely hydrophilic compounds (i.e. chemicals with log K_{ow} < 2, approximately).
BAF - Flipid × K_{ow}
FOC × $10^{(0.983 \times logKow + 0.00028)}$
F_{lipid} = 0.079
The lipid content in insects was estimated at 3.1 percent fresh weight (Taylor, 1975), which is 7.9 percent of dry weight, using a value of 61 percent water content in beetles (EPA, 1993), calculated as follows: 0.031/(1-0.61) = 0.079, or 7.9 percent.
K_{ow} values obtained from EPA Estimation Programs Interface Suite Version 4.0, http://www.epa.gov/oppt/exposure/pubs/episuitedl.htm.
AGP denotes above ground plant tissue concentration.
BAF denotes bioaccumulation factor.
COPEC denotes chemical of potential concern.
EPA denotes U.S. Environmental Protection Agency.
EW denotes earthworm tissue concentration.
K_{ow} denotes octanol/water partition coefficient.
M denotes mammal tissue concentration.

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In addition to the above receptors, the barn owl, an Ohio state endangered species that is found at the RVAAP, is broad ranging, and may use any part of the RVAAP, was also evaluated. These receptors are likely to be present at the facility and were selected consistent with Ohio EPA Guidance (Ohio EPA, 2008). Evaluation of these receptors addresses the assessment endpoints presented in the Level II Screening evaluation. Additional descriptions of these receptors and justification for their selection are presented in the *RVAAP Facility-Wide Ecological Risk Assessment Work Plan* (USACE, 2003c).

For the Level III Baseline, plants and invertebrates are not quantitatively assessed, as the protection of soil plants and invertebrates was previously addressed by the comparisons to ESVs in the Level II Screening evaluation. Exposure parameters used for the terrestrial ecological receptor species are presented in the *RVAAP Facility-Wide Ecological Risk Assessment Work Plan* (USACE, 2003c) and summarized in **Table 8-7**.

8.4.1.4 Exposure Characterization Summary

The estimated chemical intakes for each exposed receptor group under each exposure pathway and scenario are presented in the risk characterization spreadsheets in **Appendix L**. These intake estimates are combined with the COPEC toxicity values, discussed in the following section, to derive estimates and characterize potential ecological risk.

8.4.2 Toxicity Assessment

The toxicity assessment primarily describes the development of TRVs. TRVs provide a reference point for the comparison of toxicological effects upon exposure to a contaminant and are compared against calculated receptor doses. TRVs are not used for evaluating plants or invertebrates, which are evaluated in terms of potential hazards at a community scale rather than a species scale.

TRVs focusing on the growth, survival, and reproduction of species and/or populations have been developed for the Group 8 MRS SLERA. Empirical data are available for the specific receptor-endpoint combinations in some instances. The no observed adverse effect level (NOAEL) is a dose of each COPEC that produced no known adverse effects in the test species.

The NOAEL was judged to be an appropriate toxicological endpoint since it would provide the greatest degree of protection to the receptor species. In addition, the lowest observed adverse effect level (LOAEL) was used as a point of comparison for risk management decisions. The LOAEL is the lowest concentration in a laboratory test setting that is associated with an effect, and is considered to be a more realistic (although still conservative) endpoint (SAIC, 2008). In instances where data are unavailable for a MRS-associated COPEC, toxicological information for surrogate chemicals or groups of chemical was used.

Table 8-7
Exposure Parameters for Target Ecological Species

Ecological Receptor Species	Class/Order	Average Body Weight[1] (kg)	Average Home Range[1] (ha)	Dietary Intake[1] (kg[dw]/day)	Soil/Sed. Intake (kg[dw]/day)	Water Intake [1] (L/day)	Temporal Use Factor	Trophic Level	Dietary Composition[1] (percent)
Short-tailed shrew (*Blarina brevicauda*)	Mammalia/ Insectivora	0.017	0.39	0.00952	0.0012 (13%)	0.0038	1	Insectivore	Terrestrial Invertebrates: 87 Plants: 13
American robin (*Turdus migratorius*)	Aves/ Passeriformes	0.081	0.25	0.0972	0.00486 (5%)	0.011	1	Omnivore	Terrestrial Invertebrates: 50 Plants: 50
Meadow vole (*Microtus pennsyvanicus*)	Mammalia/ Rodentia	0.033	0.027	0.01089	0.00022 (2%)	0.00594	1	Herbivore	Plants: 100
Red-tailed hawk (*Buteo jamaicensis*)	Aves/ Falconiformes	1.13	697	0.1243	0	0.06441	1	Carnivore	Animals: 100
Barn owl (*Tyto alba*)	Aves/ Strigiformes	0.466	250	0.05825	0	0.0163	1	Carnivore	Animals: 100
Red fox (*Vulpes vulpes*)	Mammalia/ Carnivora	4.69	596	0.324	0.009 (2.8%)	0.399	1	Carnivore	Animals: 95.4 Plants: 4.6

[1] *Obtained from USACE, 2003c,* RVAAP Facility Wide Ecological Risk Work Plan*, April.*
dw denotes dry weight.
ha denotes hectares.
kg denotes kilogram.
L denotes liter.

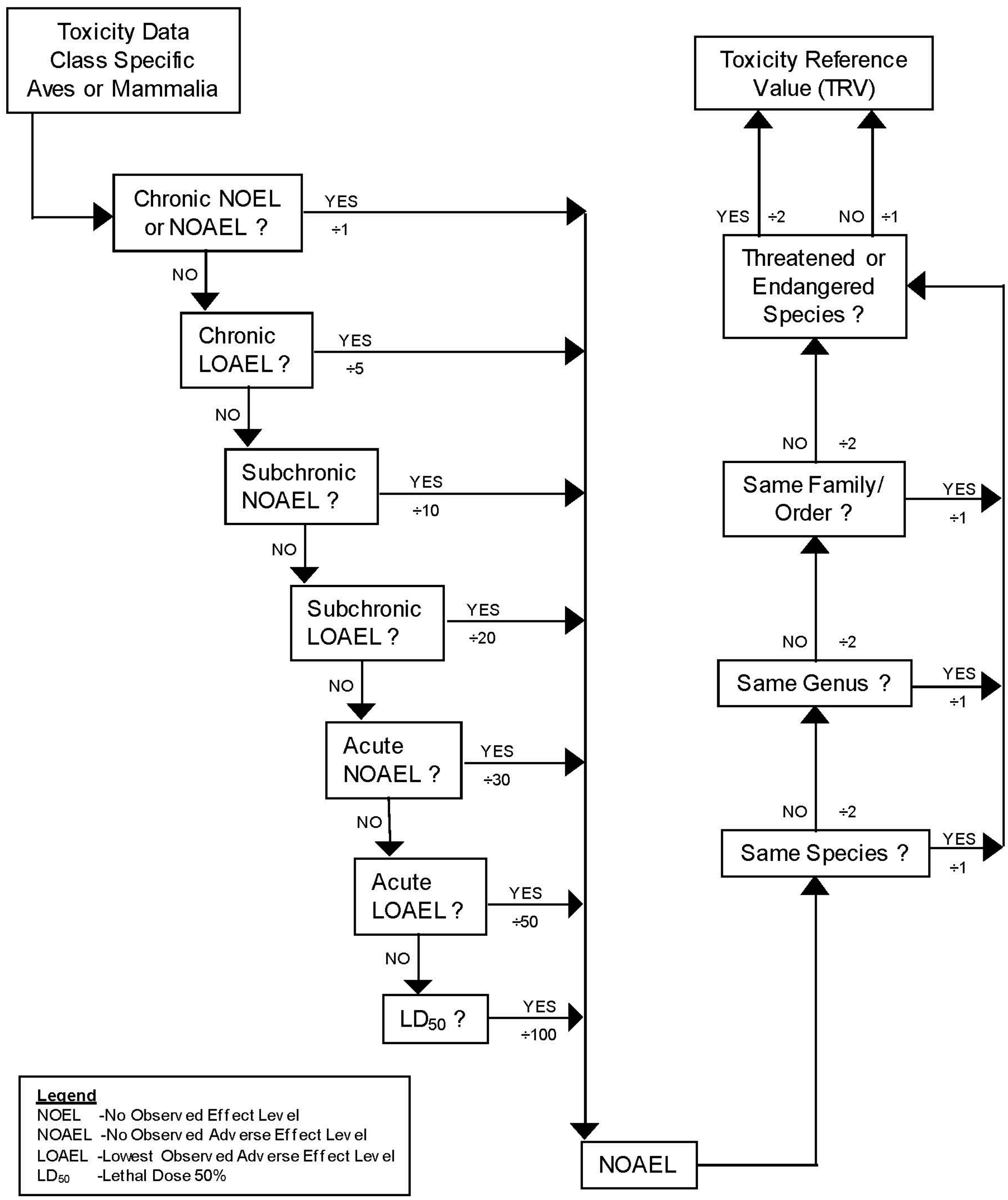
Safety factors were used to adjust for these differences and extrapolate risks to the MRS' receptors at the NOAEL and/or LOAEL endpoint. This process is described in the following paragraphs.

Because the measurement endpoint ranges from the NOAEL to the LOAEL, preference is given to chronic studies noting concentrations at which no adverse effects were observed and those for which the lowest concentrations associated with adverse effects were observed. Where data are unavailable for the exposure of a receptor to a COPEC, data for a surrogate chemical or group of chemicals may be considered.

The TRVs are developed separately for birds and mammals, as it is inappropriate to apply TRVs across classes (i.e., a TRV for a bird species may not be used to estimate hazard for a mammal species). In instances where TRVs for multiple avian or mammalian species are supported, the TRV for the most similar species to the measurement receptor based on feeding strategy and physiological attributes were used. For example, a mammalian TRV for mercury based on both mink and mouse test species data are available. The mink TRV was used in the food chain model to evaluate the terrestrial mammalian carnivore (i.e., the red fox), while the mouse TRV was used for the short-tailed shrew and meadow vole due to closer taxonomic similarity and foraging patterns. Two avian TRVs were available for lead. A TRV based on the quail test species was used for the robin, while a TRV based on a kestrel was used to evaluate the red-tailed hawk and barn owl.

The TRVs represent NOAELs and LOAELs with the safety factors presented in Wentsel, et al. (1996) applied to toxicity information that were derived from studies other than no-effects or lowest-effects studies (**Figure 8-4**). Because NOAELs and LOAELs for the selected wildlife receptor species are based on data from test species that are usually different from the species of concern, previous ERA guidance documents often applied a mathematical adjustment to the TRVs using a power function of the ratio of species body weights (i.e., Sample, et al., 1996). This practice is often referred to as allometric scaling.

Alternately, uncertainty factors have also been used to adjust the TRVs when the toxicity values were based on a different species from the evaluated receptor to account for the potential differences in species' chemical sensitivities. However, in recent years, these practices have been discouraged by most scientific and regulatory groups. Recent reviews of these practices (EPA, 2008b; Allard et al., 2009) have concluded that the use of allometric scaling of TRVs does not reflect a sound application of toxicological or ecological risk practices because supporting data for this practice are limited, and the ratio relationships used for the mathematical conversions were developed based on acute (rather than chronic) toxicity data. Allard et al. (2009) also concluded that uncertainty factors based on an arbitrary multiplier should not be used without a scientific basis for their application. Therefore, the use of toxicity data without adjustments as reported in the literature is



Credit: Adapted from Ford et al. (1992) in *Tri-Service Procedural Guidelines for Ecological Risk Assessments*, 1996

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FIGURE 8-4 PROCEDURAL FLOW CHART FOR DERIVING TOXICITY REFERENCE VALUES

regarded as the most technically sound approach, and is the adopted approach for this SLERA.

The TRVs used for the Level III Baseline are summarized in **Tables 8-8** and **8-9** for mammals and birds, respectively. Because the barn owl represents a threatened and endangered species, as an extra level of protectiveness, only the most conservative toxicity endpoints (i.e., the NOAEL TRVs) are used to evaluate this receptor.

8.4.3 Risk Characterization

The risk characterization phase integrates information on exposure, exposure-effects relationships, and defined or presumed target populations. The result is a determination of the likelihood, severity, and characteristics of adverse effects to environmental stressors present at a site. Because potential adverse affects to terrestrial and aquatic plants and invertebrates have been qualitatively assessed during the Level II Screening (Section 8.3), the Level III Baseline risk characterization focuses on potential impacts to assessment receptors.

For the semiquantitative predictive assessment, TRVs and ADDs were calculated and used to generate food chain HQs (Wentsel, et al., 1996). The HQs are calculated by summing intake doses across all exposure pathways for each chemical for a given receptor to generate an ADD and dividing by the TRV. The HQs for those chemicals that have a similar mode of toxicological action are typically summed to account for cumulative effects. Only the PCBs were considered toxicologically similar enough to warrant summing their HQs.

8.4.3.1 Hazard Estimation for Terrestrial Wildlife

The hazard estimation was performed through a series of quantitative HQ calculations that compare receptor-specific exposure doses with TRVs. The same HQ guidelines for assessing the risk posed from contaminants as described in the Level II Screening (Section 8.3) apply to the Level III Baseline as well. HQs for the identified COPECs based on both NOAEL and LOAEL values were calculated for all six representative receptor species, i.e., the meadow vole, short-tailed shrew, American robin, red-tailed hawk, barn owl, and red fox. For ISM soil samples, the MDCs of all the sampling units are used as the EPCs because a statistical estimate of the mean (i.e., a 95 percent UCL on the mean) is not an appropriate approach for evaluating ISM decision units collectively. The Group 8 MRS area of concern of 2.65 acres was used for the purposes of calculating area use factors for the various receptors.

Results for the food chain model are provided in **Table 8-10** for the combined ISM sampling units that make up the MRS decision unit and in **Tables 8-11** through **8-14** for each of the individual four ISM sampling units, respectively. In general, chemicals whose HQs using both the NOAEL- and LOAEL-based TRVs exceed 1 are interpreted to be present at concentrations of concern; because the NOAEL is based on a no-effect dose, and given other

Table 8-8
Toxicity Reference Values for Mammals

COPEC	Toxicity Value	NOAEL (mg/kg/d)	Test Species	References	Toxicity Value	LOAEL (mg/kg/d)	Test Species	References
Metals								
Antimony	--	0.125	mouse	Sample, et al., 1996	--	1.25	mouse	Sample, et al., 1996
Cadmium	--	1	rat	Sample, et al., 1996	--	10	rat	Sample, et al., 1996
Copper	--	11.7	mink	Sample, et al., 1996	--	15.14	mink	Sample, et al., 1996
Lead	--	8	rat	Sample, et al., 1996	--	80	rat	Sample, et al., 1996
Mercury (mink)	--	1	mink	Sample, et al., 1996	1.0 (NOAEL)	5	mink	Sample, et al., 1996
Mercury (mouse)	--	13.2	mouse	Sample, et al., 1996	--	132	mouse	Sample, et al., 1996
Zinc	--	160	rat	Sample, et al., 1996	--	320	rat	Sample, et al., 1996
Semivolatile Organic Compounds								
Bis(2-ethylhexyl)phthalate	--	18.33	mouse	Sample, et al., 1996	--	183	mouse	Sample, et al., 1996
Di-n-Butyl Phthalate	--	550	mouse	Sample, et al., 1996	--	1833	mouse	Sample, et al., 1996
Polychlorinated Biphenyls								
Aroclor-1254 (mink)	--	0.14	mink	Sample, et al., 1996	--	0.69	mink	Sample, et al., 1996
Aroclor-1254 (mouse)	--	0.068	mouse	Sample, et al., 1996	--	0.68	mouse	Sample, et al., 1996
Aroclor-1260	Aroclor-1254 used as a surrogate							

COPEC denotes chemical of potential concern.
LOAEL denotes lowest observed adverse effect level.
mg/kg/d denotes milligrams per kilogram per day.
NA denotes not applicable.
NOAEL denotes no observed adverse effect level.

Table 8-9
Toxicity Reference Values for Birds

COPEC	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference
Metals								
Antimony	NA							
Cadmium	NA	1.45	mallard duck	Sample, et al., 1996	NA	20	mallard duck	Sample, et al., 1996
Copper	NA	47	chicks	Sample, et al., 1996	NA	61.7	chicks	Sample, et al., 1996
Lead (quail)	NA	1.13	Japanese quail	Sample, et al., 1996	NA	11.3	Japanese quail	Sample, et al., 1996
Lead (kestrel)	NA	3.85	Am. Kestrel	Sample, et al., 1996	NA	38.5	Am. Kestrel	Sample, et al., 1996
Mercury	NA	0.45	Japanese quail	Sample, et al., 1996	NA	0.9	Japanese quail	Sample, et al., 1996
Zinc	NA	14.5	hens	Sample, et al., 1996	NA	131	hens	Sample, et al., 1996
Semivolatile Organic Compounds								
Bis(2-ethylhexyl)phthalate	NA	1.11	ringed dove	Sample, et al., 1996	NA	11.1	ringed dove	Sample, et al., 1996
Di-n-Butyl Phthalate	NA	0.11	ringed dove	Sample, et al., 1996	NA	1.1	ringed dove	Sample, et al., 1996
Polychlorinated Biphenyls								
Aroclor-1254	NA	0.18	ring neck pheasant	Sample, et al., 1996	NA	1.8	ring neck pheasant	Sample, et al., 1996
Aroclor-1260	Aroclor-1254 used as a surrogate							

COPEC denotes chemical of potential concern.
LOAEL denotes lowest observed adverse effect level.
mg/kg/d denotes milligrams per kilogram per day.
NA denotes not applicable.
NOAEL denotes no observed adverse effect level.

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Table 8-10
Wildlife Hazard Quotients for all Assessment Receptors—Group 8 MRS Decision Unit

	Short-tailed Shrew		Robin		Meadow Vole		Red-tailed Hawk		Barn Owl		Red Fox	
COPEC	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Metals												
Antimony	2.19E+01	2.19E+00	NA	NA	3.17E+00	3.17E-01	NA	NA	NA	NA[1]	1.75E-03	1.75E-04
Cadmium	4.98E+02	4.98E+01	4.21E+02	3.05E+01	8.02E+00	8.02E-01	5.60E-04	4.06E-05	1.77E-03	NA[1]	2.03E-03	2.03E-04
Copper	5.67E+00	4.38E+00	1.61E+00	1.23E+00	1.14E+00	8.78E-01	7.16E-05	5.46E-05	2.27E-04	NA[1]	4.24E-04	3.28E-04
Lead	2.14E+01	2.14E+00	1.69E+02	1.69E+01	1.33E+00	1.33E-01	9.96E-04	9.96E-05	3.16E-03	NA[1]	7.67E-04	7.67E-05
Mercury	4.51E-02	4.51E-03	1.97E+00	9.83E-01	9.09E-03	9.09E-04	6.43E-05	3.21E-05	2.04E-04	NA[1]	2.53E-05	5.06E-06
Zinc	3.13E+00	1.57E+00	4.86E+01	5.38E+00	5.17E-01	2.58E-01	1.50E-03	1.66E-04	4.75E-03	NA[1]	1.26E-04	6.31E-05
Semivolatile Organic Compounds												
Bis(2-Ethylhexyl)phthalate	9.27E-01	9.29E-02	1.88E+01	1.88E+00	7.47E-04	7.48E-05	4.03E-08	4.03E-09	1.28E-07	NA[1]	3.79E-07	3.79E-08
Di-n-Butyl Phthalate	6.19E-03	1.86E-03	3.86E+01	3.86E+00	8.18E-05	2.45E-05	9.34E-08	9.34E-09	2.96E-07	NA[1]	4.22E-09	1.27E-09
Polychlorinated Biphenyls												
Aroclor-1254	8.77E+01	8.77E+00	4.07E+01	4.07E+00	8.55E-02	8.55E-03	9.19E-07	9.19E-08	2.91E-06	NA[1]	1.92E-05	3.89E-06
Aroclor-1260	5.12E+01	5.12E+00	2.38E+01	2.38E+00	4.15E-02	4.15E-03	5.09E-07	5.09E-08	1.61E-06	NA[1]	1.06E-05	2.15E-06
Total PCBs	1.39E+02	1.39E+01	6.45E+01	6.45E+00	1.27E-01	1.27E-02	1.43E-06	1.43E-07	4.52E-06	0	2.98E-05	6.04E-06

Shaded cells indicate a hazard quotient greater than 1 when rounded.
COPEC denotes chemical of potential ecological concern.
LOAEL denotes lowest observed adverse effect level.
NA denotes no toxicity data is available; hazard quotients not calculated.
NA[1] denotes that the barn owl represents a threatened and endangered species; only hazard quotients based on the NOAEL are calculated.
NOAEL denotes no observed adverse effect level.

Table 8-11
Wildlife Hazard Quotients for all Assessment Receptors—Surface Soil Sampling Unit Location GR8SS-001M

	Short-tailed Shrew		Robin		Meadow Vole		Red-tailed Hawk		Barn Owl		Red Fox	
COPEC	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Metals												
Antimony	5.86E+00	5.86E-01	NA	NA	7.38E-01	7.38E-02	NA	NA	NA	NA[1]	3.83E-04	3.83E-05
Cadmium	1.87E+01	1.87E+00	1.64E+01	1.19E+00	6.19E-01	6.19E-02	8.10E-05	5.87E-06	2.56E-04	NA[1]	1.15E-04	1.15E-05
Copper	4.08E+00	3.15E+00	1.22E+00	9.29E-01	8.89E-01	6.87E-01	6.75E-05	5.14E-05	2.14E-04	NA[1]	3.39E-04	2.62E-04
Lead	1.17E+01	1.17E+00	9.43E+01	9.43E+00	7.65E-01	7.65E-02	7.36E-04	7.36E-05	2.33E-03	NA[1]	4.67E-04	4.67E-05
Mercury	2.80E-02	2.80E-03	1.20E+00	5.98E-01	4.57E-03	4.57E-04	1.88E-05	9.39E-06	5.95E-05	NA[1]	7.83E-06	1.57E-06
Zinc	2.23E+00	1.12E+00	3.46E+01	3.83E+00	3.21E-01	1.60E-01	1.42E-03	1.57E-04	4.48E-03	NA[1]	1.05E-04	5.26E-05
Semivolatile Organic Compounds												
Bis(2-Ethylhexyl)phthalate	3.66E-01	3.67E-02	7.43E+00	7.43E-01	2.95E-04	2.96E-05	1.59E-08	1.59E-09	5.04E-08	NA[1]	1.50E-07	1.50E-08
Di-n-Butyl Phthalate	1.88E-03	5.65E-04	1.17E+01	1.17E+00	2.49E-05	7.47E-06	2.84E-08	2.84E-09	9.01E-08	NA[1]	1.28E-09	3.85E-10
Polychlorinated Biphenyls												
Aroclor-1254	6.05E+01	6.05E+00	2.81E+01	2.81E+00	5.89E-02	5.89E-03	6.33E-07	6.33E-08	2.01E-06	NA[1]	1.32E-05	2.68E-06
Aroclor-1260	5.12E+01	5.12E+00	2.38E+01	2.38E+00	4.15E-02	4.15E-03	5.09E-07	5.09E-08	1.61E-06	NA[1]	1.06E-05	2.15E-06
Total PCBs	1.12E+02	1.12E+01	5.18E+01	5.18E+00	1.00E-01	1.00E-02	1.14E-06	1.14E-07	3.62E-06	0	2.38E-05	4.83E-06

Shaded cells indicate a hazard quotient greater than 1 when rounded.
COPEC denotes chemical of potential ecological concern.
LOAEL denotes lowest observed adverse effect level.
NA denotes no toxicity data is available; hazard quotients not calculated.
NA[1] denotes that the barn owl represents a threatened and endangered species; only hazard quotients based on the NOAEL are calculated.
NOAEL denotes no observed adverse effect level.

Table 8-12
Wildlife Hazard Quotients for all Assessment Receptors—Surface Soil Sampling Unit Location GR8SS-002M

	Short-tailed Shrew		Robin		Meadow Vole		Red-tailed Hawk		Barn Owl		Red Fox	
COPEC	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Metals												
Antimony	7.43E+00	7.43E-01	NA	NA	9.63E-01	9.63E-02	NA	NA	NA	NA[1]	5.06E-04	5.06E-05
Cadmium	5.12E+01	5.12E+00	4.43E+01	3.21E+00	1.30E+00	1.30E-01	1.47E-04	1.07E-05	4.65E-04	NA[1]	2.50E-04	2.50E-05
Copper	2.38E+00	1.84E+00	7.81E-01	5.95E-01	5.93E-01	4.58E-01	6.07E-05	4.62E-05	1.92E-04	NA[1]	2.45E-04	1.89E-04
Lead	7.59E+00	7.59E-01	6.20E+01	6.20E+00	5.18E-01	5.18E-02	5.91E-04	5.91E-05	1.87E-03	NA[1]	3.33E-04	3.33E-05
Mercury	2.58E-02	2.58E-03	1.10E+00	5.50E-01	4.07E-03	4.07E-04	1.52E-05	7.58E-06	4.80E-05	NA[1]	6.41E-06	1.28E-06
Zinc	1.98E+00	9.91E-01	3.06E+01	3.39E+00	2.69E-01	1.34E-01	1.38E-03	1.53E-04	4.39E-03	NA[1]	9.98E-05	4.99E-05
Semivolatile Organic Compounds												
Bis(2-Ethylhexyl)phthalate	1.34E-01	1.35E-02	2.73E+00	2.73E-01	1.08E-04	1.09E-05	5.84E-09	5.84E-10	1.85E-08	NA[1]	5.49E-08	5.50E-09
Di-n-Butyl Phthalate	1.35E-03	4.04E-04	8.39E+00	8.39E-01	1.78E-05	5.33E-06	2.03E-08	2.03E-09	6.43E-08	NA[1]	9.18E-10	2.75E-10
Polychlorinated Biphenyls												
Aroclor-1254	3.56E+01	3.56E+00	1.65E+01	1.65E+00	3.47E-02	3.47E-03	3.72E-07	3.72E-08	1.18E-06	NA[1]	7.78E-06	1.58E-06
Aroclor-1260	1.87E+01	1.87E+00	8.70E+00	8.70E-01	1.52E-02	1.52E-03	1.86E-07	1.86E-08	5.90E-07	NA[1]	3.87E-06	7.85E-07
Total PCBs	5.43E+01	5.43E+00	2.52E+01	2.52E+00	4.98E-02	4.98E-03	5.59E-07	5.59E-08	1.77E-06	0	1.17E-05	2.36E-06

Shaded cells indicate a hazard quotient greater than 1 when rounded.
COPEC denotes chemical of potential ecological concern.
LOAEL denotes lowest observed adverse effect level.
NA denotes no toxicity data is available; hazard quotients not calculated.
NA[1] denotes that the barn owl represents a threatened and endangered species; only hazard quotients based on the NOAEL are calculated.
NOAEL denotes no observed adverse effect level.

Table 8-13
Wildlife Hazard Quotients for all Assessment Receptors—Surface Soil Sampling Unit Location GR8SS-003M

COPEC	Short-tailed Shrew		Robin		Meadow Vole		Red-tailed Hawk		Barn Owl		Red Fox	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Metals												
Antimony	1.22E+01	1.22E+00	NA	NA	1.67E+00	1.67E-01	NA	NA	NA	NA[1]	8.96E-04	8.96E-05
Cadmium	4.76E+01	4.76E+00	4.12E+01	2.99E+00	1.23E+00	1.23E-01	1.41E-04	1.02E-05	4.46E-04	NA[1]	2.35E-04	2.35E-05
Copper	4.84E+00	3.74E+00	1.41E+00	1.07E+00	1.01E+00	7.81E-01	6.96E-05	5.31E-05	2.21E-04	NA[1]	3.80E-04	2.94E-04
Lead	2.14E+01	2.14E+00	1.69E+02	1.69E+01	1.33E+00	1.33E-01	9.96E-04	9.96E-05	3.16E-03	NA[1]	7.67E-04	7.67E-05
Mercury	4.51E-02	4.51E-03	1.97E+00	9.83E-01	9.09E-03	9.09E-04	6.43E-05	3.21E-05	2.04E-04	NA[1]	2.53E-05	5.06E-06
Zinc	3.13E+00	1.57E+00	4.86E+01	5.38E+00	5.17E-01	2.58E-01	1.50E-03	1.66E-04	4.75E-03	NA[1]	1.26E-04	6.31E-05
Semivolatile Organic Compounds												
Bis(2-Ethylhexyl)phthalate	9.51E-02	9.52E-03	1.93E+00	1.93E-01	7.66E-05	7.67E-06	4.13E-09	4.13E-10	1.31E-08	NA[1]	3.88E-08	3.89E-09
Di-n-Butyl Phthalate	1.48E-03	4.44E-04	9.23E+00	9.23E-01	1.95E-05	5.87E-06	2.23E-08	2.23E-09	7.08E-08	NA[1]	1.01E-09	3.03E-10
Polychlorinated Biphenyls												
Aroclor-1254	8.77E+01	8.77E+00	4.07E+01	4.07E+00	8.55E-02	8.55E-03	9.19E-07	9.19E-08	2.91E-06	NA[1]	1.92E-05	3.89E-06
Aroclor-1260	2.87E+01	2.87E+00	1.33E+01	1.33E+00	2.33E-02	2.33E-03	2.86E-07	2.86E-08	9.04E-07	NA[1]	5.94E-06	1.20E-06
Total PCBs	1.16E+02	1.16E+01	5.40E+01	5.40E+00	1.09E-01	1.09E-02	1.20E-06	1.20E-07	3.81E-06	0	2.51E-05	5.10E-06

Shaded cells indicate a hazard quotient greater than 1 when rounded.
COPEC denotes chemical of potential ecological concern.
LOAEL denotes lowest observed adverse effect level.
NA denotes no toxicity data is available; hazard quotients not calculated.
NA[1] denotes that the barn owl represents a threatened and endangered species; only hazard quotients based on the NOAEL are calculated.
NOAEL denotes no observed adverse effect level.

Table 8-14
Wildlife Hazard Quotients for all Assessment Receptors—Surface Soil Sampling Unit Location GR8SS-004M

COPEC	Short-tailed Shrew		Robin		Meadow Vole		Red-tailed Hawk		Barn Owl		Red Fox	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Metals												
Antimony	2.19E+01	2.19E+00	NA	NA	3.17E+00	3.17E-01	NA	NA	NA	NA[1]	1.75E-03	1.75E-04
Cadmium	4.98E+02	4.98E+01	4.21E+02	3.05E+01	8.02E+00	8.02E-01	5.60E-04	4.06E-05	1.77E-03	NA[1]	2.03E-03	2.03E-04
Copper	5.67E+00	4.38E+00	1.61E+00	1.23E+00	1.14E+00	8.78E-01	7.16E-05	5.46E-05	2.27E-04	NA[1]	4.24E-04	3.28E-04
Lead	1.97E+01	1.97E+00	1.56E+02	1.56E+01	1.23E+00	1.23E-01	9.54E-04	9.54E-05	3.02E-03	NA[1]	7.13E-04	7.13E-05
Mercury	3.92E-02	3.92E-03	1.70E+00	8.52E-01	7.48E-03	7.48E-04	4.55E-05	2.28E-05	1.44E-04	NA[1]	1.82E-05	3.63E-06
Zinc	3.08E+00	1.54E+00	4.78E+01	5.30E+00	5.05E-01	2.53E-01	1.49E-03	1.65E-04	4.73E-03	NA[1]	1.25E-04	6.25E-05
Semivolatile Organic Compounds												
Bis(2-Ethylhexyl)phthalate	9.27E-01	9.29E-02	1.88E+01	1.88E+00	7.47E-04	7.48E-05	4.03E-08	4.03E-09	1.28E-07	NA[1]	3.79E-07	3.79E-08
Di-n-Butyl Phthalate	6.19E-03	1.86E-03	3.86E+01	3.86E+00	8.18E-05	2.45E-05	9.34E-08	9.34E-09	2.96E-07	NA[1]	4.22E-09	1.27E-09
Polychlorinated Biphenyls												
Aroclor-1254	6.88E+01	6.88E+00	3.19E+01	3.19E+00	6.70E-02	6.70E-03	7.20E-07	7.20E-08	2.28E-06	NA[1]	1.50E-05	3.05E-06
Aroclor-1260	2.00E+01	2.00E+00	9.28E+00	9.28E-01	1.62E-02	1.62E-03	1.99E-07	1.99E-08	6.29E-07	NA[1]	4.13E-06	8.38E-07
Total PCBs	8.88E+01	8.88E+00	4.12E+01	4.12E+00	8.32E-02	8.32E-03	9.19E-07	9.19E-08	2.91E-06	0	1.92E-05	3.89E-06

Shaded cells indicate a hazard quotient greater than 1 when rounded.
COPEC denotes chemical of potential ecological concern.
LOAEL denotes lowest observed adverse effect level.
NA denotes no toxicity data is available; hazard quotients not calculated.
NA[1] denotes that the barn owl represents a threatened and endangered species; only hazard quotients based on the NOAEL are calculated.
NOAEL denotes no observed adverse effect level.

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conservative assumptions inherent in the food chain model (i.e., 100 percent bioavailability), chemicals whose NOAEL (but not LOAEL) HQs exceed 1 are unlikely to be present at concentrations harmful to environmental receptors. It is noted from **Tables 8-10** through **8-14** that only small range receptors are potentially at risk from chemicals present at the Group 8 MRS; the MRS is too small to adversely impact large range receptors such as the red-tailed hawk. Chemicals whose NOAEL- and LOAEL-based HQs exceeded 1, when rounded, for the individual ISM sample locations include the following:

- GR8SS-001M (**Table 8-11**)
  - Cadmium (Short-tailed shrew)
  - Copper (Short-tailed shrew)
  - Lead (American robin)
  - Zinc (American robin)
  - Aroclor-1254 (Short-tailed shrew and American robin)
  - Aroclor-1260 (Short-tailed shrew and American robin)
- GR8SS-002M (**Table 8-12**)
  - Cadmium (Short-tailed shrew and American robin)
  - Copper (Short-tailed shrew)
  - Lead (American robin)
  - Zinc (American robin)
  - Aroclor-1254 (Short-tailed shrew and American robin)
  - Aroclor-1260 (Short-tailed shrew)
- GR8SS-003M (**Table 8-13**)
  - Cadmium (Short-tailed shrew and American robin)
  - Copper (Short-tailed shrew)
  - Lead (Short-tailed shrew and American robin)
  - Zinc (Short-tailed shrew and American robin)
  - Aroclor-1254 (Short-tailed shrew and American robin)
  - Aroclor-1260 (Short-tailed shrew)

- GR8SS-004M (**Table 8-14**)
  - Antimony (Short-tailed shrew)
  - Cadmium (Short-tailed shrew and American robin)
  - Copper (Short-tailed shrew)
  - Lead (Short-tailed shrew and American robin)
  - Zinc (Short-tailed shrew and American robin)
  - Aroclor-1254 (Short-tailed shrew and American robin)
  - Aroclor-1260 (Short-tailed shrew)
  - Bis(2-ethylhexyl)phthalate (American robin)
  - Di-n-butyl phthalate (American robin)

8.4.4 Uncertainty Analysis

A number of factors contribute to the overall variability and uncertainty inherent in ecological risk assessments. Variability is due primarily to measurement error and natural variability of chemical concentrations in environmental media. Laboratory media analyses, sampling design/methods, and receptor study design are the major sources of this kind of error. Uncertainty, on the other hand, is associated primarily with deficiency or irrelevancy of effects, exposure, or habitat data than to actual ecological conditions at the MRS. Species physiology, feeding patterns, and nesting behavior are poorly predictable; therefore, all toxicity information derived from toxicity testing, field studies, or observation have uncertainties associated with them. Laboratory studies conducted to obtain MRS-specific, measured information often suffer from poor relevance to the actual exposure and uptake conditions on site (i.e., bioavailability, exposure, assimilation, etc., are generally greater under laboratory conditions as compared to field conditions). Calculating an estimated value based on a large number of assumptions is often the only alternative to the accurate, albeit costly, methods of direct field or laboratory observation, measurement, and/or testing. Finally, habitat- or MRS-specific species may be misidentified if, for example, the observational assessment results are based on only one or two brief MRS reconnaissance surveys.

The uncertainty analysis describes many of the major assumptions made for the SLERA. When discernible, the direction of bias caused by each assumption (i.e., whether the uncertainty results in an overestimate or underestimate of risk) is provided as well. Where possible, a description of recommendations for minimizing the identified uncertainties is also presented if the SLERA progresses to higher level assessment phases. The most important uncertainties associated with this SLERA are discussed in the following paragraphs.

8.4.4.1 Assumptions of Bioavailability

The assumption that COPECs are 100 percent bioavailable likely overestimates the potential for adverse effects. The duration that has lapsed since the contaminant release affects bioavailability as the contaminant becomes sequestered or transformed within the environmental media. Sequestration, transformation, and bioavailability are influenced by medium characteristics including pH, temperature, and organic carbon content.

8.4.4.2 Use of Laboratory-Derived or Empirically Estimated Partitioning and Transfer Factors

The use of laboratory-derived or empirically estimated partitioning and transfer factors to predict COPEC concentrations in plants, invertebrates, and prey species, likely overestimates potential risks. As discussed previously, the incorporation of COPECs into the food chain is influenced by the characteristics of the exposure medium, which likely differs from that used in the laboratory to derive partitioning and transfer factors.

8.4.4.3 Use of Laboratory-Derived Toxicity Reference Values

The use of laboratory-derived TRVs may overestimate or underestimate the potential for adverse effects. The method of administration of the contaminant in the laboratory is typically different than that experienced in the wild by the receptors. Also, laboratories typically use “naïve” organisms in their toxicity testing, which are likely to be much more sensitive to toxicants than organisms living in the wild or at the MRS, which have likely developed resistances or have otherwise adapted to ambient concentrations of chemicals in their environment.

8.4.4.4 Use of the HQ Method to Estimate Risks to Populations or Communities

The calculation of HQs also introduces uncertainty. The following limitations associated with HQs (Tannenbaum, 2005) are noted:

- HQs are not measures of risk.
- HQs are not population-based.
- HQs are not linearly scaled.
- HQs are often produced that are unrealistically high and toxicologically impossible (i.e., estimated HQs greater than 1,000, such as the HQ of 1,431 for mercury that was calculated during the initial screen against the ESV).

- Trace soil concentrations of inorganic chemicals (including concentrations well below background levels) can lead to HQ threshold exceedances.

Therefore, it should be understood that HQs greater than 1 do not mean that adverse ecological effects are occurring or may occur in the future.

8.4.4.5 Sampling and Analytical Limitations

It is not possible to completely characterize the nature and extent of contamination on any MRS. Uncertainties arise from limits on the number of locations that can be sampled. The sampling protocol used at the Group 8 MRS, however, was designed to optimize efficiency of the sampling effort and reduce uncertainty by providing coverage of the affected area using an ISM sampling approach that is designed to provide a more realistic estimate of the average concentrations of chemicals at the MRS.

8.4.4.6 Identifying Background Chemicals

Metals are judged to be present at concentrations comparable to background if the MDC does not exceed the BSV. The comparison of "average" concentrations as represented by ISM sampling results to a BSV that is based on discrete background samples may be inappropriate because the distributions of data produced by the two methods are typically different (USACE, 2009b). The direction of bias is unknown. However, because the BSVs are intended to be conservative representatives of background concentrations, comparing an ISM result to the BSV should typically provide the information necessary to make a sound decision as to whether the chemical is present at concentrations greater than background.

8.4.5 Level III Baseline Conclusions and Recommendations

Ten COPECs in ISM soil samples [antimony, cadmium, copper, lead, mercury, zinc, bis(2-ethylhexly)phthalate, di-n-butyl phthalate, Aroclor-1254, and Aroclor-1260] were recommended to be evaluated under the Level III Baseline evaluation following the Level II Screening (Section 8.3). Food chain modeling was used to estimate ecological hazards to three avian and three mammalian representative species to address assessment endpoints designed to be protective of terrestrial receptors (the protection of plants and terrestrial invertebrates were assessment endpoints that were previously addressed during the Level II Screening, which evaluates direct toxicity). Food chain modeling was performed using the ISM data sets. The MDCs were used as the EPCs for the ISM sample data, and results were also calculated for each of the individual ISM sampling units that make up the MRS decision unit. For the ISM sample data set, all COPECs evaluated in the Level III Baseline had at least one HQ that exceeded 1 in at least one ISM surface soil sampling unit using both the LOAEL and NOAEL TRVs except mercury. Mercury only exceeded an HQ of 1 using its more conservative NOAEL-based TRV. Therefore, exposure to mercury is unlikely to result in adverse effects to ecological receptors.

Multiple COPECs were identified for the MRS that resulted in elevated HQs in many of the ISM sampling units. These COPECs represent a potential for localized impacts to soil invertebrates and small range receptors (particularly the short-tailed shrew and American robin) at the Group 8 MRS. Based on the small size of the MRS (less than 3 acres), the conservative nature of the Level III Baseline, and the low habitat quality of the MRS, the potential for adverse effects to populations of ecological receptors is most likely overestimated; however, the potential risks posed to the ecological receptors at the MRS are not discounted in this RI Report and are considered to be representative of the site conditions.

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9.0 REVISED CONCEPTUAL SITE MODELS

This chapter presents the revised CSMs for MEC and MC at the Group 8 MRS based on the results of the data collected for the RI previous information provided in the HRR (e^2M, 2007) and the SI Report (e^2M, 2008). The preliminary CSMs for MEC and MC were discussed in Section 2.0 and the summary of the RI results were presented in Section 4.0. Potential human health and environmental risks for the Group 8 MRS 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 RIs and are discussed at the end this chapter.

9.1 MEC Exposure Analysis

This section summarizes the RI data results for the MEC exposure pathway analyses for the MRS. As discussed in Section 2.1, "Preliminary CSM and Project Approach," each pathway includes a source, activity, access, and receptor, with complete, potentially complete, and incomplete exposure pathways identified for each receptor.

9.1.1 Source

A MEC source is the location where MPPEH or ordnance is situated or is expected to be found. The Group 8 MRS was reportedly used for the OB of debris trash for an undetermined amount of time and as evidenced by the RI findings, the burning activities may have included munitions demilitarization. These activities may have resulted in the potential for MEC to be present in surface and subsurface soils at the MRS.

MEC has been found at the MRS prior to the RI field activities. In 1996, OHARNG personnel found one antipersonnel fragmentation bomb with HE on the ground surface. The 2007 SI field activities documented the presence of MEC items that consisted of two T-bar fuzes in shallow surface soils (i.e., partially buried). Based on historical operations at the MRS and the RI findings, any potential MEC/MD would be expected to be found on the surface and/or subsurface soils.

All accessible areas of the MRS were effectively covered by the DGM survey during the RI and a total of 2,690 anomalies were identified for an average anomaly density of 1,015 anomalies per acre. Three areas were considered to have localized high anomaly densities, which accounted for 1,049 of the 2,690 anomalies. Outside of these high density areas, there were a total of 1,641 individual target anomalies identified for potential investigation and a statistical sampling approach was used to estimate the required sample size for populations. The amount of anomalies that were investigated was 16 percent (or 264) of the 1,641 individual anomalies identified during the DGM survey. In addition, 14 exploratory trenches were excavated at the 3 areas at the MRS with high anomaly densities.

No MEC were identified during the intrusive investigation at any of the point source anomalies locations or high anomaly trenching locations which meets the DQOs. However, a total of 359 MD items (1,418 lbs) were encountered throughout the MRS at depths ranging from 1 inch to 4 feet bgs during the intrusive investigation. The statistical analysis of the intrusive findings states that there is a 99 percent probability that there is no MEC present in any of remaining 1,377 anomalies that were not investigated during the RI field activities. Taking into consideration the amount of buried MD that was removed during the RI field work, the various types of MD found, the distribution and depth at which the MD was found, the relatively minimal size of the MRS at 2.65 acres, and that MEC items were found at the MRS prior to the RI field activities, there is the potential for an explosive hazard at the MRS.

9.1.2 Activity

Activity describes ways that receptors come into contact with a source. Current activities at the MRS include security patrols, maintenance activities and access to the road network to access adjacent buildings. Biota activities at the MRS may include occasional meandering and occupation on the MRS by assorted species and burrowing activities. The OHARNG projected future land use for the Group 8 MRS is military training.

9.1.3 Access

Access describes the degree to which a MEC source or environment containing MEC is available to potential receptors. There is a perimeter fence that helps prevent unauthorized access into the installation. The MRS boundary is marked with Siebert stakes and signage warning receptors about the MRS to help deter access.

9.1.4 Receptors

A receptor is an organism (human or ecological) that comes into physical contact with MEC. Human receptors identified for the Group 8 MRS include both current and anticipated future land users. Ecological receptors (biota) are based on animal species that are likely to occur in the terrestrial habitats at the MRS. The primary MRS-specific biota identified for the MRS include terrestrial invertebrates (earthworms), voles, shrews, robins, foxes, barn owls, and hawks (USACE, 2003c).

Human receptors associated with the current land uses at the MRS include facility personnel and contractors. The National Guard Trainee has been identified as the military training future land use receptor and is the most sensitive of the identified current and future human receptors that have the potential to be exposed to any potentially remaining MEC at the Group 8 MRS.

9.1.5 MEC Exposure Conclusions

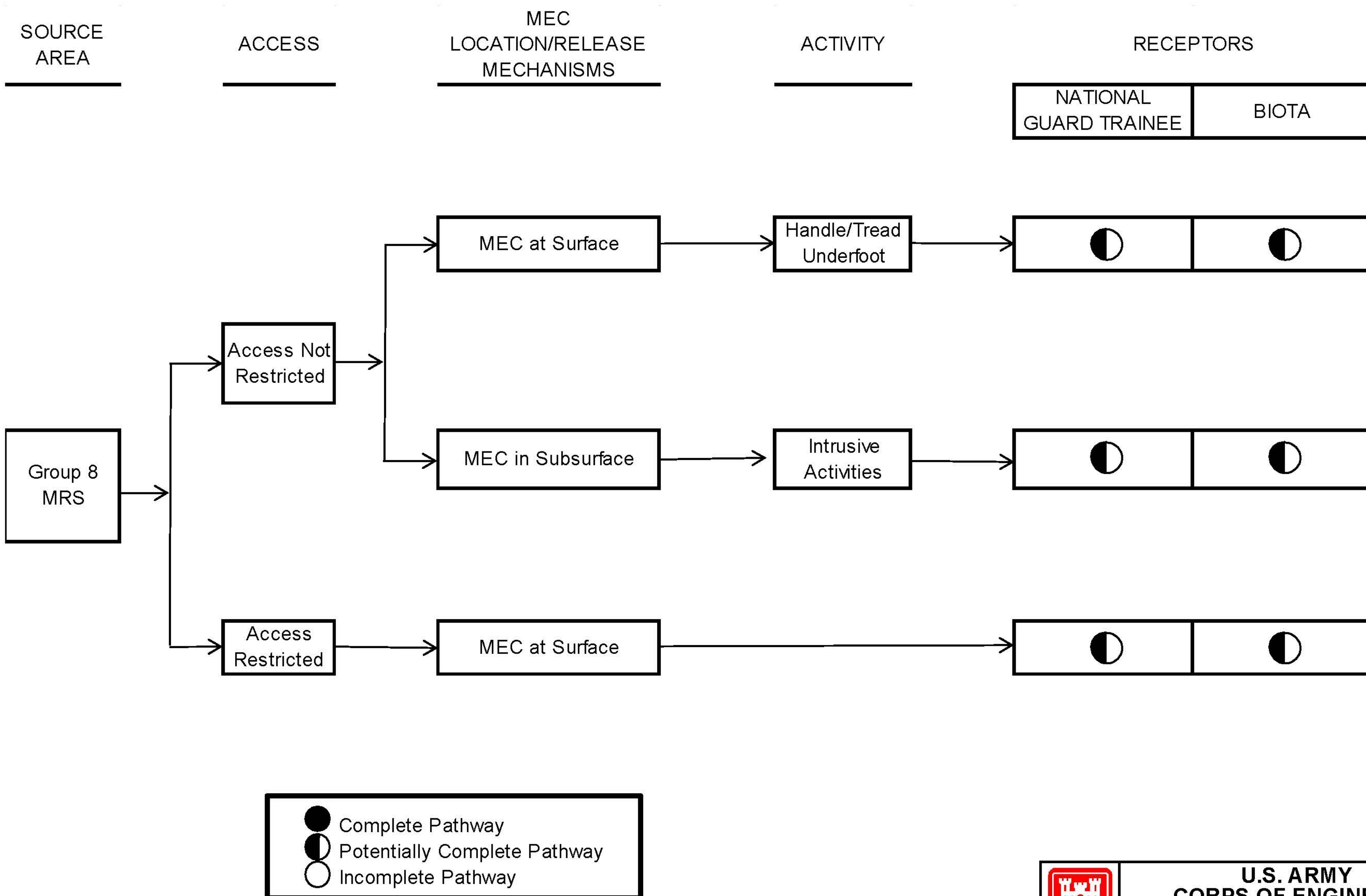
The information collected during the RI was used to update the preliminary MEC CSM for the Group 8 MRS and to identify all actual, potentially complete, or incomplete source-receptor interactions for the MRS for current and anticipated future land uses. Evaluation of the end use receptors for future land use in the revised CSM is consistent with the RVAAP HHRA approach (USACE, 2005). The revised MEC CSM that presents the exposure pathway analysis for the Group 8 MRS is presented as **Figure 9-1**.

Complete DGM coverage of accessible areas was conducted at the MRS during the RI and a statistical approach was taken for the selection of anomalies for intrusive investigation. No MEC was identified at the MRS during the RI intrusive investigation activities; however, numerous MD items of various types were encountered at depths ranging from 1 inch to 4 feet bgs. Although a MEC explosive hazard was not identified at the MRS during the RI and statistical analysis of the intrusive investigation results indicates that no MEC is present at a 99 percent confidence level, the amount of MD encountered (359 items), the distribution of the MD items throughout the MRS, and the previously documented MEC items at the MRS is taken into consideration. Therefore, a MEC explosive hazard may remain at the MRS and potentially complete pathways are identified for all receptors accessing surface or subsurface soils.

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 and identify all complete, potentially complete, or incomplete source-receptor interactions for the MRS for current and reasonably anticipated future land-use activities. The revised MC CSM that presents the exposure pathway analysis for the Group 8 MRS is presented as **Figure 9-2**.

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. Although not documented, OB of MEC/MD may have occurred at the MRS, which may have resulted in MC contamination to the surrounding soil. In addition, corrosion of the buried MD found during the RI intrusive investigation activities may have released MC into the surrounding soil.



U.S. ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT

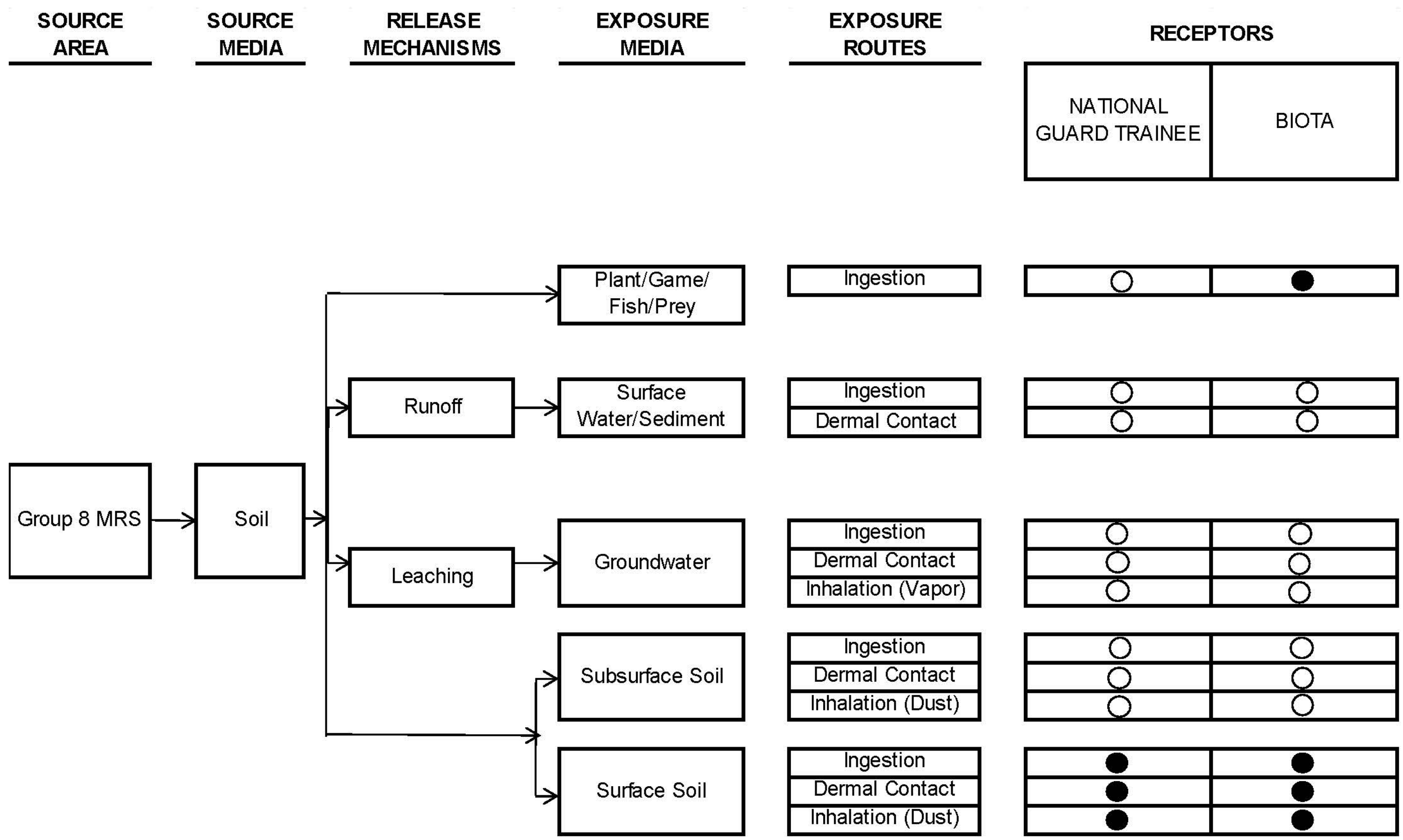
MILITARY MUNITIONS RESPONSE PROGRAM

GROUP 8 MRS
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Project Number: 136147 Generated By: MM Date: 04/02/13 File Path:\\crpbtrpgi01\arcgisprod3\MAMMS\Ravenna\GIS_Documents\Project_Maps\MMRP\RIFS\RIFS_Group8\RVAAP_Group8_023_Fig9_1_Rev_MECCSM.mxd

FIGURE 9-1 REVISED MEC CONCEPTUAL SITE MODEL



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

Complete Pathway
Potentially Complete Pathway
Incomplete Pathway

U.S. ARMY CORPS OF ENGINEERS
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FIGURE 9-2 REVISED MC CONCEPTUAL SITE MODEL

The determination as to whether MC characterization was required at the MRS was made based on historical evidence and the results of the MEC investigation. In accordance with the Work Plan Addendum (Shaw, 2011), four ISM surface soil samples were collected from sampling units of the same size for the entire MRS. Additional samples were proposed in areas with concentrated MEC/MD and three additional ISM soil samples were collected from the bottom of the trenches where concentrated buried MD was encountered at the MRS. The trench samples were evaluated in the risk assessments as subsurface samples.

The detected chemicals were evaluated in accordance with the RVAAP data use evaluation process to identify SRCs. In all, 35 SRCs were identified in surface soils (0 to 0.5 feet bgs) and 24 SRCs were identified in subsurface soils (4 to 4.5 feet bgs).

A HHRA was conducted for the surface and subsurface soil samples to determine if the identified SRCs were COPCs and/or COCs that may pose a risk to future human receptors. The OHARNG future land use at the MRS is military training. Evaluation of the future land use, in conjunction with the evaluation of agricultural-residential land uses and associated receptors, form the basis for identifying COPCs and COCs in the RI. Residential Land Use, specifically the Residential Farmer (Adult and Child) scenario, is included to evaluate COCs for unrestricted land use at the MRS as required by the CERCLA process. Nine COCs that included cadmium, iron, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, Aroclor-1254, and Aroclor-1260 were identified in surface soils for the Residential Farmer (Adult and Child). Cadmium and lead were identified as two COCs in surface soil for the National Guard Trainee. Only iron was identified as a COC in subsurface soil for the residential land use receptors. No COCs were identified for the National Guard Trainee in subsurface soils.

The National Guard Trainee is considered as the most sensitive of the identified current and future human land use receptors that have the potential to be exposed to COCs at the Group 8 MRS. The COCs in surface soil (0 to 0.5 feet bgs) were considered to pose a risk to the National Guard Trainee, but the COCs identified for the National Guard Trainee in subsurface soil (4 to 4.5 feet bgs) were not considered to be present at concentrations great enough to pose a risk. Therefore, the MC CSM for the National Guard Trainee has been updated to reflect a complete pathway for surface soil and incomplete pathway for subsurface soil.

Ten COPECs in the surface soil were recommended to be evaluated under the Level III Baseline evaluation following the Level II Screening. COPECs are determined in the ERA and may differ from COPCs. The COPECs identified included antimony, cadmium, copper, lead, mercury, zinc, bis(2-ethylhexly)phthalate, di-n-butyl phthalate, Aroclor-1254, and Aroclor-1260.

Sufficient time has elapsed for COCs and COPECs in the surface soil to have migrated to potential exposure media including surface water and sediment, resulting in possible exposure of plants, fish, and animals that come into contact with these media. With the exception of a small drainage ditch along the south side of the MRS, there are no significant surface water features where COCs or COPECs in surface soil may have migrated. Therefore, the MC exposure pathways for all receptors at the MRS to the aquatic environments, including surface water and sediment, and the plant/game/fish/prey exposure media are considered incomplete.

The major exposure routes for chemical toxicity from surface soil to the environmental receptors include ingestion (for terrestrial invertebrates, voles, shrews, American robins, foxes, and hawks) and direct contact (for terrestrial plants and invertebrates). The ingestion exposure routes for voles, shrews, American robins, foxes, owls, and hawks include soil, as well as plant and/or animal food (i.e., food chain) that were exposed to the surface soil. Minor exposure routes for surface soil include direct contact and inhalation of fugitive dust. Various COPECs in surface soil were determined to present potential threats to likely ecological receptors; therefore, the MC exposure pathways for ecological receptors in surface soil are considered complete.

Groundwater beneath the RVAAP is evaluated on a facility-wide basis and MRS-specific sampling was not intended for an MRS being investigated under the MMRP unless there is a likely impact from a MEC source. The soil conditions at the MRS are considered low to moderately permeable, the detected concentrations of explosives are low and the detected metals, SVOCs, and PCBs are expected to remain in the top several inches of soil on the ground surface or in subsurface soils beneath concentrated areas of buried MD where they were deposited; therefore, groundwater conditions have most likely not been impacted. No groundwater samples were collected at the Group 8 MRS during the RI field work and the groundwater exposure pathway is considered incomplete for all receptors.

9.3 Uncertainties

The purpose of the DQO process is to adequately characterize and define the hazards/risks posed by the MRS; however, this process does not remove all uncertainty associated with the MRS. There are minimal levels of uncertainties associated with the RI results at the Group 8 MRS that are presented in this section.

The primary uncertainty related to the evaluation of the RI results at the Group 8 MRS is associated with the incomplete record of historical disposal operations pertaining to munitions items burned along with construction debris. No records have been identified to date stating that munitions items were burned and disposed at the MRS, and only the physical evidence found during the RI field activities most likely indicates that munitions were burned and the demilitarized MD disposed via burial operations at the MRS. The timeframe of the disposal for the MD is unknown. It is also unknown as to whether the burial pits were used for burning or if burial took place after the OB activities were completed on the ground surface. Based on the amount of MD uncovered during the RI field activities, it is likely that the demilitarized MD was buried/disposed at the MRS for an extended time or in volume over a short term. If munitions items were burned and disposed at the MRS, then any remaining MEC type would have been expected to be found in the surface or subsurface soils. This is supported by the fact that MEC items have been found both on the ground surface at the MRS by OHARNG personnel in 1996 and partially buried during the SI field activities in 2007. Therefore, there is uncertainty as to whether MEC is present at the MRS, and the amount of potential MEC within the MRS is not anticipated to be overstated.

In order to determine the quantity and type of MEC present, if any, a combination of DGM survey and anomaly investigations were performed at the Group 8 MRS for the RI. The DGM survey coverage was designed based on complete (100 percent) coverage of the MRS due to the minimal size (2.65 acres) of the MRS and the actual area of coverage was nearly 97 percent. The number of anomalies requiring intrusive investigation was designed based on a hypergeometric statistics module that estimates the required sample size of populations. A total of 264 of 1,641 anomalies, which represent 16 percent of the individual anomalies within the MRS, were successfully investigated. In addition, 14 exploratory trenches were mechanically excavated at three areas at the MRS with high anomaly densities. No MEC was found during the RI field activities and the statistical approach used to quantify the intrusive findings of the RI indicates that there is a 99 percent probability there is no MEC present at the remaining 1,377 anomaly locations that were not investigated during the RI field activities. These results reduce the uncertainty that MEC is present at the MRS.

There are uncertainties and limitations associated with the delineation of MD at the Group 8 MRS. Three MD items were found along the northeast and east boundaries of the MRS during the RI intrusive investigation. Starting at the northernmost anomaly and going clockwise, these items were numbered as targets 1646, 1658, and 1611. The maximum depth of the MD point source anomalies found during the intrusive investigation was 36 inches at a trash pit at one location (target 1610) at the southeast portion of the MRS. The MD items found at 24 of the 26 point source anomaly locations were at depths less than 12 inches. The three MD items identified along the northeast and east MRS boundaries were found at a maximum depth of 8 inches. For the MD identified along the boundary of the MRS, step–out, Schonstedt-assisted visual surveys were performed where possible but were not tracked with the global positioning system. Most of the northern and southern MRS boundaries are limited by the adjacent buildings as is a portion of the western MRS boundary. Investigation beyond the northeast boundary where target 1646 was found was limited by OHARNG vehicle storage and interference to the Schonstedt magnetometer along the access road due to slag. The MD items found at the western portion of the MRS were not close to the west boundary; therefore, the Schonstedt-assisted survey was not conducted much further beyond the boundary in this direction. The step-out surveys along the east boundary were conducted for approximately 50 feet until dense tree and vegetation areas were encountered. The only anomalies found along the step-outs from the MRS were surface metal debris. It is possible that the lateral extent of buried MD for the Group 8 MRS is underestimated and may extend beyond MRS; however, the Schonstedt-assisted visual survey that was performed outside of the MRS with no findings of MEC or MD reduces this uncertainty.

9.4 Munitions Response Site Prioritization Protocol

The DoD proposed the MRSPP (32 Code of Federal Regulations Part 179) to assign a relative 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 Code of Federal Regulations 179.3]). The revised MRSPP document for the Group 8 MRS is being prepared separately from the RI and is included in **Appendix M** for reference only.

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10.0 SUMMARY AND CONCLUSIONS

This chapter summarizes the results of the RI field activities conducted at Group 8 MRS. The purpose of this RI is to determine whether the Group 8 MRS warrants further response action pursuant to CERCLA and the NCP. More specifically, the RI is intended to determine the nature and extent of MEC and 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 FS, if required. As a result of the investigation activities, the objectives of the RI have been satisfied. A summary of the RI results for each MRS is presented in **Table 10-1**.

Table 10-1
Summary of Remedial Investigation Results

MRS Name	Proposed Investigation Area (Acres)	Actual Investigation Area (Acres)	MEC and/or MD Found?	MC Detected?	MC Risk Analysis
Group 8 MRS	2.65	2.563	Yes (MD)	Yes	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 available for the Group 8 MRS relating to the potential presence of MEC and MC is compiled and evaluated in this RI Report. The sources of this information were obtained from previous investigations and historical records 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 (e^2M, 2008) phase of the CERCLA process and were used identify the data needs and DQOs as outlined in the Work Plan Addendum (Shaw, 2011). The data needs and DQOs were determined at the planning stage and included characterization for MEC and MC associated with 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 Group 8 MRS identified the following decision rules that were implemented in evaluating the MRS:

- Perform a geophysical investigation to identify if buried MEC or MD is present.

- Perform an intrusive investigation of anomalies identified during the geophysical investigation to evaluate if MEC/MD is present.
- Collect incremental and/or discrete soil samples (surface and subsurface) in areas with concentrated MEC/MD, if any.
- 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 is required under the CERCLA process.

Between October 31, 2011, and November 14, 2011, full coverage DGM was performed to identify potential subsurface areas of MEC and/or MD at the Group 8 MRS. The DGM data were collected in all accessible areas within the MRS and the spatial coverage was 2.563 acres or nearly 97 percent of the 2.65 acres MRS. No MEC or MD was identified on the ground surface during the DGM survey.

Evaluation of the data collected during the DGM survey identified 2,690 anomalies which had signal strength greater than or equal to 8 mV (Channel 2) for an average anomaly density of 1,015 anomalies per acre. Three areas were considered to have localized high anomaly densities, which accounted for 1,049 of the 2,690 anomalies. The majority of the high density areas were located south of the gravel roadway. Outside of these high density areas, there were a total of 1,641 anomalies identified for potential investigation. In general, the geophysical data indicate that the anomaly density at the MRS is high and dispersed throughout the MRS with defined localized areas of higher density than found throughout the other areas at the MRS.

Following the completion of the DGM survey in November 2011, an intrusive investigation was conducted for the locations identified as potentially containing subsurface MEC and/or MD based on an analysis of the DGM survey data. A total of 264 of the 1,641 single point anomalies (16 percent) and 14 exploratory trenches within the 3 areas of high anomaly density were successfully investigated. No MEC was identified during the intrusive investigation activities; however, 359 individual MD items that weighted 1,418 lbs were recovered at depths ranging from 1 inch to 4 feet bgs.

The determination as to whether MC characterization was required at the MRS was made based on historical evidence and the results of the MEC investigation. In accordance with the Work Plan Addendum (Shaw, 2011), four ISM surface soil samples were collected from sampling units of the same size for the entire MRS at depths between 0 and 0.5 feet bgs. Additional samples were proposed in areas with concentrated MEC/MD and three additional ISM soil samples were collected from the bottom of the trenches at depths of 4 to 4.5 feet bgs where concentrated buried MD was encountered at the MRS. The trench samples were evaluated/considered as subsurface samples in the risk assessments.

10.2 Nature and Extent of SRCs

The SRCs for the Group 8 MRS were determined for the ISM surface soil and subsurface soil samples collected during the RI field activities through the RVAAP data screening process as presented in the FWCUG Report (SAIC, 2010). A total of 35 SRCs were identified in surface soil (0 to 0.5 feet bgs) and 24 SRCs were identified in subsurface soil (4 to 4.5 feet bgs). The detected chemicals identified as SRCs in surface and subsurface soils following the screening process included the following.

- Surface Soil (0 to 0.5 feet bgs):
  - *Explosives and Propellants*: nitroguanidine and TNT
  - *Metals:* antimony, barium, cadmium, chromium, copper, iron, lead, mercury, strontium, and zinc
  - *SVOCs:* 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, carbazole, chrysene, dibenzo(a,h)anthracene, dibenzofuran, di-n-butyl phthalate, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene
  - *PCBs:* Aroclor-1254 and Aroclor-1260
- Subsurface Soil (4 to 4.5 feet bgs):
  - *Metals:* antimony, cadmium, copper, iron, lead, mercury, strontium, and zinc
  - *SVOCs:* 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, dibenzofuran, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene
  - *PCBs:* Aroclor-1254 and Aroclor-1260

No explosives or propellants were detected in subsurface soils.

10.3 Fate and Transport

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 movement) 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. No MEC was found at the Group 8 MRS during the RI field activities; however, numerous types of MD were found at the MRS. The MD items located at or near the surface appeared to have succumbed to oxidation caused by exposure to water and air, which may have released MC to the environment.

During the RI field activities, buried MD was found at a maximum depth of 4 feet bgs and native soil was not encountered until 4 feet bgs at 11 of the 14 trench locations. Therefore, at a minimum, surface soil conditions at some areas of the MRS have been disturbed or reworked to approximately 4 feet bgs.

The explosives SRCs, nitroguanidine and TNT, are considered mobile in soil and the impact to subsurface soils beneath potential MD source areas to a maximum depth of 4.5 feet bgs were evaluated for this RI. The concentrations of nitroguanidine and TNT that were detected in the surface soil (0 to 0.5 feet bgs) were low and no concentrations of these explosives were detected in the subsurface soils (4.0 to 4.5 feet bgs). Based on the detected results, significant sources of nitroguanidine and TNT were most likely not released during previous activities at the MRS and the low to medium permeability of the soils at the MRS mitigated any potential migration of residual concentrations to subsurface soils.

The metals SRCs have a tendency to sorb to soil at soil pH of 4 or greater, depending on the specific analyte. The MRS-specific pH of 7.72 indicates that metals SRCs would be expected to be found in the top several inches where they were released, with only limited downward migration. The detected PCBs and SVOCs that include PAHs are also anticipated to sorb to soils based on the K_{oc} values (i.e., have the tendency to be sorbed to the organic fraction of soil) and are not expected to leach into surface water runoff or migrate through the soil column.

One of the principle migration pathways at the Group 8 MRS is infiltration through the unsaturated soil to groundwater that is approximately 15 to 20 feet bgs. A distinct boundary between native and fill material was identified at approximately 4 feet at 11 of the 14 trench locations during the RI field activities. The native material is described primarily as the Mahoning-Urban land complex that is somewhat poorly drained to moderately well-drained (AMEC, 2008). Based on the local topography, some of the precipitation falling as rainfall and snow likely leaves the MRS as surface runoff to the drainage ditch along the southern portion of the MRS. The precipitation that does not leave the MRS as surface runoff infiltrates into the subsurface. Some of the infiltrating water is lost to the atmosphere as evapotranspiration. The remainder of the infiltrating water recharges the groundwater. The rate of infiltration and eventual recharge of the groundwater is controlled by soil cover, ground slope, saturated hydraulic conductivity of the soil, and meteorological conditions throughout the MRS. Based on the aforementioned soil conditions, the low concentrations of explosives, and that metals, SVOCs, and PCBs are expected to remain in the top several inches of soil on the ground surface or in subsurface soils beneath concentrated areas of buried MD where they were deposited, groundwater conditions have most likely not been impacted.

10.4 MEC Hazard Assessment

The MEC HA evaluation in this RI Report is inclusive of the information available for the MRS up to and including the RI field activities and provides a scoring summary for the current and future land use activities, assuming no response actions. A MEC HA is performed for an MRS when an explosive safety hazard is identified. In the case for the Group 8 MRS, MEC items were reportedly found on the ground surface at the MRS by OHARNG personnel in the past and during the 2007 SI field activities; however, only MD items were found during complete coverage of the MRS during the RI field activities. Taking into consideration the amount of buried MD that was removed during the RI field work (1,418 lbs), the various types of MD found, the distribution and depth at which the MD was found, the relatively minimal size of the MRS at 2.65 acres, and that MEC items were found at the MRS prior to the RI field activities; it was determined that a potential explosive safety hazard may be present at the Group 8 MRS and calculation of a MEC HA score was warranted.

The MEC HA score for current conditions at the Group 8 MRS was calculated to be 705, which equates to a Hazard Level of 3 (moderate potential explosive hazard condition). The future land use at the MRS will be military training with the potential for intrusive activities and resulted in a MEC HA score of 805. This equates to a Hazard Level of 2 (high potential explosive hazard condition). The increase in the hazard level score is solely the result of an increase in receptor hours for the future land use.

10.5 MC Risk Assessment Summary

Following the identification of the SRCs at the Group 8 MRS for surface and subsurface soil through the RVAAP data screening process, the 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:

10.5.1 Protection of Human Health

A HHRA was conducted for the surface and subsurface soil samples to determine if the identified SRCs were COPCs and/or COCs that may pose a risk to future human receptors.

The OHARNG future land use at the MRS is military training. Evaluation of the future land use, in conjunction with the evaluation of agricultural-residential land uses and associated receptors, form the basis for identifying COPCs and COCs in the RI. Residential Land Use, specifically the Residential Farmer (Adult and Child) scenario, is included to evaluate COCs for unrestricted land use at the MRS as required by the CERCLA process.

Nine COCs that included cadmium, iron, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, Aroclor-1254, and Aroclor-1260 were identified in surface soils (0 to 0.5 feet bgs) for the Residential Farmer (Adult and Child). Cadmium and lead were identified as two COCs in surface soil for the National Guard Trainee (0 to 0.5 feet bgs). Only iron was identified as a COC in subsurface soil (4 to 4.5 feet bgs) for the residential land use receptors. No COCs were identified for the National Guard Trainee in subsurface soils.

Based on the results of the HHRA, it can be concluded that COCs pose a hazard to both the unrestricted land use and likely military training future land use receptors in surface soil. Weight of evidence suggests that the iron concentrations in subsurface soil are unlikely to pose a hazard to human receptors.

10.5.2 Protection of Ecological Receptors

Ten COPECs in the surface soil were recommended to be evaluated under the Level III Baseline evaluation following the Level II Screening. COPECs are determined in the ERA and may differ from COPCs. The COPECs identified included antimony, cadmium, copper, lead, mercury, zinc, bis(2-ethylhexly)phthalate, di-n-butyl phthalate, Aroclor-1254, and Aroclor-1260.

Multiple COPECs were identified for the MRS that resulted in elevated HQs in many of the ISM sampling units. These COPECs represent a potential for localized impacts to soil invertebrates and small range receptors (particularly the short-tailed shrew and American robin) at the Group 8 MRS. Based on the small size of the MRS (less than 3 acres), the conservative nature of the Level III Baseline, and the low habitat quality of the MRS, the potential for adverse effects to populations of ecological receptors is most likely overestimated; however, the potential risks posed to the ecological receptors at the MRS are not discounted in this RI Report and are considered to be representative of the site conditions.

10.6 Conceptual Site Model

The information collected during the RI field activities were used to update the CSM for MEC and MC for the Group 8 MRS as presented in the SI Report (e^2M, 2008). The purpose of the CSM is to identify all complete, potentially complete, or incomplete source-receptor interactions for reasonably anticipated 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.

Complete DGM coverage of accessible land-based areas was conducted at the MRS during the RI and a statistical approach was taken for the selection of anomalies for intrusive investigation. No MEC was identified at the MRS during the RI intrusive investigation activities; however, numerous MD items of various types were encountered at depths ranging from 1 inch to 4 feet bgs. A MEC explosive hazard was not identified at the MRS during the RI and statistical analysis of the intrusive investigation results indicates that no MEC is present at the remaining 1,377 individual anomaly locations that were not investigated at a 99 percent confidence level, Therefore, the amount of MD encountered (359 items), the distribution of the MD items throughout the MRS, and the previously documented MEC items at the MRS are taken into consideration. Based on this consideration, a MEC explosive hazard may remain at the MRS and potentially complete pathways are identified for all receptors accessing surface or subsurface soils.

Sampling for MC was performed at the Group 8 MRS based on historical evidence and the results of the RI intrusive investigation. Although no MEC was found during the RI, various MD items were encountered and detected SRCs were evaluated as MC. The SRCs were carried through the risk assessment process to determine if they were COCs or COPECs that may pose risks to future human and ecological receptors, respectively.

The National Guard Trainee is considered as the most sensitive of the identified current and future human land use receptors that have the potential to be exposed to COCs at the Group 8 MRS. The COCs in surface soil (0 to 0.5 feet bgs) were considered to pose a risk to the National Guard Trainee, but the COCs identified for the National Guard Trainee in subsurface soil (4 to 4.5 feet bgs) were not considered to be present at concentrations great enough to pose a risk. Therefore, the MC CSM for the National Guard Trainee has been updated to reflect a complete pathway for surface soil and incomplete pathway for subsurface soil.

Sufficient time has elapsed for COCs and COPECs in the surface soil to have migrated to potential exposure media including surface water and sediment, resulting in possible exposure of plants, fish, and animals that come into contact with these media. With the exception of a small drainage ditch along the south side of the MRS, there are no significant surface water features where COCs or COPECs in surface soil may have migrated. Therefore, the MC exposure pathways for all receptors at the MRS to the aquatic environments, including surface water and sediment, and the plant/game/fish/prey exposure media are considered incomplete.

The major exposure routes for chemical toxicity from surface soil to the environmental receptors include ingestion (for terrestrial invertebrates, voles, shrews, American robins, foxes, and hawks) and direct contact (for terrestrial plants and invertebrates). The ingestion exposure routes for voles, shrews, American robins, foxes, owls, and hawks include soil, as well as plant and/or animal food (i.e., food chain) that was exposed to the surface soil. Minor exposure routes for surface soil include direct contact and inhalation of fugitive dust. Various COPECs in surface soil were determined to present potential threats to likely ecological receptors; therefore, the MC exposure pathways for ecological receptors in surface soil are considered complete.

Groundwater beneath the RVAAP is evaluated on a facility-wide basis and MRS-specific sampling is not intended for an MRS being investigated under the MMRP unless there is a likely impact from a MEC source. The soil conditions at the MRS are considered low to moderately permeable; the detected concentrations of explosives are low; and the detected metals, SVOCs, and PCBs are expected to remain in the top several inches of soil on the ground surface or in subsurface soils beneath concentrated areas of buried MD where they were deposited. Therefore, groundwater conditions have most likely not been impacted. No groundwater samples were collected at the Group 8 MRS during the RI field work and the groundwater exposure pathway is considered incomplete for all receptors.

10.7 Uncertainties

The primary uncertainty related to the evaluation of the RI results at the Group 8 MRS is associated with the incomplete record of historical disposal operations pertaining to munitions items burned along with construction debris. No records have been identified to date stating that munitions items were burned and disposed at the MRS, and only the physical evidence found during the RI field activities most likely indicates that munitions were burned and the demilitarized MD disposed via burial operations at the MRS. The timeframe of the disposal for the MD is unknown. It is also unknown as to whether the burial pits were used for burning or if burial took place after the OB activities were completed on the ground surface. Based on the amount of MD uncovered during the RI field activities, it is likely that the demilitarized MD was buried/disposed at the MRS for an extended time or in volume over a short term. If munitions items were burned and disposed at the MRS then any remaining MEC type would have been expected to be found in the surface or subsurface soils. This is supported by the fact that MEC items have been found both on the ground surface at the MRS by OHARNG personnel in 1996 and partially buried during the SI field activities in 2007. Therefore, there is uncertainty as to whether MEC is present at the MRS and the amount of potential MEC within the MRS is not anticipated to be overstated.

In order to determine the quantity and type of MEC present, if any, a combination of DGM survey and anomaly investigations were performed at the Group 8 MRS for the RI. The DGM survey coverage was designed based on complete (100 percent) coverage of the MRS due to the minimal size (2.65 acres) of the MRS. The actual area of coverage was nearly 97 percent. The number of anomalies requiring intrusive investigation was designed based on a hypergeometric statistics module that estimates the required sample size of populations. A total of 264 of 1,641 anomalies, which represent 16 percent of the individual anomalies within the MRS, were successfully investigated. In addition, 14 exploratory trenches were mechanically excavated at 3 areas at the MRS with high anomaly densities. No MEC was found during the RI field activities. The statistical approach used to quantify the intrusive findings of the RI indicates that there is a 99 percent probability there is no MEC present at the remaining 1,377 anomaly locations that were not investigated during the RI field activities. These results reduce the uncertainty that MEC is present at the MRS.

There are uncertainties and limitations associated with the delineation of MD at the Group 8 MRS. Three MD items were found along the northeast and east boundaries of the MRS during the RI intrusive investigation. Starting at the northernmost anomaly and going clockwise, these items were numbered as targets 1646, 1658, and 1611. The maximum depth of the MD point source anomalies found during the intrusive investigation was 36 inches at a trash pit at one location (target 1610) at the southeast portion of the MRS. The MD items found at 24 of the 26 point source anomaly locations were at depths at less than 12 inches. The three MD items identified along the northeast and east MRS boundaries were found at a maximum depth of 8 inches. For the MD identified along the boundary of the MRS, step-out Schonstedt-assisted visual surveys were performed where possible but were not tracked with the global positioning system. Most of the northern and southern MRS boundaries are limited by the adjacent buildings as is a portion of the western MRS boundary. Investigation beyond the northeast boundary where target 1646 was found was limited by OHARNG vehicle storage and interference to the Schonstedt magnetometer along the access road due to slag. The MD items found at the western portion of the MRS were not close to the west boundary; therefore, the Schonstedt-assisted survey was not conducted much further beyond the boundary in this direction. The step-out surveys along the east boundary were conducted for approximately 50 feet until dense tree and vegetation areas were encountered. The only anomalies found along the step-outs from the MRS were surface metal debris. It is possible that the lateral extent of buried MD for the Group 8 MRS is underestimated and may extend beyond MRS; however, the Schonstedt-assisted visual survey that was performed outside of the MRS with no findings of MEC or MD reduces this uncertainty.

10.8 Conclusions

The following conclusions can be made for the Group 8 MRS based on the results of the RI field activities:

- Complete DGM coverage was performed at the MRS for the RI and nearly 97 percent coverage of the 2.65 acres MRS was achieved.
- Subsurface MD was encountered at various locations throughout the MRS at depths ranging between 1 inch and 4 feet bgs.
- No MEC was encountered during the RI field activities; however, the MEC items identified at the MRS prior to the RI and the amount, types, distribution, and depth of MD encountered during the intrusive investigations are taken into consideration, and an explosive hazard may be present at the MRS.
- The HHRA indicates that detected COCs in surface soil present risks to the unrestricted and likely military training future land use receptors.
- The ERA indicates that detected COPECs in surface soil have the potential for localized impacts to soil invertebrates and small range receptors.

Based on these conclusions, it is determined that the Group MRS has been adequately characterized and the DQOs presented in the Work Plan Addendum (Shaw, 2011) have been satisfied. The ARNG's next course of action for the Group 8 MRS will be to conduct a FS.

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Appendix A
Digital Geophysical Mapping Report

Draft Geophysical Mapping Report for
RVAAP-063-R-01 Group 8 MRS
Version 1.0

Ravenna Army Ammunition Plant
Ravenna, Ohio

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

Prepared for:

U.S. Army Corps of Engineers
Baltimore District
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April 10, 2013

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Note: The data and information in Attachment 1 are provided in electronic format on compact disc. The data in Attachment 1 require the Oasis Montaj UX Process program in order to open the files. The data in Attachment 1 relate to the digitization of the information shown on Figure 1 and Figure 3 in Attachment 3 and on Figure 4-1, Figure 4-2, and Figure 4-3 in the main body of the Group 8 MRS Remedial Investigation Report.

Acronyms and Abbreviations

<	less than
=	equal to
ASCII	American Standard Code for Information Interchange
DGM	digital geophysical mapping
DQO	data quality objective
e^2M	engineering-environmental Management, Inc.
FADL	field activity daily log
GIS	geographic information system
IVS	instrument verification strip
MD	munitions debris
MEC	munitions and explosives of concern
mm	millimeter
MMRP	Military Munitions Response Program
mph	miles per hour
MRS	munitions response site
mV	millivolt
Ohio EPA	Ohio Environmental Protection Agency
QA	quality assurance
QC	quality control
RI	remedial investigation
RMS	root mean square
RTS	robotic total station
RVAAP	Ravenna Army Ammunition Plant
Shaw	Shaw Environmental & Infrastructure, Inc.
stdev	standard deviation
TDEM	time-domain electromagnetic
USACE	United States Army Corps of Engineers
USAESCH	United States Army Engineering Support Center, Huntsville
UXO	unexploded ordnance

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1.0 INTRODUCTION

This Digital Geophysical Mapping (DGM) Report documents the finding and conclusions of the field DGM survey at the Group 8 Munitions Response Site (MRS) in support of remedial investigation (RI) field activities at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio. This DGM Report is being prepared by Shaw Environmental & Infrastructure, Inc. (Shaw), a CB&I company, under Delivery Order 0002 for the Military Munitions Response Program (MMRP) Environmental Services at the RVAAP 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 Army Corps of Engineers (USACE), Baltimore District on May 27, 2009.

The results of the DGM survey presented herein include a summary of the field activities, geophysical data processing and interpretation, and results of the quality control (QC) program for the DGM investigation at the Group 8 MRS. The geophysical program at the MRS was performed in accordance with the *Final Work Plan Addendum for Military Munitions Response Program Remedial Investigation Environmental Services* (Shaw, 2011), herein referred to as the "Work Plan Addendum"; Data Item Description MMRP-09-004, *Geophysics* (USACE, 2009); and the *Performance Requirements for Remedial Investigation/Feasibility Studies using DGM* (United States Army Engineering Support Center, Huntsville [USAECH], 2008).

1.1 Background and History

The Group 8 MRS is a 2.65-acre MRS located between Buildings 846 and 849 which was used for an undetermined amount of time to burn construction debris and rubbish. Although it has not been documented, previous discoveries of munitions and explosives of concern (MEC) and munitions debris (MD) indicate that the area also received various munitions items which may also have been burned at the MRS. After burning activities ceased, the area was used as a staging area for military vehicles. The MRS is currently vacant with no improvements (engineering-environmental Management, Inc. [e^2M], 2008).

In 1996, one anti-personnel fragmentation bomb with high explosives and a demilitarized (i.e., cut in half) 175-millimeter (mm) projectile were both found on the ground surface within the MRS boundary. The fragmentation bomb found in 1996 was removed from the MRS and detonated at the Open Demolition Area #2. The demilitarized 175 mm projectile was removed and taken to Building 1501 (e^2M, 2007). The 2007 SI field activities documented the presence of MEC items that consisted of two T-bar fuzes in shallow surface soils (i.e., partially buried).

The principle source of potential buried MEC at the Group 8 MRS was the burning activities that may have included munitions demilitarization followed by burial of the items. Based on historical operations at the MRS and the RI findings, any potential MEC/MD would be expected to be found on the surface and/or subsurface soils.

1.2 Data Quality Objectives

The data quality objectives (DQOs) for the DGM survey were to identify if MEC and/or MD were present at the Group 8 MRS. The DGM information obtained during the RI was used to evaluate whether there are unacceptable risks of MEC and/or material potentially presenting an explosive hazard to likely human and environmental receptors and to make a determination if further investigation is required at the MRS in accordance with the *Comprehensive Environmental Responsibility, Compensation, and Liability Act of 1980*.

2.0 GEOPHYSICAL SURVEY EQUIPMENT

This section presents a discussion of the geophysical sensor and the positioning systems and methods used to perform the DGM investigation at the Group 8 MRS.

2.1 Geonics EM61-MK2 Geophysical Sensor

The Geonics EM61-MK2 is a four-channel high-sensitivity time-domain electromagnetic (TDEM) instrument sensor designed to detect ferrous and non-ferrous metallic objects with good spatial resolution and minimal interference from adjacent metallic features. The TDEM sensors utilize a transmitter that generates a pulsed primary electromagnetic field in the earth, which induces currents in nearby metallic objects. The current decay produces a secondary magnetic field measured by the receiver coils of the EM61-MK2. Measurements are acquired over a relatively long time after the primary pulse at specified time gates, which allows the current induced in the ground to dissipate, leaving only the current in the metal to still produce a significant secondary field.

The EM61-MK2 system used at the Group 8 MRS consisted of two 1-meter by 0.5-meter rectangular coils arranged in a coaxial geometry and separated by 40 centimeters. The coils were mounted on a wheeled platform 16 inches (42 centimeters) above the ground surface. Secondary voltages induced in the bottom and top coils were measured in millivolts (mV) by the instrument electronics and recorded to a Juniper Allegro data logger.

The EM61-MK2 measures four time gates from the lower coil (216, 366, 660, and 1,266 microseconds; otherwise known as “4” mode) or the first three time gates from the lower coil and the 660 time gate from both the lower and upper coil, also known as “D” mode. One mode is not more sensitive than the other. The “4” mode provides a later time gate than the differential (“D”) mode which can help determine if there are larger pieces of metal in the ground as well as provide additional information by presenting an additional reading to calculate decay rates between each time gate. For this project, the “4” mode of acquisition was used.

The EM61-MK2 is designed to detect individual small items at shallow depths and relatively larger items (e.g., 155 mm projectile) at depths approaching 5 to 7 feet below ground surface. The resulting data can be used to differentiate, in simplistic fashion, the relative size and distance (or depth) of metal items when the anomaly density is relatively low. In cluttered areas where the anomaly density is relatively high and the anomaly signatures overlap, the determination of size and depth is much more difficult.

2.2 Positioning Systems/Methods

The positioning systems used for the project provided coordinates for the geophysical measurements and were also utilized to identify natural and man-made features at the MRS so that these features can be accounted for during data analysis and interpretation. Position data for the project are presented in Universal Transverse Mercator coordinates; Zone 17 North, in meters.

The Group 8 MRS is characterized by relatively “open” areas devoid of thick vegetation and canopy (tree cover) with tree canopy located around the MRS boundary. Within the MRS there are physical obstacles such as small stands of trees, power line poles, and wire fences. Due to the tall canopy and buildings surrounding the MRS that had the potential to provide signal interferences, a robotic total station (RTS) was used to provide positions for the EM61-MK2 sensor measurements.

Robotic Total Station Positioning System

The Leica TPS1200 series total station is a motorized RTS that uses automatic target recognition to track the location of a 360-degree survey prism and has a highly accurate distance/azimuth measurement system. The RTS was set up using known locations that were certified by a registered land surveyor in the state of Ohio. A National Marine Electronics Association data string was connected via serial link directly into the Juniper Allegro data logger and the coordinate positions were integrated into the EM61-MK2 data file. The accuracies of the positions for the RTS system were within several centimeters when signal lock on the prism was maintained.

3.0 DATA ACQUISITION

This section provides a summary of the field activities performed and DGM data generated for the RI activities at the Group 8 MRS.

3.1 Summary of DGM Field Activities

The geophysical field crew performed the DGM survey at the Group 8 MRS and surrounding area from October 31 through November 14, 2011. For unexploded ordnance (UXO) avoidance purposes, UXO Technicians performed initial ground surface clearance with a Schonstedt Model GA-52Cx magnetometer prior to the DGM survey being performed.

A licensed Ohio surveyor established three survey monuments at the Group 8 MRS. Each monument was established with third-order horizontal accuracy (residual error less than or equal to 1 part in 10,000). The survey monuments were used to provide positional data to set up the RTS which streamed positional data directly to the EM61-MK2. All of the survey data documenting MRS features and obstructions are referenced to the established survey monuments.

The team that performed the DGM survey consisted of a geophysicist and UXO-qualified assistant. Equipment used for the DGM survey consisted of an EM61-MK2 TDEM instrument and a Leica TPS1200 RTS system for positioning. The DGM platform consisted of a standard wheeled configuration with the lower coil 16 inches above the ground surface.

For QC purposes, the RTS positioning system was used to reacquire a known, fixed location each time the system was set up on one of the survey monuments. Per the project metrics defined in the Work Plan Addendum (Shaw, 2011), static measurements for the positioning system were required not to exceed 0.5 feet. The RTS system provides centimeter (or better) accuracy and 100 percent of location checks satisfied the project metric.

Full coverage DGM data were acquired over all accessible areas of the MRS on lines spaced at approximately 2.5-foot intervals, which resulted in a spatial coverage of 96.7 percent of the 2.65-acre MRS. The remaining 0.087 acres could not be investigated due to obstructions (small stand of trees, power poles, and barbed wire fence). Within the areas accessible to DGM, 99 percent of the data were acquired at a line spacing of less than 3.5 feet which meets the metric specified in Section 3.3.13 of the Work Plan Addendum (Shaw, 2011).

Positioning system data were recorded at a minimum rate of 1 hertz and the EM61-MK2 measurements were recorded at a rate of 12 to 15 hertz which translates into a measurement sample density along the ground surface of approximately 0.3 to 0.4 feet. The EM61-MK2 and position data were digitally recorded using Geonics software on a Juniper Allegro CX data logger.

The Leica TPS1200 RTS was used to augment geophysical data and improve geophysical mapping through capture of visual observations made during MRS walk-over. During this process, the positioning system was used to record the positions of cultural features (e.g., utility poles, fence posts, surface debris, etc.) so that these features could be accounted for during the interpretation of the geophysical data.

3.2 DGM System Instrument Functional Tests

At the beginning and end of each day, instrument functional checks were performed to ensure the performance metrics designated in the Work Plan Addendum (Shaw, 2011) were achieved. The DGM data were uploaded to a field computer at the end of each day and transferred to the Shaw corporate server. QC procedures, including additional details regarding instrument functional tests performed for the DGM activities, are discussed further in Section 5.0, "Quality Control."

3.3 Field Documentation

The geophysical data files generated during the DGM activities include raw DGM field data and instrument functional check data. A field activity daily log (FADL) and "readme.txt" file were completed by the DGM field crew each day to document MRS activities related to the DGM investigation. Digital photographs documenting the MRS characteristics were also acquired and are included in **Appendix F** of the RI Report.

4.0 GEOPHYSICAL DATA PROCESSING AND ANALYSIS

This section presents a review of the data processing and analysis activities performed during the geophysical investigation. Geosoft's Oasis Montaj was the primary software used to complete data processing tasks. All DGM data were transferred to the client and Shaw's Geographic Information System (GIS) Department for inclusion into the project GIS. Processing and analysis of the DGM data was conducted in accordance with the specifications and requirements presented in Sections 3.3.7 through 3.3.9 of the Work Plan Addendum (Shaw, 2011).

At the end of each field day, the field geophysicist uploaded the DGM data to a dedicated computer, where the data was archived, backed-up, and initially processed and analyzed. Data were also transferred to the Shaw Processing Center in Concord, California on a daily basis for review by the data processor. The geophysical data files generated during the DGM activities include DGM field data and QC test data files that are included in **Attachment 1** to this report, and are discussed in subsequent sections.

The data processing sequence included assessing the daily instrument functional checks, track path and spatial sample density, and performing latency correction and data leveling using the UX Process tools in Oasis Montaj. Subsequent to the processing and review of the data, color-coded images of the geophysical sensor data were created for review and planning of the next day's field activities. Shaw utilized the following software to process the data:

- Geonics DAT61MK2 (or Trackmaker 61) for initial review of the EM61-MK2 data and output of the data in American Standard Code for Information Interchange (ASCII) format
- Shaw routine for converting data processed with Trackmaker 61 to an ASCII file with x-y coordinates
- Geosoft Oasis Montaj for latency correction; data leveling; interpolation and generation of color-coded images and statistical analysis of the data in terms of the performance and quality metrics such as along and across track sample density, speed, and dynamic noise

The Oasis processing log file (process.log) was recorded by the software and serves as the digital documentation of the processing sequence and parameters for each data acquisition session. During the analysis of the data, the track path and responses from cultural features such as signs, construction debris, monitoring wells, etc. were superimposed on the color-coded images in order to permit a more comprehensive evaluation of the geophysical data.

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5.0 QUALITY CONTROL

This section presents a summary of the QC regimen and procedures performed throughout the duration of DGM activities. The performance metrics for the twice-daily instrument functional tests and the quality objectives for spatial sampling, anomaly selection and reacquire, and the feedback process were also evaluated as part of the data processing procedures and are presented in this section. A Microsoft© Excel spreadsheet that summarizes the results of the DGM quality program was provided to the USACE Baltimore District on a consistent basis throughout the project for review and concurrence. The geophysical data files generated during the DGM activities include DGM field data and QC test data files that are included in **Attachment 1** to this report, and are discussed in subsequent sections.

5.1 Daily Instrument Functional Tests

QC procedures during the field survey were performed in accordance with the Work Plan Addendum (Shaw, 2011). Each day, the following required QC tests were performed in the field, documented, and evaluated during processing to ensure the data collected was of sufficient quantity and quality to meet the project objectives:

- Instrument warm-up
- Static noise test
- Personnel metal check and test
- Cable shake test
- Static spike test
- Instrument verification strip (IVS) repeat data
- Dynamic noise evaluation
- Known position check (RTS)

The results of the instrument warm-up and personnel metal check are documented in the FADL and/or field logbook by the DGM field crew. The dynamic noise primarily summarizes the noise characteristics of the DGM instrumentation and is therefore provided in the same table with other daily instrument tests that characterize instrument functionality and sensitivity. Dynamic noise is evaluated by the data processor on a daily basis for each acquisition session by analyzing the instrument noise in background areas of the site (i.e., areas where no metal exists). The metrics for the daily instrument tests are described in Section 3.3.13 of the Work Plan Addendum (Shaw, 2011).

The results of the initial IVS effort are documented in the *Instrument Verification Strip Technical Memorandum in support of Digital Geophysical Mapping Activities for Military Munitions Response Program Remedial Investigation Environmental Services*, which is included in **Attachment 2** of this report.

In summary, the instrument functional checks and the dynamic noise achieved the performance metrics throughout the duration of the project. The dynamic noise at the IVS for all Channels of the EM61-MK2 achieved the metric of +- 2 mV. During data collection activities, the standard deviation of Channel 2 was approximately 0.6 to 0.9 mV in background areas of the MRS. **Table 5-1** presents a summary of the DGM performance metrics for the entire Group 8 MRS DGM investigation.

5.2 Geophysical Quality Objectives

The Microsoft© Excel spreadsheet that summarizes the results of the DGM QC program was provided to the USACE at regular intervals throughout the project. The spreadsheet documents the results for the instrument functional checks and spatial sampling statistics for the project (speed and along/across track coverage). The results of the anomaly reacquire and feedback processes are documented in the project database.

The objectives for mean speed and along/across track spacing were consistently achieved during project execution, as were the objectives for latency correction, data consistency, anomaly selection and reacquire, and the feedback process. Metrics for these elements are described in Section 3.3.13 of the Work Plan Addendum (Shaw, 2011) and are as follows:

- **Mean Speed**: 95 percent less than < 3.4 miles per hour
- **Along track sampling**: 98 percent less than 0.8 feet
- **Across track sampling:** 90 percent of the area will be covered at a 3.5-foot line spacing or less excluding data gaps from trees or other obstacles that preclude the survey platform from providing complete coverage.
- **Latency Correction:** Data aligned to one sample interval (approximately 0.5 feet). No significant residual scalloping in the color-coded images.
- **Data Consistency:** Consistent channel naming conventions, processing parameters and methods used for all datasets and channels within each dataset.

Table 5-1
Summary of DGM Performance Metrics at Group 8 MRS

EM61-MK2 Channel	Personnel Test	Cable Shake Test	Static Noise Test	Static Spike Test	Repeatability (IVS)	Known Position Check (RTS)	Dynamic Noise (IVS)
Channel 1	98.39 % within +- 2 mV	100% within +- 3 mV	98.85 % within +- 2 mV	100% within 10% of reference value			100 % within +- 2 mV (stdev)
Channel 2	100 % within +- 2 mV	100 % within +- 3 mV	100% within +- 2 mV	100 % within 10 % of reference value	100% > 75 % of reference value and 100% less than or equal to 2.0 foot position accuracy		100 % within +- 2 mV (stdev)
Channel 3	100 % within +- 2 mV	100 % within +- 3 mV	100 % within +- 2 mV	100 % within 10 % of reference value			100% within +- 2 mV (stdev)
Channel 4	100 % within +- 2 mV	100% within +- 3 mV	100 % within +- 2 mV	100 % within 10 % of reference value			100 % within +- 2 mV (stdev)
						100% <= 0.5 foot	

< denotes less than.
= denotes equal to.
IVS denotes instrument verification strip.
mV denotes millivolts.
RTS denotes robotic total station.
stdev denotes standard deviation.

- **Anomaly Selection:** All anomalies included on the dig sheet will meet the anomaly selection criteria as established at the beginning of the project. If the anomaly selection criteria are modified during project execution based on the intrusive findings then the USACE and the Ohio Environmental Protection Agency (Ohio EPA) will be notified in advance via a field change order.
- **Anomaly Reacquisition:** The dig location marked in the field after anomaly reacquire will be within 2 feet of the interpreted dig sheet location for full coverage surveys.
- **Feedback Process:** For anomalies that are intrusively investigated during the project, the field geophysicist or designee will review the excavation results with respect to the geophysical anomaly characteristics and selection criteria. If there are potential discrepancies they will be documented in the project database.
- **Intrusive Anomaly Verification.** The USACE Table "*Performance Requirements for RI/FS using DGM Methods*" (USAECH, 2008) will be used to ensure that that there is a 90 percent confidence that less than 5 percent of the anomalies are unresolved.

Latency corrections employed during processing resulted in data without "scalloping" and with accurate location of QC points. Scalloping is similar to a chevron or latency that occurs between the RTS reading and the EM61-MK2 reading. If there is any significant latency it can be depicted as offsets on linear features in the data as the DGM paths are typically collected in opposite directions on each pair of lines. As latency was not an issue, this data does not show any sign of this effect.

Consistent data processing routines were used by the data processor, and the anomaly selection criteria were deemed representative based on the subsequent results of the intrusive phase of the project.

The root mean square (RMS) X-Y reacquire offset of 0.56 feet from the interpreted location for 96 percent of the anomalies is within the defined metric. At twelve anomaly locations the metric of 2 feet was slightly exceeded. Two of these anomalies are near the edge of the data, and the remainders of the locations are in "cluttered" areas of high anomaly density.

All anomalies included on the dig sheet met the anomaly selection criteria as established at the beginning of the project. As a result, the anomaly selection criteria were not modified during project execution and there were no deviations from the Work Plan Addendum (Shaw, 2011). Further discussion regarding anomaly selection is presented in Section 6.1.

The feedback process was performed by reviewing the results of the intrusive data and comparing the information with the geophysical anomaly characteristics. During this check, no significant discrepancies were identified by the field geophysicist. The results of the anomaly review (feedback) process are documented in the project database.

A total of 44 of the 272 anomaly locations selected for investigation were randomly selected for post-excavation QC with the EM61-MK2 based on the USACE “Acceptance Sampling Table”. At 42 of the locations, the residual signal from the sensor was less than 4 mV (Channel 2). Two locations (targets 1,550 and 1,556) were classified as trash pits and all of the metal could not be removed. Based on the results of the post-excavation QC checks, no additional excavation locations were required to be investigated.

Table 5-2 summarizes the results of the DGM quality objectives for the Group 8 MRS DGM investigation.

Table 5-2
Summary of DGM Quality Objectives at Group 8 MRS

Mean Speed	Along Track Sampling	Across Track Sampling	Latency Correction	Data Consistency	Anomaly Selection	Anomaly Reacquire	Feedback Process	Intrusive Anomaly Verification
96.28% < 3.4 mph	99.99% <0.8 feet	> 99% of data collected at < 3.5 feet	Color-coded images passed QC and QA review	Oasis GDBs passed QC and QA review	Anomaly selection passed QC and QA review	RMS average X-Y offset = 0.56 feet and 12 (4%) exceeded 2 feet	Applied and documented in project database	Applied and documented in project database

< denotes less than.
= denotes equal to.
mph denotes miles per hour.
QA denotes quality assurance.
QC denotes quality control.
RMS denotes root mean square.

6.0 DATA INTERPRETATION AND RESULTS

This section discusses the interpretation of data collected for the DGM investigations at the Group 8 MRS. Performance metrics discussed in Section 5.0, "Quality Control," demonstrate that the data collected meet the intent of the data quality objectives specified in the Work Plan Addendum (Shaw, 2011).

6.1 Data Interpretation of DGM Results

As part of the data analysis and interpretation sequence the data interpreter reviewed the following data characteristics: (1) static and dynamic measurements in background areas of the site, (2) mean speed, (3) along and across track spacing, (4) latency correction, and (5) position checks. The data collected were processed and interpreted in accordance with Sections 3.3.7 through 3.3.9 of the Work Plan Addendum, and the DGM quality metrics specified in Section 3.3.13 of the Work Plan Addendum were achieved for all of the data collected at the MRS (Shaw, 2011).

The data interpretation for the MRS was performed with regards to the EM61-MK2 signal intensities of Channels 1 through 4, anomaly shape, spatial distribution of anomalies, surface clearance findings, MRS features mapping, field crew notes, vegetation and terrain, and historical information from aerial photos. Interpretation of the geophysical data indicates that the anomaly density at the MRS is relatively high. A total of 2,690 anomalies were identified through the DGM process that range in intensity from 8 mV to 11,431 mV (Channel 2). Several zones of localized high anomaly density were selected by the data interpreter. A total of 1,641 individual target anomalies were identified for potential investigation outside of the high anomaly density zones. Prior to generation of the final dig list the data analyst removed anomalies from cultural features such as fence posts, utility poles, construction debris, and nails placed by the DGM team for QC purposes. Anomalies outside the boundary of the MRS were also removed from consideration at this stage.

Concurrence of the data quality, interpretation, and intrusive results by the USACE was received following the completion of DGM activities and prior to the intrusive investigation of target anomalies. Shaw presented the results of the DGM survey and proposed intrusive investigation locations to the USACE and the Ohio EPA for review and approval in the *Final DGM Survey Results and Proposed Dig Locations for the Group 8 MRS (RVAAP-063-R-01)* technical memorandum (**Attachment 3**).

Figure 1 and Figure 2 in the technical memorandum in **Attachment 3** and **Figure 4-1** through **Figure 4-3** of the RI Report present the DGM data collected at the Group 8 MRS. **Figure 2** in the technical memorandum and **Figure 4-1** in the RI Report illustrate the full coverage DGM obtained during the RI field activities. **Figure 4-2** in the RI Report provides a sensitive color scale that highlights all anomalies above a signal threshold of approximately 8 mV for Channel 2. **Figure 1** in the technical memorandum and **Figure 4-3** in the RI Report use a lower sensitivity color scale to delineate the major aggregates of buried metal at the MRS with increased definition.

6.2 Anomaly Selection

This section presents a discussion of the target dig list development and the intrusive investigation procedures performed for the evaluation of MEC and MD at the MRS. The proposed intrusive investigation locations were submitted to the USACE and Ohio EPA for review and approval in the *DGM Survey Results and Proposed Dig Locations for the Group 8 MRS (RVAAP-063-R-01)* technical memorandum included in **Attachment 3**. The Ohio EPA correspondence is provided in **Attachment 4**.

The selection process used to determine the 8 mV threshold anomaly selection criteria is in accordance with Section 3.3.10 of the Work Plan Addendum (Shaw, 2011). The 8 mV criteria (Channel 2) for anomaly selection is based on the smallest MEC item at each MRS that needs to be detected at the greatest depth. The 8 mV threshold was found to be reasonable for the work being performed at the MRS based on the results of the IVS where smaller MEC items in the near-surface produced a response that exceeds 8 mV, as well as the results of the field activities at the Atlas Scrap Yard MRS, Ramsdell Quarry Area 1, and Open Demolition Area #2 MRS. At these MRSs, the excavation results indicated approximately 30 percent of the anomalies less than 5 mV were "no finds".

6.2.1 Anomaly Selection for High Density Areas

Evaluation for the selection of the target dig locations was conducted in accordance with Section 3.2.10 of the Work Plan Addendum (Shaw, 2011). Interpretation of the data collected during the DGM survey identified 2,690 individual anomalies greater than 8 mV (Channel 2). Several zones of localized high anomaly density were selected by the data interpreter where 11 trenches were proposed as the primary investigative technique. Three additional exploratory trenches were included, for a total of 14 trenches, based on Ohio EPA's review and comments of the initial target list presented in the technical memorandum in **Attachment 3**. The use of trenching to investigate zones of high anomaly density was also used at Atlas Scrap Yard MRS, Ramsdell Quarry Area 1, and Open Demolition Area #2 MRS during Shaw's RI field activities at the RVAAP under the MMRP. Outside of the high anomaly density zones, 1,641 individual target anomalies were identified for potential investigation. Once the proposed trench locations were approved by the USACE and the Ohio EPA, they were transferred to a dig sheet and provided to Shaw's Geographical

Information System Department for inclusion in the ShawMEC database for the RVAAP that is used to track the investigation results.

6.2.2 Anomaly Selection for Individual Anomalies

Since a significant percentage of the accessible areas within the MRS were effectively covered by the geophysical survey (96.7 percent), the statistical sampling method used was a hypergeometric statistics module based on estimating the required sample size for populations. This module was used in conjunction with the HYPERGEOM program in Microsoft© Excel to provide a quality check of the results. The proposed method was approved by the USACE Baltimore District through review of the DGM information and identification of the target dig list. The hypergeometric method for determining the number of anomalies to sample (n) is based on the following equation:

$$n = Nz^2pq/(E^2(N–1) + z^2pq)$$

Where:

N = population size
z = confidence level
E = allowable error
p = probability
q = 1–p

Using input parameters of 95 percent confidence (z), 5 percent probability (p), and 2.5 percent error limits (E), 248 anomalies, representing nearly 15 percent of the total population of the 1,641 individual target anomalies (N), were selected and met the DQOs.

The program used to pick the actual locations of the target anomalies in order to eliminate manually biasing the process was the "RANDBETWEEN" function in Microsoft© Excel. The Microsoft© Excel "HYPGEOMDIST" function was used as a QC measure to check the results of the approved statistics module following the intrusive investigation.

An additional 24 individual anomaly locations and 3 exploratory trenches were added to the target dig list based on review comments provided by the Ohio EPA for the *Final DGM Survey Results and Proposed Dig Locations for the Group 8 MRS (RVAAP-063-R-01)* technical memorandum. This resulted in a total of 272 individual anomalies and 14 exploratory trenches that required investigation and effectively meets the DQOs. The 272 individual anomalies and 14 trench locations were transferred to a dig sheet and provided to Shaw's GIS Department for inclusion in the ShawMEC database for the RVAAP that is used to track the investigation results.

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7.0 ANOMALY REACQUIRE AND INTRUSIVE INVESTIGATION ACTIVITIES

This section presents a discussion of the anomaly reacquire and the intrusive investigation activities that were performed at the Group 8 MRS based on the DGM results and investigation rationale discussed in Section 6.0. A combination of individual target anomalies and test pits/trenches were intrusively investigated at the MRS in order to evaluate for potential subsurface MEC conditions.

7.1 Anomaly Reacquire and Intrusive Investigation Procedures

The anomaly reacquire and intrusive investigation activities at the individual target anomaly locations requiring investigation using hand tools and the burial features requiring trenching are presented below.

7.1.1 Individual Anomaly Locations

The UXO-qualified personnel used a Schonstedt magnetometer to first reacquire and then investigate ferrous anomalies identified during the DGM survey as individual target anomalies. These personnel used hand tools to unearth an item and as the excavation progressed toward the anomaly source. The UXO Technician continued to use the Schonstedt magnetometer to determine the item location both horizontally and vertically. To locate the ground position of the interpreted anomaly coordinates, the navigational system “Waypoint Location” mode was used for the RTS positioning system. A nonmetallic pin flag, labeled with the unique anomaly identification, was placed in the ground at the interpreted location. Reacquisition of any sampling or dig sheet locations (i.e., interpreted location) was performed to ±0.5 feet of the coordinates specified on the dig sheet.

Once the item was determined not to be MEC or MD, it was temporarily removed from the excavation and the Schonstedt magnetometer was used to confirm no additional ferrous items were located beneath the first item. Nonmunitions-related items were replaced and the soil was returned back into the investigation hole in reverse order from which it was excavated. All munitions related items (i.e., MEC/MD) were managed and disposed in accordance with the Work Plan Addendum (Shaw, 2011). The UXO-qualified personnel were also conscious of encountering any cultural artifacts associated with historical cultural or archeological resources.

7.1.2 High Density Anomaly Areas

Locating the ground position for the high-density areas was similar to the individual target anomalies, except on a larger scale. The navigational system “Waypoint Location” mode was used for the real-time kinematic global positioning system positioning system to locate the coordinates of the trench boundary. Nonmetallic pin flags, labeled with the unique anomaly identification, were placed in the ground at the interpreted location of the trench. As for the individual target anomaly locations, reacquisition of any sampling or dig sheet locations (i.e., interpreted location) was performed to ±0.5 feet of the coordinates specified on the dig sheet.

All trenches were mechanically excavated using an excavator. Each trench was continued in depth until the target anomalies were identified, native material was identified and a clear, distinct boundary between the native and fill material was evident, a maximum depth of 10 feet was attained, or the water table was reached. Soil material in each trench was removed in layers at approximately 1-foot intervals.

During the excavation activities, one UXO Technician stood in a safe area at the front of the operation and was responsible for examining the area to be advanced into and to visually observe for the presence of MEC or MD. If an anomaly was uncovered in a trench, the UXO Team worked to identify the anomaly before it was removed. Once the item was determined not to be MEC, it was temporarily removed from the excavation hole and a Schonstedt magnetometer was used to confirm no additional ferrous items were located beneath the first item. The soils that were excavated in 1-foot lifts were spread on 6-mil polyethylene sheeting in an adjacent area where the UXO Technician visually examined it for MEC and/or MD materials. Once confirmed that the source had been identified and no MEC or MD was present, nonmunitions-related items were replaced and the soil was returned back into the investigation trench in reverse order from which it was excavated. No soil was segregated for off-site disposal.

7.2 Intrusive Investigation Results

A total of 272 individual target source anomalies were agreed upon for reacquisition as presented in the technical memorandum (**Attachment 3)**. The dig locations were approved by the USACE Project Geologist and the Ohio EPA Project Manager. Seven of the 272 anomalies could not be reacquired successfully due to significant interference from adjacent buildings. The exact reason for the interference is not known. The equipment in the nearby buildings is used for humidity control and operates on an intermittent basis, which may be a reason as to why interference occurred during reacquisition and not during the data collection activities. One anomaly (Target 1,647) was located beneath a small area of asphalt at the northeast entrance to the MRS and was not intrusively investigated. In all, a total of 264 of the 272 proposed anomalies were successfully reacquired during the intrusive investigation.

At the 264 individual target anomaly locations that were successfully reacquired, 26 of the locations were found to consist of MD. Several of the individual target anomaly locations with MD were classified as trash pits that also contained general metal debris. The MD items at the 26 individual target anomaly locations were found up to 36 inches in depth, with the average depth of MD being approximately 7 inches. The average depth for all of the individual target anomalies was approximately 6 inches. The results of the intrusive investigation at the individual target anomaly locations are discussed in detail in Section 4.2.2 of the RI Report.

No MEC was found at any of the 14 exploratory trench locations; however, 277 MD items were identified in 9 of the 14 exploratory trenches at depths up to 48 inches. The total weight of the recovered MD items was 1,179.25 pounds. Various "other debris" were encountered in the trenches as well. The results of the intrusive investigation at the high density anomaly areas are discussed in detail in Section 4.2.1 of the RI Report.

7.3 Post-Excavation Field Quality Control

A total of 44 anomaly locations were randomly selected for post-excavation QC with the EM61-MK2 following the intrusive investigation in accordance with the Work Plan Addendum (Shaw, 2011). The purpose of the post-excavation QC checks were to perform intrusive anomaly verification to ensure that at a 90 percent confidence level, less than 5 percent of the remaining anomalies are "unresolved" (i.e., there is a low probability that a significant item related to MEC is present within the dig locations that were not checked post-excavation). At 42 of the locations, the residual signal from the sensor was less than 4 mV (Channel 2). Two locations (Anomalies 1,550 and 1,556) were classified as trash pits and all of the metal could not be removed. Based on the results of the post-excavation QC, no additional excavation locations were required to be investigated.

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8.0 REFERENCES

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United States Army Engineering Support Center, Huntsville (USAESCH), 2009. *Geophysics*, Data Item Description MMRP-09-004, August.

USAESCH, 2008. *Performance Requirements for Remedial Investigation/Feasibility Studies using DGM*, June.

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Attachment 1
Geophysical Data and Electronic Files

Note: Data submitted on compact disc.

Attachment 2
Instrument Verification Strip Technical Memorandum

Instrument Verification Strip Technical Memorandum in support of Digital Geophysical Mapping Activities for Military Munitions Response Program Remedial Investigation Environmental Services Version 1.0

Ravenna Army Ammunition Plant
Ravenna, Ohio

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

Prepared for:

US Army Corps of Engineers

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May 19, 2011

1.0 Introduction

Shaw Environmental & Infrastructure Inc. (Shaw) is submitting this *Instrument Verification Strip Technical Memorandum in support of Digital Geophysical Mapping Activities for Military Munitions Response Program Remedial Investigation Environmental Services at Ravenna Army Ammunition Plant* to the United States Army in accordance with the Performance Work Statement included in Multiple Award Military Munitions Services Contract No. W912DR-09-D-005, Delivery Order 002.

Shaw constructed an instrument verification strip (IVS) at Load Line 7 at the Ravenna Army Ammunition Plant (RVAAP) to validate the geophysical equipment and acquisition methodology proposed for the digital geophysical mapping (DGM) activities in support of environmental services for the Military Munitions Response Program (MMRP). The IVS location was chosen because it is considered to be representative of the major types of geologic, soil, and surface terrain conditions present at the RVAAP. The IVS uses industry standard objects (ISOs) to demonstrate sensor performance by comparison of the sensor response to physics-based models. The IVS activities were conducted between 28 April 2011 and 6 May 2011.

The ISOs were used to confirm the sensitivity of the Geonics EM61-MK2 sensor and the positioning capabilities of the Leica 1200 RTK global positioning system (GPS). Shaw also tested the data acquisition parameters (line spacing, sampling frequency, positioning system accuracy and precision, and sensor height above the ground surface) by comparing the sensor responses from the ISOs to standardized, physics-based models of the ISOs created specifically for munitions response projects by the Naval Research Laboratory (NRL).

The sensor responses for the inert munitions will be used as reference information to assist the interpreter(s) in defining the initial anomaly selection criteria for the project. Multiple acquisition lines were collected at offset distances from the center line of the IVS in order to determine the site-specific "noise," which is an important component in determining the anomaly selection criteria.

Prior to DGM activities at the IVS, instrument functional tests were performed and documented in accordance with the project *Work Plan for Military Munitions Response Program Remedial Investigation Environmental Services* (Shaw, 2011), hereafter referred to as the "work plan." The raw, processed, and interpreted digital data for the instrument functional tests and IVS were uploaded to the Ravenna Project Share Point and Shaw FTP site for distribution to members of the project delivery team (PDT).

2.0 IVS Construction

Shaw geophysicists performed a background survey near the existing GPO with the EM61-MK2 and Leica 1200 RTK GPS on 28 April 2011 to determine a suitable site for the IVS. During the initial DGM survey of the area on 28 April 2011, numerous subsurface anomalies were detected and subsequently removed by qualified UXO personnel using the DGM data as a guide to reacquire and excavate the anomalies. On 29 April 2011, a post excavation DGM survey was performed to ensure the IVS area was clear of anomalies that could potentially impact the IVS process.

On 5 March 2011 the following items were buried at the IVS:

Table 1
Items Buried at the IVS

Seed Item	Easting (m)	Northing (m)	Depth to Top (m)	2DCQ (m)	3DCQ (m)	Azimuth (deg*)	Inclination*
105mm projectile	490949.240	4559105.215	0.76	0.0106	0.0205	90	0
Large ISO	490950.613	4559099.496	0.76	0.0085	0.0169	90	0
Medium ISO	490952.004	4559093.477	0.46	0.0081	0.0154	90	-22
Medium ISO	490952.888	4559088.964	0.46	0.0082	0.0157	90	0
40mm proj. nose piece	490953.900	4559084.563	0.10	0.0079	0.0149	90	0
Small ISO	490954.509	4559081.703	0.10	0.0084	0.016	90	0

**stated azimuth is relative to trend of data acquisition line directly over buried items*
**Azimuth and inclination units are degrees*
Coordinate system is UTM Zone 17N, units of meters
CQ = coordinate quality
Easting and Northing coordinates are based on Shaw RTK GPS data
ISO = Industry Standard Object

Pictures of the IVS items are provided in Addendum 2. The ISOs consist of 1-inch by 4-inch (small), 2-inch by-8 inch (medium), and 4-inch by 12-inch (large) pipe nipples threaded at both ends and made from Schedule 40 black carbon steel. The ISOs were obtained from McMaster-Carr in Alabama in order to use the exact same items that were used by the NRL to generate the detection curves for the EM61-MK2. The table below describes the manufacturing details of the small, medium, and large ISOs.

Table 2
Manufacturing Details of the Small, Medium, and Large ISOs

Item	Nominal Pipe Size	Outside Diameter	Length	Part Number
Small Surrogate	1”	1.315” (33.4 mm)	4”	44615K466
Medium Surrogate	2”	2.375” (60.3 mm)	8”	44615K529
Large Surrogate	4”	4.500” (114.3 mm)	12”	44615K137

Source: *EM61-MK2 Response of Standard Munition Items, NRL et al October, 2008*

The inert 105mm projectile was obtained through the assistance of the USACE Explosives Ordnance Safety Specialist (EOSS). The inert 40mm projectile nose piece was unearthed based on the excavation activities that occurred during the background DGM survey of the IVS area. An inert 60mm mortar could not be obtained for the IVS and a medium ISO was substituted with concurrence from Tom Colozza, the USACE Project Geologist. The medium ISO produces a response that is very similar to the 60mm mortar based on the NRL detection curves presented in the document *EM61-MK2 Response of Standard Munition Items (NRL et al October, 2008).*

The small ISO was buried at the southern end of the plot and the 105mm projectile was buried at the north end of the IVS. The resulting layout is a slight trend from southeast to northwest for the IVS center line. The inclination and orientation of the IVS items were selected to represent the minimum signal response for the EM61-MK2 so that the results could be used to assist in the determination of the minimum signal intensity anticipated for anomaly selection.

The relative depth below the ground surface of each item was measured by Shaw geophysicists using a rigid measuring tape, and the x – y coordinates for the center of each item were determined with the Shaw Leica 1200 RTK GPS system. An Ohio registered professional land surveyor (PLS) from Vista also provided x – y coordinates for each IVS item as per the work plan. The general procedures outlined in the USACE document *Geophysical Investigations for Buried Munitions, Operational Procedures and Quality Control Manual (USAESCH, June, 2002)* were adhered to during the construction of the IVS.

Addendum 1 contains the following images related to the construction of the IVS:

- Color-coded images of the DGM data for the initial background and post excavation surveys
- Representative buried metal items removed from the IVS area
- Relative positions for the IVS items
- IVS items in the open hole

3.0 QA Oversight

A USACE Baltimore representative (Cyprian Fonge) performed oversight of the pre-burial and burial activities on 5 May 2011 during the construction of the IVS. These activities included digging of holes at predefined locations; burial of the IVS items at the required depth, azimuth, and orientation; and use of the RTK GPS to locate the coordinates of the center of each item. Additional activities included photographing the IVS items in the open hole and collection of static EM61-MK2 data over the items. As required by the Work Plan, an Ohio registered PLS also determined the coordinates for each IVS item.

4.0 Data Collection

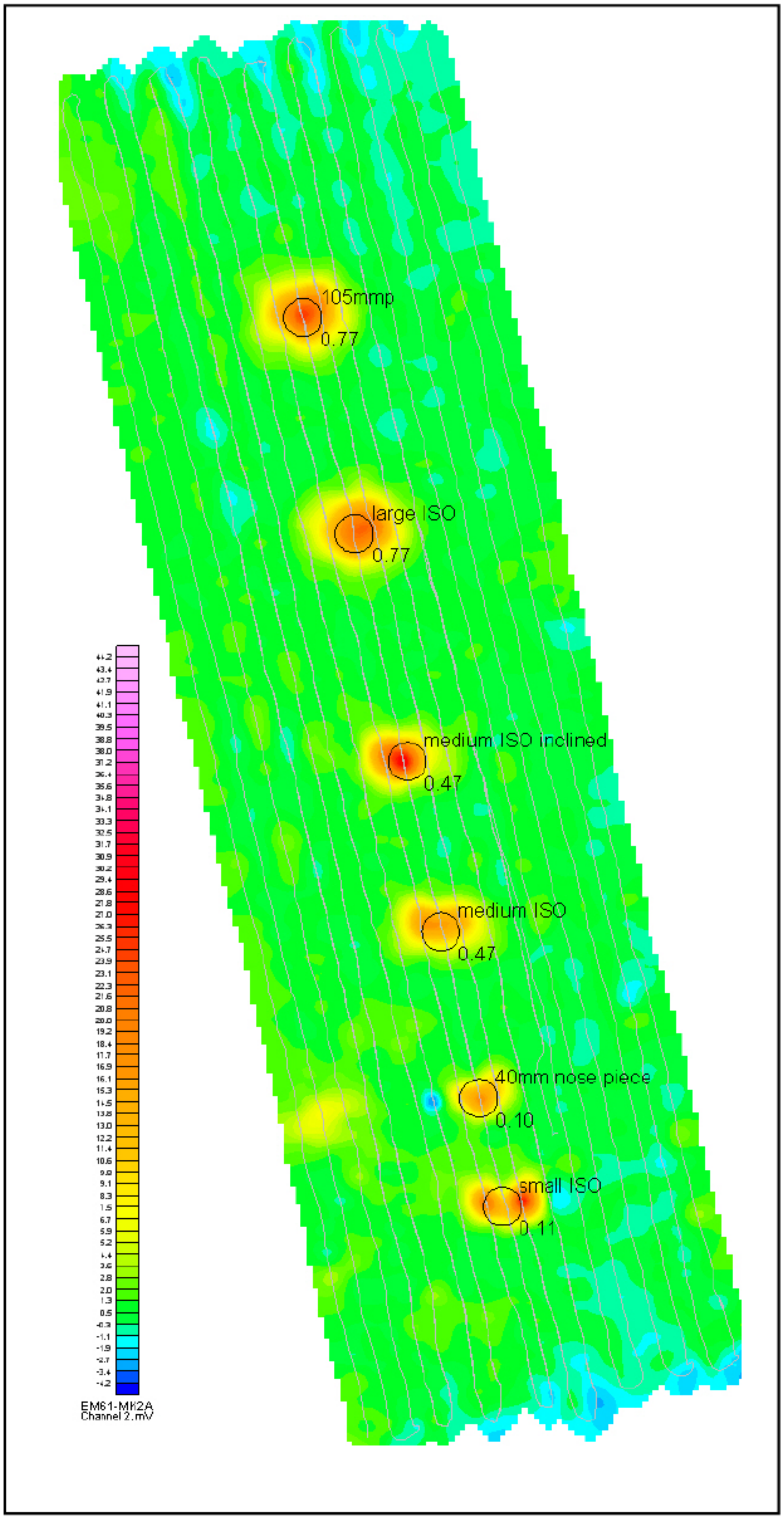
On 6 March 2011, a DGM survey was performed over the IVS by Shaw geophysicists. The equipment and data acquisition platform consisted of a standard EM61-MK2A model on a wheeled platform with the lower coil 42 centimeters (cm) above the ground surface and the RTK GPS antenna centered over the EM61 coils. Four time gates of the EM61-MK2A were acquired at a rate of 15 times per second, and a NMEA (National Marine Electronics Association) position string was output from the Leica 1200 RTK GPS twice per second and integrated with the EM61-MK2A measurements in real time using a ruggedized Juniper Allegro data logger. The data collection platform and recording parameters are consistent with those used for MMRP geophysical investigations for RI projects.

5.0 Results

Seventeen (17) parallel lines (8 on each side of the IVS center line) spaced at ≈0.6 meter intervals were collected to provide a complete, two-dimensional view of the anomaly characteristics for the IVS items (**Figure 1**). The acquisition line at the eastern edge of the data collection area is void of subsurface metal and signatures from the buried items and is considered a “noise” line that is used to assess the background noise at the site in areas void of subsurface metal.

The standard deviation of the measurements is an industry accepted method for determining the natural ambient noise from external EM sources and the noise attributed to the data acquisition process. The standard deviation of the channel 2 measurements on the east side of the IVS ranges from 0.6 to 0.8 millivolts (mV), which is consistent with values presented in the report *EM61-MK2 Response of Standard Munition Items (NRL et al October, 2008).*

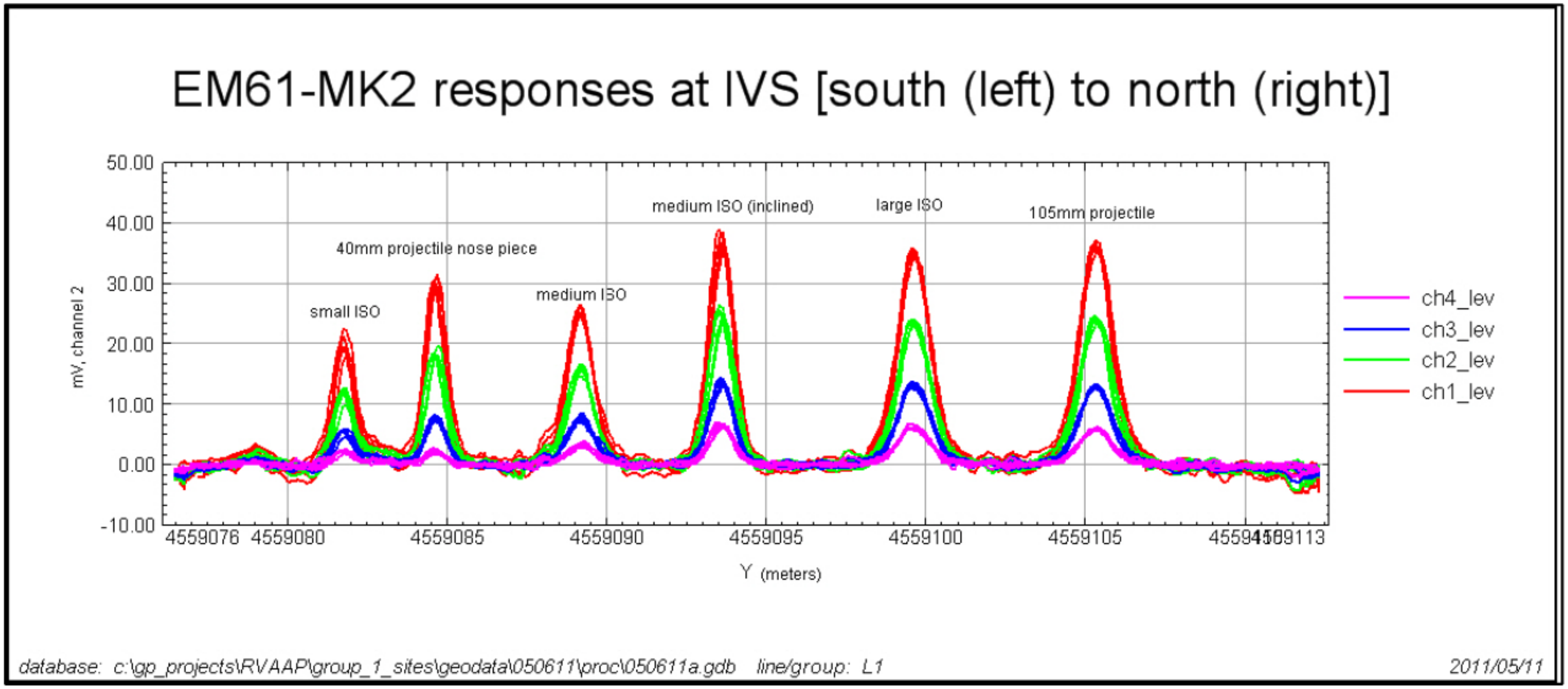
Figure 1
EM61-MK2 Channel 2 IVS Data



Shaw geophysicists also collected data over the IVS center line six times in alternate directions to demonstrate the repeatability of the DGM system and data acquisition methodology (**Figure 2**). The EM61-MK2 responses for the small, medium, and large ISOs and the 105mm projectile have been transcribed onto the NRL detection curves and are provided in **Addendum 2**. The statistics for the background noise at the IVS were used to designate the "noise line" (also known as the signal intensity threshold) on the NRL detection curves for the ISOs and the 105mm projectile. In general, if anomalies are selected near the noise threshold during interpretation there will likely be more false positives (i.e., excavations where no metal is present that is consistent with the geophysical anomaly characteristics).

The specific positions of the sensor responses on the detection curve graphs in **Addendum 2** are consistent with the expected sensor responses for small, medium, and large items buried at minimum response orientation. During one of the six passes across the IVS center line, the response for the small ISO was within 10 percent of the lower detection curve. The inclination and orientation of the IVS items were selected to represent the worst case scenario in terms of the anticipated response of the EM61-MK2 in order to ensure the proposed DGM system can meet the objectives of the investigations. Based on our recent experiences using small ISOs at minimum response orientation, the cause for the relatively lower sensor value for one pass is the result of (1) the normal variations in the attitude and orientation of the sensor platform as it crosses the burial location, and (2) limitations associated with the ability of the system to collect an infinite number of samples (the recording rate for the EM61-MK2 is set at the maximum of 15 samples per second).

Figure 2
EM61-MK2 Channel 1-4 IVS Data over Center Line (six passes)



The UCEPICK module in Oasis Montaj was used to interpret one of the passes over the center line of the IVS using the guidelines presented in the work plan. The table below represents the results of the automated interpretation. The results indicate that the items of interest can be accurately located using the proposed field procedures and data recording parameters for the EM61-MK2 and RTK GPS.

Table 3
Results of Automated Interpretation

Item	X_pick	Y_pick	ch1_lev	ch2_lev	ch3_lev	ch4_lev	ch2_lev_Wid	x_known	y_known	offset_x_m	offset_y_m
Small ISO	490954.60	4559081.76	22.44	12.75	5.96	2.52	1.93	490954.51	4559081.70	-0.09	-0.05
40mm nose piece	490953.93	4559084.58	30.65	18.54	7.65	2.25	2.04	490953.90	4559084.56	-0.03	-0.01
Medium ISO	490952.88	4559089.19	26.38	16.70	8.44	3.72	2.47	490952.89	4559088.96	0.01	-0.23
Medium ISO_inclined	490952.01	4559093.52	38.87	25.26	14.32	7.00	2.42	490952.00	4559093.48	0.00	-0.04
Large ISO	490950.73	4559099.48	35.27	23.91	13.59	6.78	3.09	490950.61	4559099.50	-0.12	0.02
105mm projectile	490949.27	4559105.27	36.84	24.62	13.21	6.02	3.59	490949.24	4559105.21	-0.03	-0.05

Based on the results of the IVS, the proposed DGM system and data acquisition methodology will provide data of sufficient quantity and quality to meet the project objectives. The following interpretation approach is suggested:

- Review MEC items present at each MRS and their likely depth of burial.
- Use IVS results to determine minimum signal intensity for anomaly selection based on smallest item(s) anticipated and/or the item with the minimum response at the depth of interest.
- Use interpretation strategy outlined in project Work Plan to select candidate anomalies for excavation.

6.0 Quality Control

The performance metrics for the project are based on MMRP guidance from the USACE issued in the *Performance Requirements for RI/FS using DGM Methods (USACE, 2008).*

Images of the results of the instrument functional checks performed prior to the DGM survey of the IVS are summarized in **Addendum 3** along with the metrics for platform velocity and spatial sampling (coverage). All performance metrics stated in the work plan were achieved for the IVS survey.

An Excel spreadsheet that tabulates and documents the results of all of the instrument functional tests and the spatial sampling performance metrics, as presented in **Table 4**, is uploaded daily to the Ravenna SharePoint site in the "QC" folder.

Table 4
Instrument Functional Tests and Spatial Sampling Performance Metrics

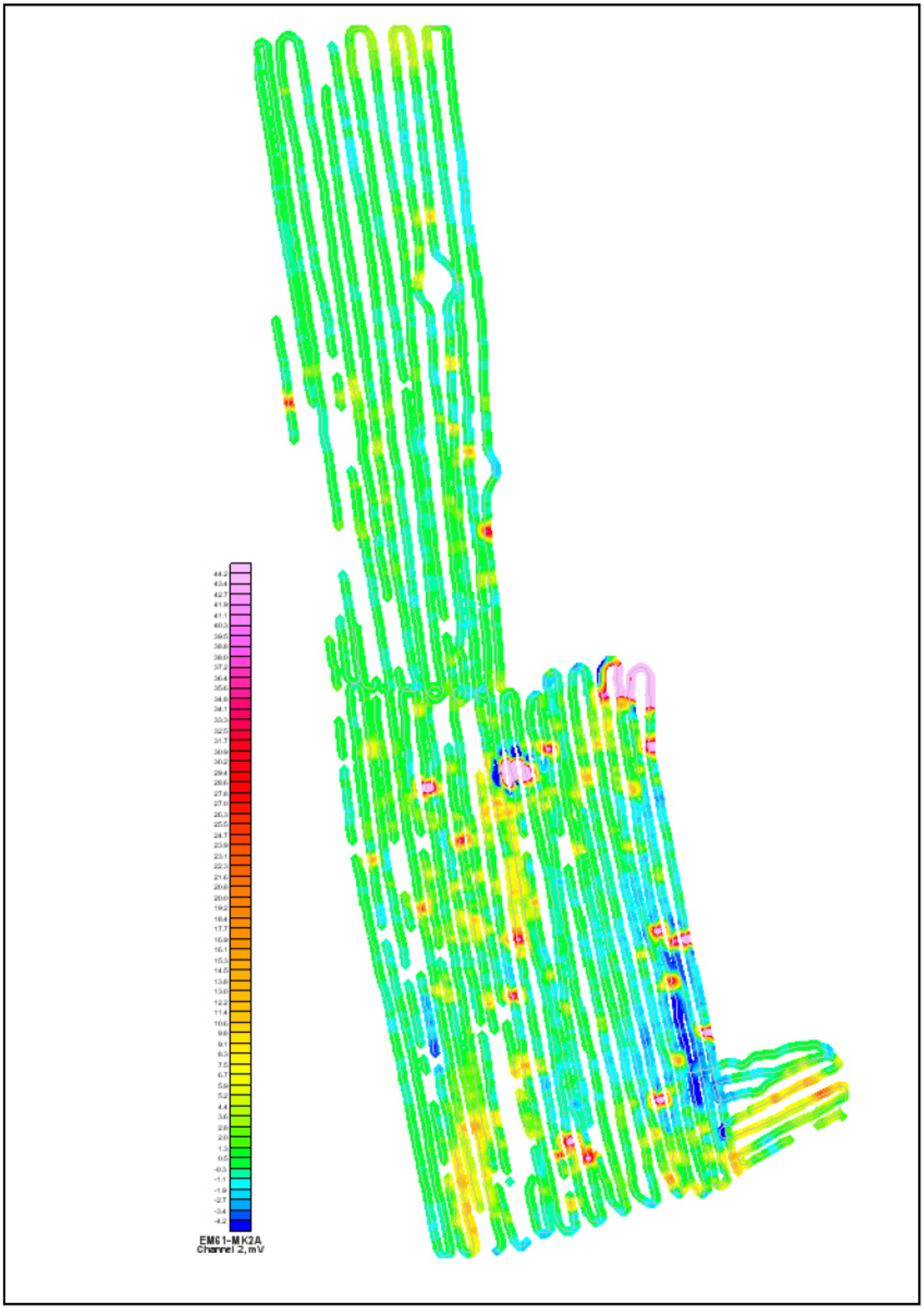
Instrument Functional Check	Performance Metric	Results
Static Test	Static background readings for all EM61-MK2 channels will remain within 2.0 mV of background.	100 % of the measurements for all EM61-MK2 data channels were within 2.0 mV of background.
Static Spike Test	For all EM61-MK2 channels, the static spike test will be +- 10 % calculated as a running average of each data channel for the first week of tests.	All EM61-MK2 data channels were +- 10 % of the average value determined from the first week of tests.
Personnel Test	All channels of the EM61 MK2 will remain within 2 mV of background determined as the standard deviation of the measurements.	All EM61-MK2 data channels were within 2 mV of background
Cable Shake Test	All EM61-MK2 data channels will be free from spikes greater than 3 mV.	All EM61-MK2 data channels were free from spikes greater than 3 mV.
IVS repeatability	The response of all EM61 MK2 data channels to the standard test item (small ISO) located at the midpoint of the IVS line will be ≥ 75 percent of the expected minimum value as determined during the first week of tests.	The EM61-MK2 channel 2 response of the small ISO placed at minimum response orientation along the ground surface produced a response greater than or equal to 75 % of the average value determined during the first week of tests.
Known Position Check	The acceptable difference in location measurement at a grid corner, transect endpoint, or survey monument is less than or equal to 0.15 meters.	The offset at the SE control point at the original GPO plot was 0.009 meters.
Dynamic Noise	Dynamic background readings (standard deviation) for the EM61 MK2 will remain within 2.0 mV of background for all data channels.	The range of the standard deviation for EM61-MK2 channels 1-4 was 1.13, 0.83, 0.53, and 0.41 mV respectively for the IVS noise line on the east side of the IVS.
Sensor Velocity	Ninety-five (95) percent of the EM61 MK2 sensor measurements will be acquired at a speed of less than or equal to 1.5 meters per second (3.4 miles per hour; 5 feet per second).	99.94 % of the measurements were acquired at a speed of less than 1.5 meters per second.
Along Track Sampling	Ninety-eight (98) percent of the EM61 MK2 sensor measurements will be less than or equal to 0.24 meters (0.8 ft).	99.97 % of the measurements were acquired at a spacing of less than 0.24 meters.

Instrument Functional Check	Performance Metric	Results
Across Track Sampling	Ninety (90) percent of the area will be covered at 1.1 meter (3.5 ft) line spacing or less excluding data gaps from trees or other obstacles that preclude the survey platform from providing complete coverage. The not-to-exceed line spacing is 1.2 meters (4.0 ft).	100 % of the IVS area was covered at a line spacing of 1.1 meters (3.5 ft) or less.
Dynamic Position Check	The interpreted location of the grid corner nails will be ≤ 0.76 meters (2.5 ft) for the EM61 MK2 2D full coverage survey at the Firestone Test Facility. For the EM61 MK2 1D transect surveys that use the RTK GPS or RTS to determine position the interpreted location of the nails at the transect endpoints will be ≤ 0.46 meters (1.5 ft) projected perpendicular to the instrument direction). For the 1D transects that use fiducial positioning the interpreted location of the nails at the transect endpoints will be ≤ 0.6 meters (2 ft).	The data were interpreted using the UCEPICK module in Oasis Montaj. The average position offset in the along-track direction for the buried items at the IVS is 0.07 meters. The largest offset was 0.23 meters.
Latency Correction	The EM61 MK2 sensor data will be aligned to one sample increment (approximately 0.15 meters (0.5 ft) so no visible chevron effects are present in the color coded images of the EM61-MK2 data.	No visible chevron effects are present in the EM61-MK2 color coded images.
Data Consistency	Consistent channel naming conventions, processing parameters and methods will be used for all datasets and channels within each dataset by utilizing Oasis Montaj scripts.	Oasis Montaj scripts were used to process the IVS data.

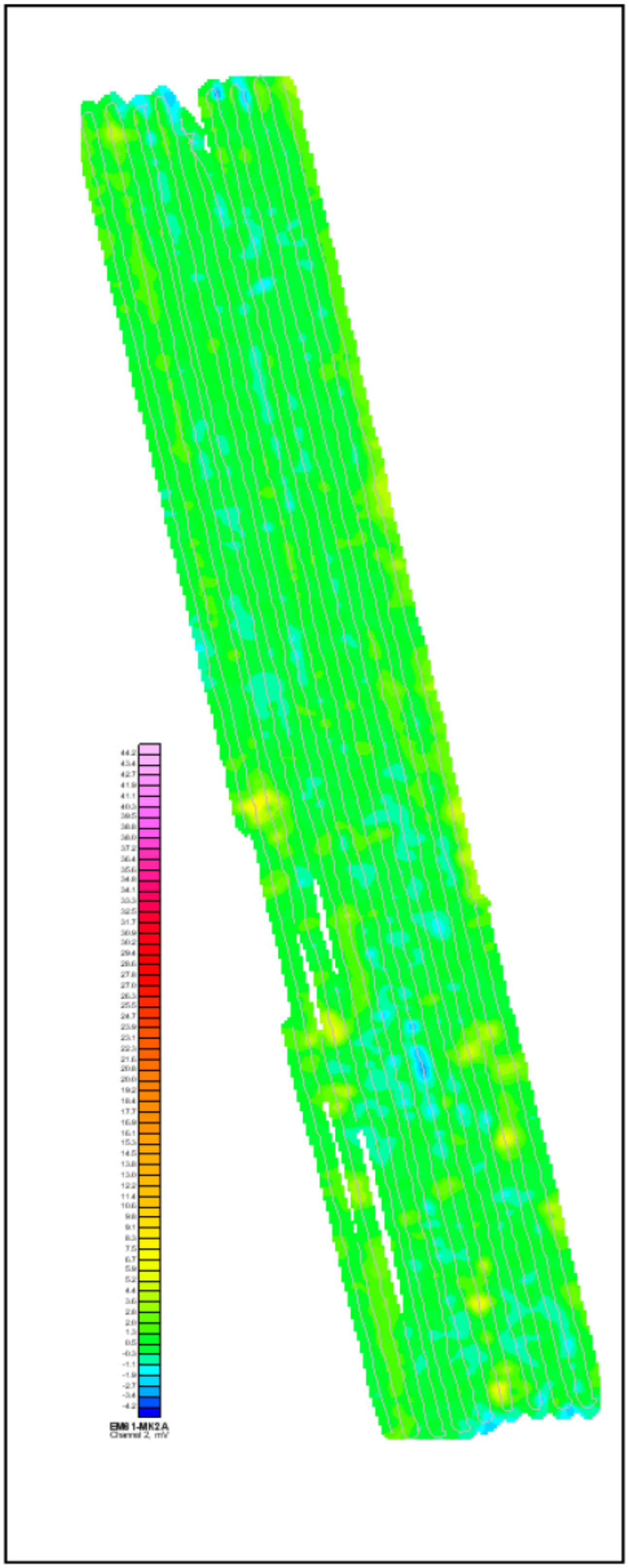
7.0 Conclusions

The results of the IVS indicate that the instrument functional test program and performance metrics proposed in the project work plan will ensure the data collected are of sufficient quantity and quality to meet the project objectives for the RVAAP DGM investigation. There were no critical failures during any of the instrument functional checks. Based on the DGM data collected, processed, and interpreted at the IVS, no modifications to the existing performance metrics or data processing sequence are proposed.

Addendum 1
IVS Images



EM61-MK2 background survey at IVS area on April 28th



EM61-MK2 background survey at northern portion of IVS area on April 29th after excavation of some anomalies

Representative items excavated at IVS area based on background DGM surveys

IVS item azimuth and relative position along IVS center line (southeast [bottom] to northwest [top])

Small ISO in open hole

40mm projectile nose piece in open hole

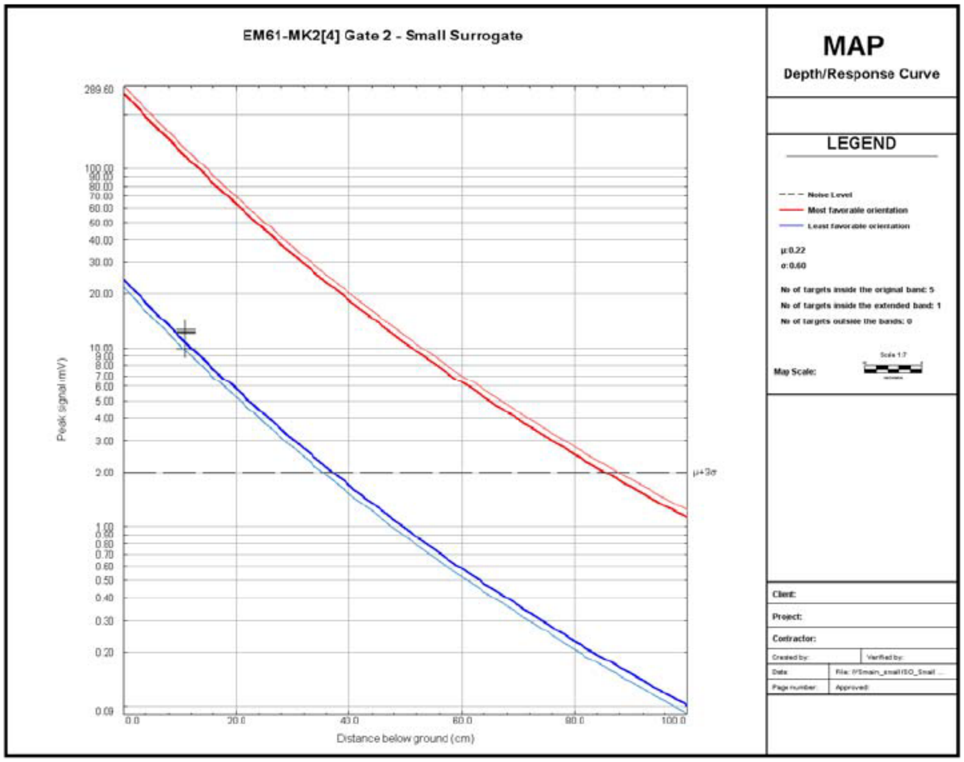
Medium ISO in open hole

Medium ISO (inclined) in open hole

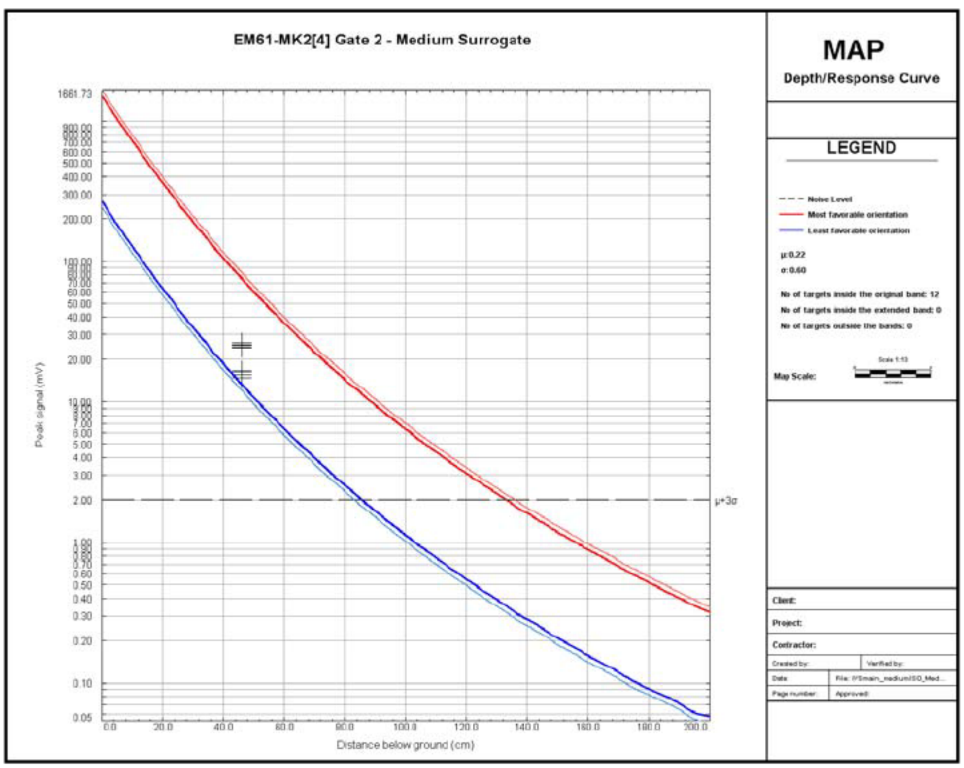
Large ISO in open hole

105 mm projectile (inert) in open hole

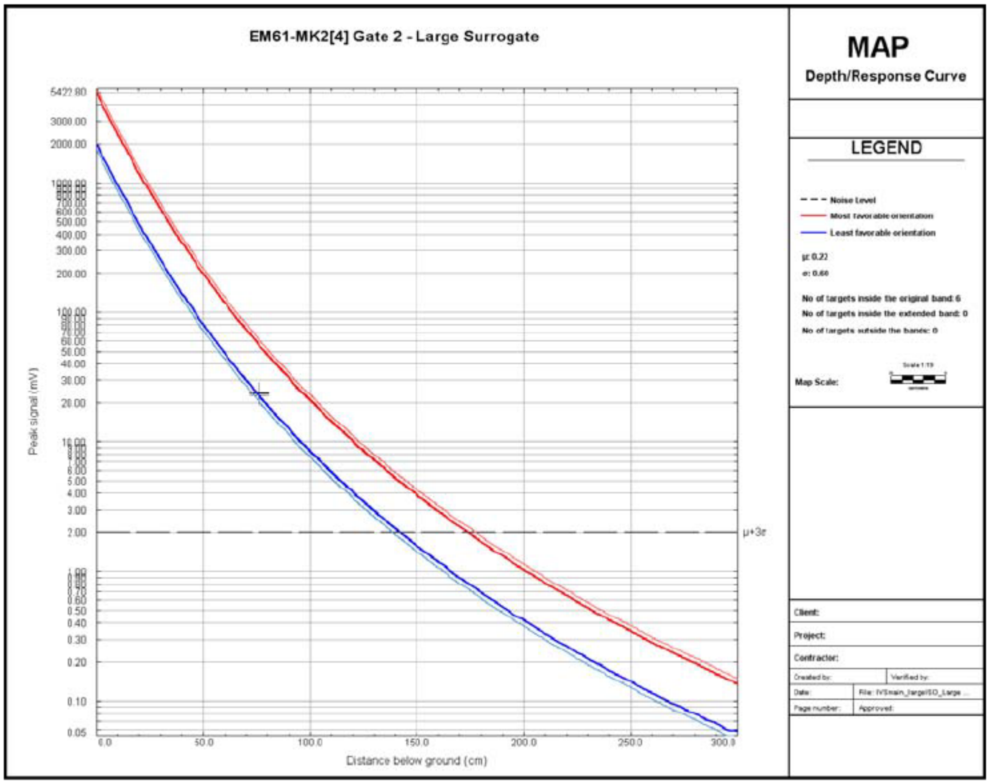
Addendum 2
EM61-MK2 IVS Responses / NRL Detection Curves



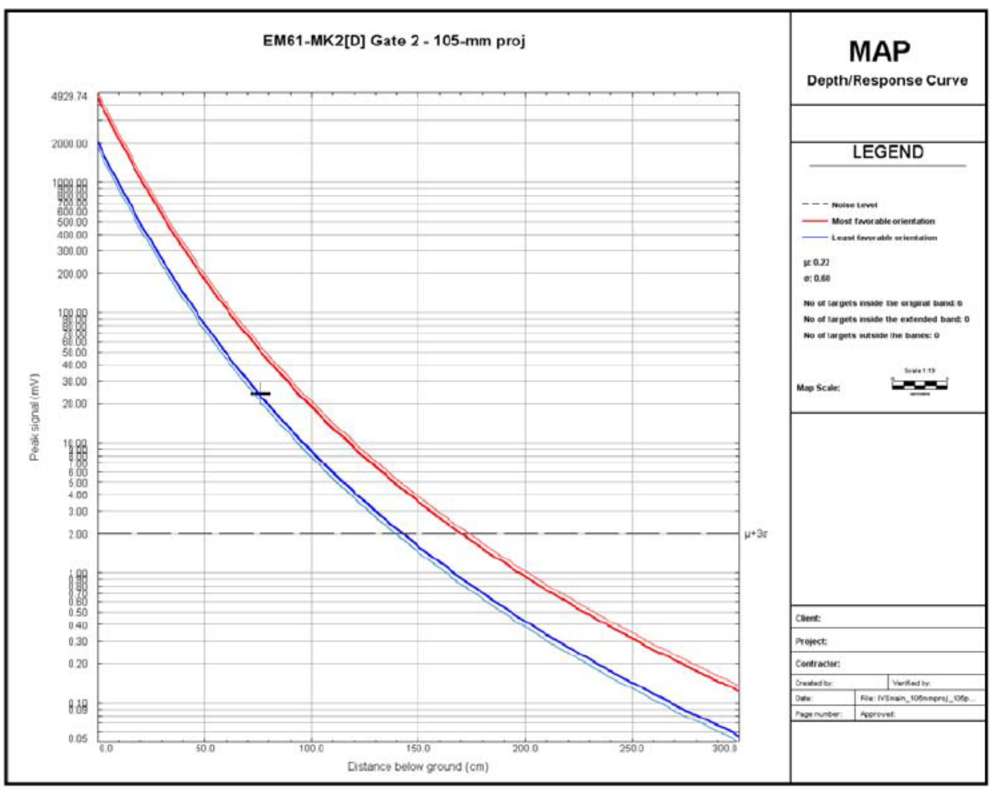
Small ISO



Medium ISO (horizontal and inclined)



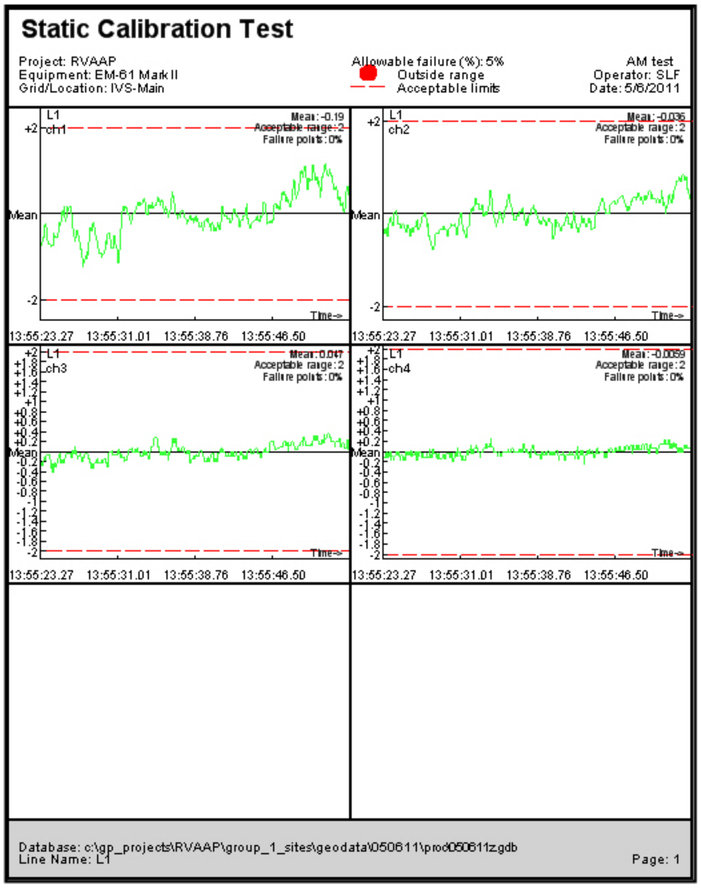
Large ISO



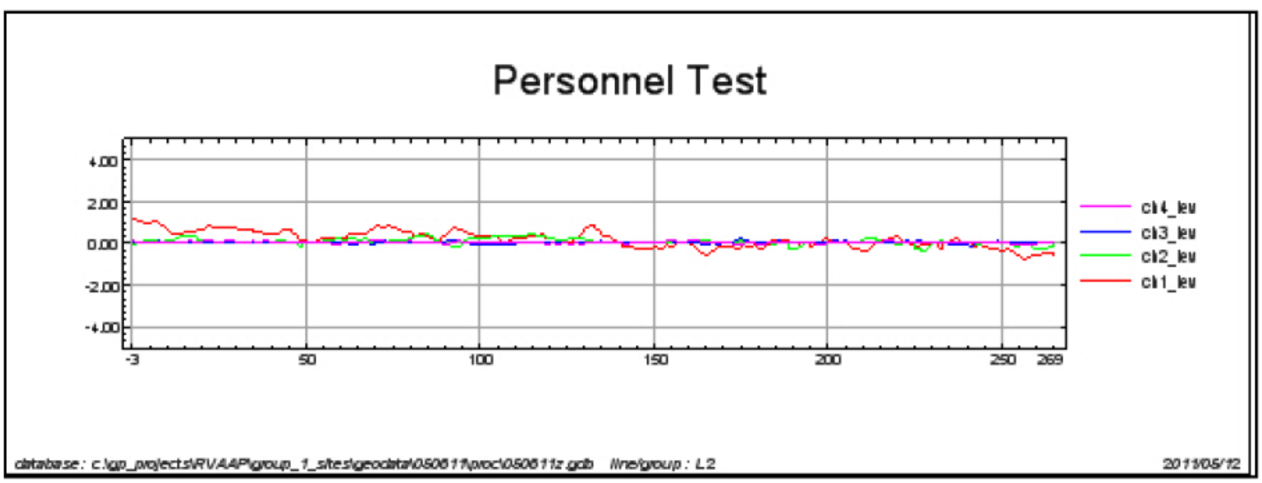
105mm projectile

Addendum 3
Images for Instrument Functional Checks and Spatial Sampling Performance Metrics

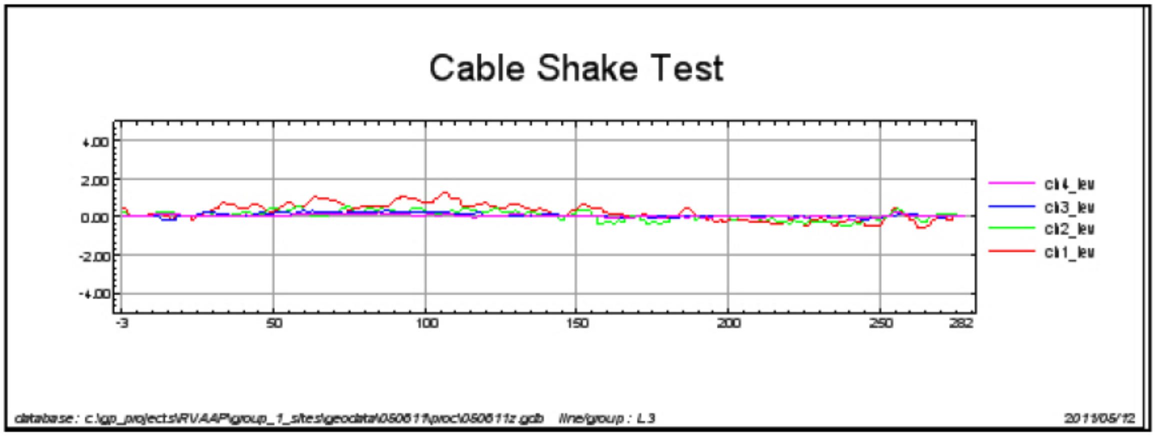
Images for Instrument Functional Checks



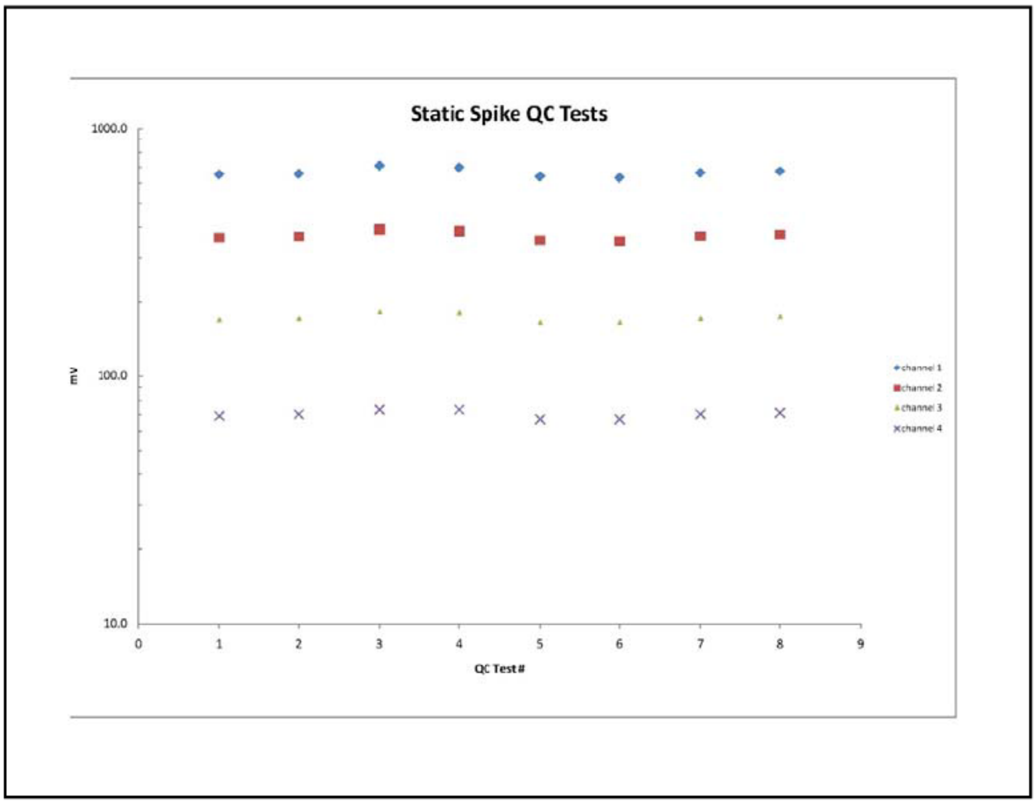
Static Test (metric: +-2 mV for all EM61-MK2 data channels)



Personnel Test (metric: +- 2 mV for all EM61-MK2 data channels)



Cable Shake Test (metric: no data spikes that exceed 3 mV for all EM61-MK2 data channels)



Static Response (Spike) Test (metric: within 10 percent of the average of the first week of tests). Results shown include data from start of project

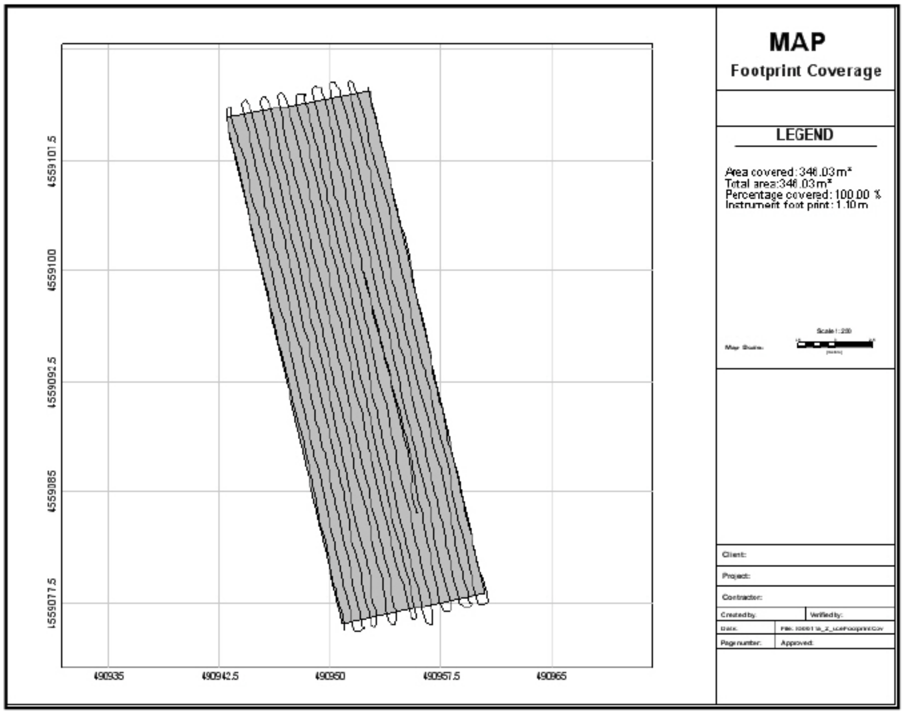
ID	E	N	2DCQ	3DCQ	date	site	sort	notes
CHK RAV11	497217.598	4559443.244	0.0066	0.0144	5/6/2011	Atlas	RTK check	RTK check
GPO SE	491055.636	4558845.717	0.0091	0.0155	5/6/2011	IVS	RTK check	RTK check

Known position check (metric: 0.15 meters). The known position check for the Leica RTK GPS check was within 0.009 meters of the actual location of the control point near the IVS. A second RTK check was performed with the system on 6 May 2011 at a control point near Atlas Scrap Yard and the check was within 0.007 meters of the actual control point location.

Spatial Sampling Performance Metrics

Performance metrics associated with speed of data acquisition platform and the spatial sampling are summarized below.

- **Background dynamic geophysical sensor check**. The standard deviation for dynamic noise (i.e., areas where no metal is present) for the EM61 MK2 will remain within 2.0 mV of background for all data channels. *All EM61-MK2 data channels achieved the metric. The range of the standard deviation for channels 1-4 was 1.13, 0.83, 0.53, and 0.41 mV respectively for the IVS noise line on the east side of the IVS.*
- **Sensor velocity check (Speed)**. Ninety-five (95) percent of the EM61 MK2 sensor measurements will be acquired at a speed of less than or equal to 3.4 miles per hour (1.5 meters per second). *99.94 percent of the measurements were acquired at a speed of less than 1.5 meters per second, which achieves the metric.*
- **Along Track Sampling**. Ninety-eight (98) percent of the EM61 MK2 sensor measurements will be less than or equal to 0.24 meters. *99.97 percent of the measurements were acquired at a spacing of less than 0.24 meters, which achieves the metric.*
- **Across Track Sampling**. The line spacing for the EM61-MK2 full coverage survey methodology is 2.5 to 3 feet. Ninety (90) percent of the area will be covered at a 3.5-foot line spacing or less excluding data gaps from trees or other obstacles that preclude the survey platform from providing complete coverage. The not-to-exceed line spacing is 4.0 feet. Areas that exceed the metric may be identified by the data processor as potential “fill-in” areas at the Firestone Test Facility MRS where full coverage will be performed. Data gaps will be not be specified by the processor where the collection of additional data will not provide useable information (e.g., high density anomaly areas, buildings, adjacent to cultural features). This metric is intended to control data gaps due to inconsistent navigation that are not associated with trees or other obstructions. The UX Process utility “ucefootprintcov.gx” will be used to evaluate this metric. *100 percent of the area was covered at a line spacing of 1.1 meters (3.5 ft) or less, which achieves the metric.*



- **Known Location Dynamic Positioning Check**. The interpreted location of the grid corner nails will be ≤ 2.5 feet for the EM61 MK2 2D full coverage survey at the Firestone Test Facility. For the EM61 MK2 1D transect surveys that use the RTK GPS or RTS to determine position the interpreted location of the nails at the transect endpoints will be ≤ 1.5 feet (projected perpendicular to the instrument direction). For the 1D transects that use fiducial positioning the interpreted location of the nails at the transect endpoints will be ≤ 2.0 feet. *The average offset in the along-track direction for the buried items at the IVS is 0.07 meters, which achieves the metric.*

Attachment 3
Technical Memorandum for DGM Survey Results and Proposed Intrusive Investigation Locations for the Group 8 MRS (RVAAP-063-R-01)

Shaw®
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Memorandum

100 TECHNOLOGY CENTER DRIVE, STOUGHTON, MA 02072 • 617.589.5111 • FAX 617.589.2992 • THE SHAW GROUP INC®

From: Dave Cobb, Shaw Project Manager

To: Ms. Eileen Mohr, Ohio EPA Project Manager

cc: Todd Fisher, Ohio EPA
Travis McCoun, USACE Baltimore
Eric Cheng, USACE Louisville
Jay Trumble, USACE Louisville
Mark Patterson, BRACD
Kim Harriz, NGB
Katie Tait, OHARNG/Camp Ravenna

Date: November 30, 2011

Re: **DGM Survey Results and Proposed Dig Locations for the Group 8 MRS (RVAAP-063-R-01)**

Introduction

The purpose of this memorandum is to present the results of the digital geophysical mapping (DGM) survey performed at the Group 8 Munitions Response Site (MRS), RVAAP-063-R-01, at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio and present proposed target reacquisition locations. The survey activities were conducted by Shaw Environmental & Infrastructure, Inc. (Shaw) in accordance with the *Draft Work Plan Addendum for Military Munitions Response Program Remedial Investigation Environmental Services* (Shaw, 2011); hereafter referred to as the "work plan addendum". Since the work plan addendum has not been finalized, Shaw performed the DGM work under conditional approval from the Ohio Environmental Protection Agency (Ohio EPA).

History

The 2.65-acre Group 8 MRS consists of the area between Buildings 846 and 849 near the southern Installation boundary. The MRS consists of disturbed land that may have historically been used for burning construction debris and rubbish. In 1996, one anti-personnel fragmentation bomb with high explosives (HE) was found at the MRS. In addition, one demilitarized 175mm projectile was found on the ground surface at the MRS. During the 2007 Site Inspection (SI) field activities, numerous munitions debris (MD) items were identified in the MRS.

The Group 8 MRS is no longer used by the Ohio Army National Guard (OHARNG) to store/stage vehicles since it is a MRS and is Siebert staked (which indicates it is a no-go area). The OHARNG still uses the road to the MRS for ingress and egress of equipment to the surrounding area but do not access the MRS. The area surrounding the MRS is used for vehicle and equipment storage and staging.

Summary of Work

In November 2011, Shaw performed a DGM survey at the Group 8 MRS to identify potential areas of munitions and explosives of concern (MEC) or MD. **Figure 1** and **Figure 2** present the interpretation and spatial coverage for the DGM data respectively.

The Team that performed the DGM survey consisted of a geophysicist and unexploded ordnance (UXO)-qualified assistant. Equipment used for the DGM survey consisted of an EM61-MK2 time domain electromagnetic instrument (TDEM) and a Leica 1200 RTS system for positioning. The DGM platform consisted of a standard wheeled configuration with the lower coil 16 inches above the ground surface. Full coverage DGM data were acquired over all accessible areas of the site on lines spaced at approximately 2.5-foot intervals, which resulted in a spatial coverage of 96.7% of the 2.65 acres of the MRS. The remaining 0.087 acres could not be investigated due to obstructions (large tree, buildings, power poles, fences, etc.). Within the areas accessible to DGM, greater than 99% of the data were acquired at a line spacing of less than 3.3 feet, which meets the metric specified in Section 3.13.13 of the work plan addendum.

Summary of DGM Results

The data were processed and interpreted in accordance with the work plan addendum and the DGM quality metrics specified in the work plan addendum were achieved for all of the data collected with two exceptions. The exceptions included matters with the platform speed in certain areas that occurred on November 1, 2011 and the AM static test that occurred on November 14, 2011. For the platform speed, the metric was exceeded in specific areas due to the adverse surface conditions; however, the sampling interval for these data achieved the required metric (98% of data collected are required to have a sample to sample interval of less than 0.24 meters). In actuality, 99.98% of the data collected had a sample to sample interval of less than 0.24 meters. With regards to the AM static test, low level external noise was noted by the field crew. The PM static test data were not affected by the noise source. It is thought that the AM noise might be associated with intermittent operation of electrical equipment in the nearby buildings. The data collected on November 14th represent a very small amount of fill-in data in one of the high anomlay density zones. Based on the interpretation of the data results, including the identified exceptions, the data quality is considered acceptable.

A total of 2,690 anomalies were selected that are greater than or equal to 8 millivolts (mV) (Channel 2), which represents an average anomaly density for the MRS of 1,015 per acre. Several zones of localized high anomaly density ("hot spots") were selected by the data interpreter where 11 trenches are proposed as the primary investigative technique. The use of trenching to investigate zones of high anomaly density was also used at Atlas Scrap Yard, Ramsdell Quarry Area 1, and Open Demolition Area #2 MRSs where dense areas of buried anomalies were identified during the DGM field activities. Outside of the high anomaly density zones (blue dotted lines on **Figure 1**) there are 1,641 anomalies. A total of 248 of the 1,641 anomalies (15%) were randomly selected for investigation. Histograms for the 1,641 anomaly selections and the 248 targets selected for investigation are provided in **Figure 3.** The histograms indicate that the targets selected for investigation are representative of the entire anomaly population at the site for the individual anomalies.

Concurrence of the data quality and interpretation was received from the U.S. Army Corps of Engineers (USACE), Baltimore District. The USACE DGM Quality Assurance (QA) Form that provides approval of the data quality, interpretation and proposed dig locations is presented in **Addendum 1** to this memorandum. All Army comments in the USACE DGM QA Form have been addressed.

Proposed Dig Locations

Shaw has evaluated the geophysical data to identify target dig locations in accordance with Section 3.2.10 of the work plan addendum (**Figure 1**). Since a significant percentage of the accessible areas within the MRS were effectively covered by the geophysical survey (99.05%), the statistical sampling method used by Shaw is a Hypergeometric Statistics Module based on estimating the required sample size for populations. This module was used in conjunction with the HYPERGEOM program in Microsoft Excel to provide a quality check of the results. The proposed method was approved by the USACE Baltimore District through review of the DGM information and identification of the target dig list. The statistical inputs that we used for the module were 95% confidence, 2.5% error limits, and a probability of 0.05 (5%) to determine the number of individual anomalies to investigate. Based on the HYPERGEOM program in Excel, if 15% of the individual anomalies are investigated (i.e., 248 of 1,641 identified anomalies), there is a 95% probability that seven or more items of interest will be identified as is shown on the following table.

No. of Items Found	% Probability
1 or more	100%
2 or more	99.99%
3 or more	99.93%
4 or more	99.72%
5 or more	99.11%
6 or more	97.66%
7 or more	94.75%
8 or more	89.75%
9 or more	82.23%
10 or more	72.26%
11 or more	60.46%

Inputs
Probability = 0.05
1,641 items
248 samples selected

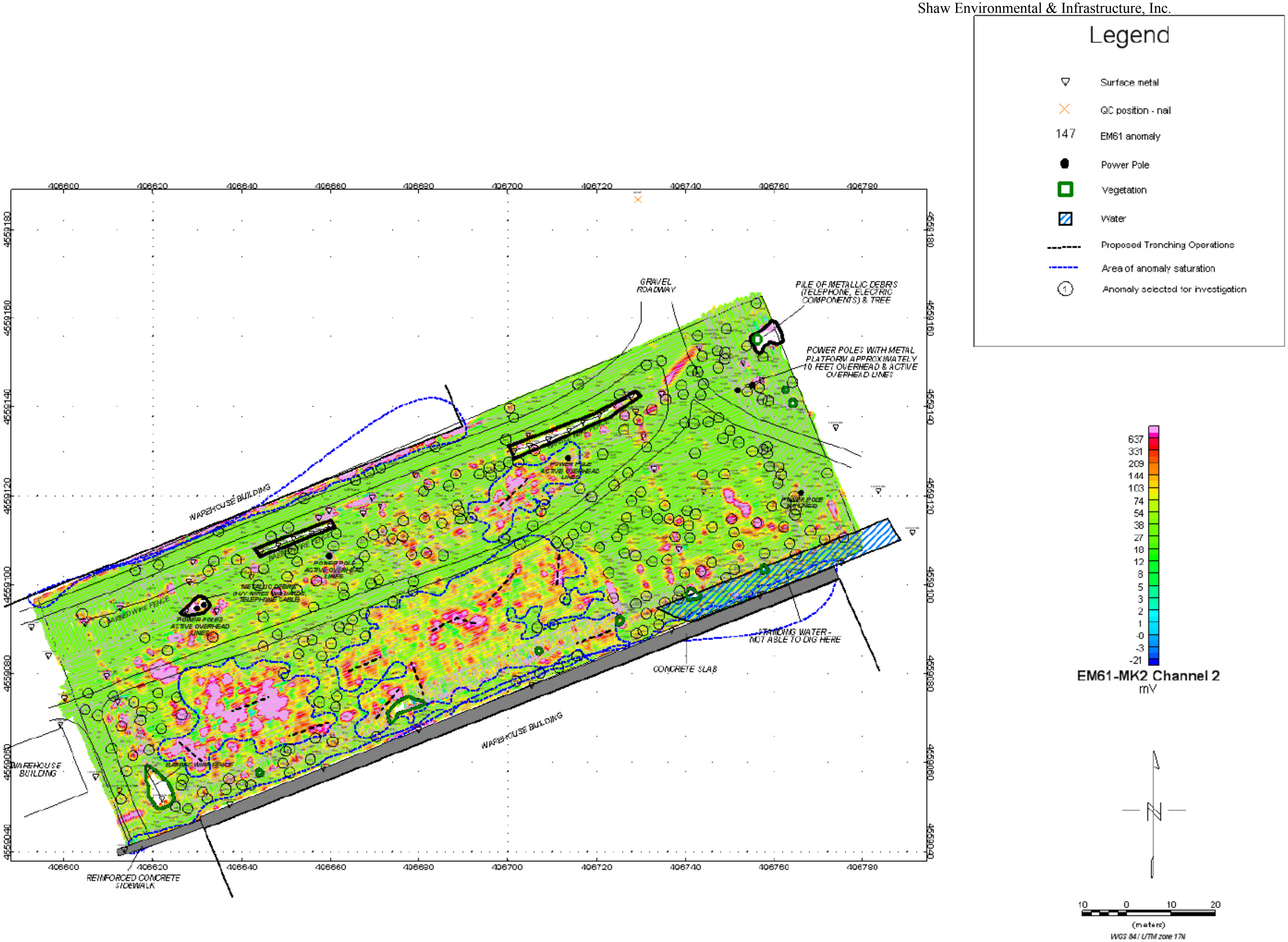
The program used to pick the actual locations of the target anomalies in order to eliminate manually biasing the process was the “Randbetween” program in Microsoft Excel. This method was previously used at the Firestone Test Facility and Water Works #4 Dump MRS’s where full coverage DGM was performed over the entire MRSs.

In summary, based on the statistical methodology and the automated target programs that were used, the recommended output was to investigate 248 of the 1,641 individual anomalies identified The number of dig locations represents an investigation percentage of approximately 15% of the individual anomalies. The additional anomalous zones investigated within the 11 trenches will effectively meet the Remedial Investigation Data Quality Objectives.

Dig Activities

Dig activities will be conducted in accordance with Section 3.6 of the work plan addendum. The results of the intrusive investigation will be compared with the geophysical anomaly characteristics to ensure the results are representative. Based on the feedback process, anomalies may be re-investigated as described in the work plan addendum.

Figures

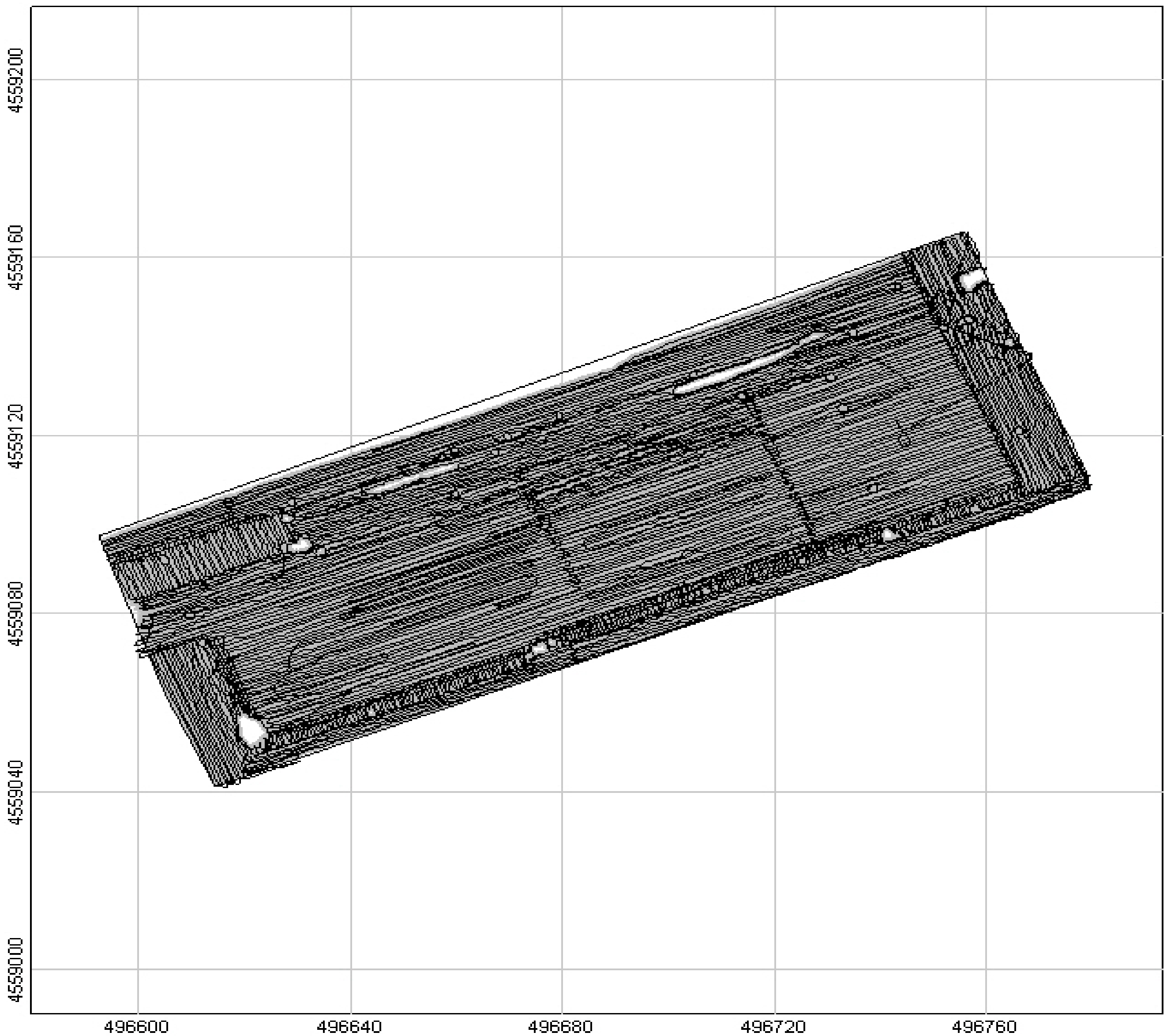


USACE Baltimore

Camp Ravenna, Ohio
EM61-MK2A Wheeled Platform
Leica RTK/RTS Positioning

Group 8
DRAFT

Shaw GP



MAP

Footprint Coverage

LEGEND

Area covered: 10605.87 m²
Total area:10966.49 m²
Percentage covered: 96.71 %
Instrument foot print: 1.07 m

Map Scale: Scale 1:1350

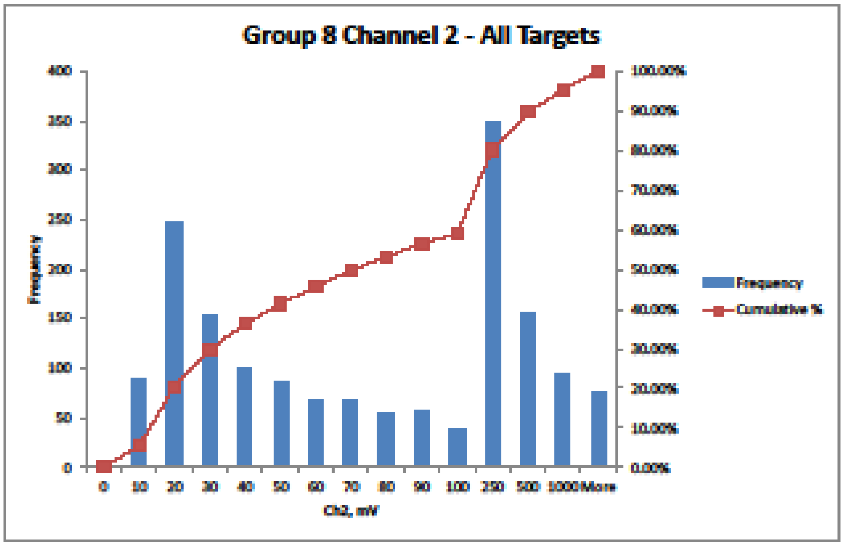
N

Grid North : 0°0'0"
Mag North : 0°0'0"

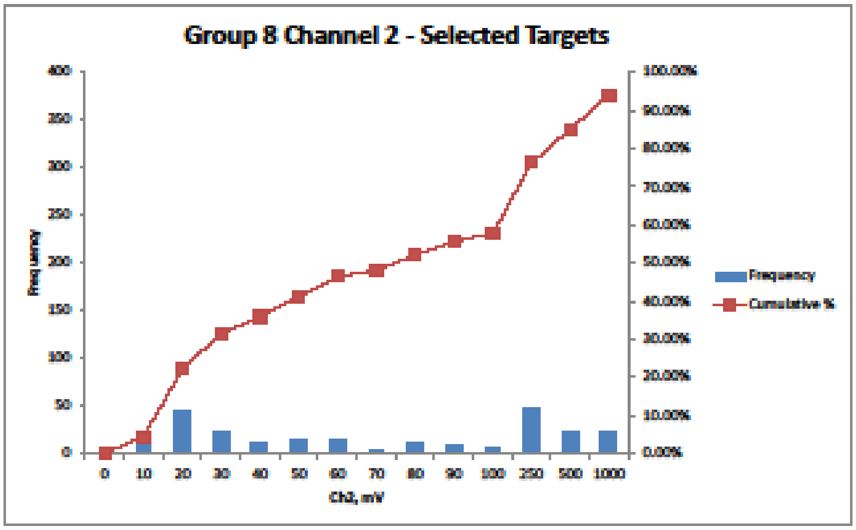
Client:	
Project:	
Contractor:	
Created by:	Verified by:
Date:	File : master_group8_uoe Footpr...
Page number:	Approved:

Figure 3
Histograms of Anomalies Identified and Dig Targets Selected

bin	*Frequency*	*Cumulative %*
0	0	0.00%
10	90	5.48%
20	247	20.54%
30	154	29.92%
40	101	36.08%
50	87	41.38%
60	69	45.58%
70	69	49.79%
80	54	53.08%
90	58	56.61%
100	39	58.99%
250	348	80.20%
500	155	89.64%
1000	94	95.37%
More	76	100.00%
	1641	



bin	*Frequency*	*Cumulative %*
0	0	0.00%
10	11	4.44%
20	44	22.18%
30	23	31.45%
40	11	35.89%
50	13	41.13%
60	13	46.37%
70	4	47.98%
80	10	52.02%
90	9	55.65%
100	5	57.66%
250	46	76.21%
500	22	85.08%
1000	22	93.95%
More	15	100.00%
	248	



Addendum 1
DGM Quality Assurance Forms

DIGITAL GEOPHYSICAL MAPPING QUALITY ASSURANCE FORM*(DATA SUBMITTAL)*

U.S. Army Engineering & Support Center, Baltimore, MD

Recommend Payment: Yes [X] No [ ]
QA Reviewer: D. King
Date: 11/30/2011

Lot ID: Group 8 MRS

	Pass	*Fail*	*See Comments*	*Field Observation*	*N/A*
1) Submittal Ontime	X				
2) Submittal Complete (raw/processed data files (mapping & QC), maps, field data sheets, updated Access DB (includes QC results, target selection tables, etc.)	X				
3) Performance Requirements Results (all results documented & failures have RCAs: Static Repeatability, Along line measurement spacing, Speed, Coverage, Dynamic Detection & Positioning Repeatability, Geodetic Equipment Functionality/internal consistency/accuracy)	X				
4) Periodic Recalculation of Performance Requirements (include details in comments section)					
(a) Static Repeatability	X				
(b) Along Line Measurement Spacing	X				
(c) Speed	X				
(d) Coverage	X				
(e) Dynamic Detection Repeatability	X				
(f) Dynamic Positioning Repeatability	X				
(g) Geodetic Functionality	X				
(h) Geodetic Internal Consistency	X				
5) Review of Maps/Gridded data (Assess Potential Field) (visual check: background levelling, striping, latency, noise, in particular view seed items for dynamic detection repeatability)	X				
6) Target Selection (following selection criteria for anomaly & dig lists, each single anomaly has one unique ID, cultural features noted/not selected to dig, no gridding artifacts, reporting of anomaly characteristics accurate)	X		X		
7) Root Cause Analyses/Non-conformances Reported & Accepted					X
8) Any additional field observations/QA (add notes below)	X				

Quality Assurance Comments:

6. There are serveral clusters of anomalies located within the MRS. Instead of digging each anomaly the clusters have been polygon out and trenches are going to be digged to detemine nature of the cluster.

Addendum 2
Target Dig List

Target Dig List
Group 8 MRS

Target_ID	X	Y	channel_1_response	channel_2_response	channel_3_response	sum_or_other_response_value	response	equipment	QC_point	comments	mask_select
12	496604.1	4559093.4	469.3605346	342.8724669	222.8945312	1169.394531	mV	EM61MKII	N		1
14	496604.8	4559071.9	16.79826926	10.50117492	5.292625899	34.82770154	mV	EM61MKII	N		1
15	496605.4	4559075.6	24.0974636	16.39385985	9.056144709	53.93698499	mV	EM61MKII	N		1
24	496607.6	4559070.6	28.21076012	16.7776947	7.899513719	55.80438613	mV	EM61MKII	N		1
32	496609.1	4559091.6	706.3167721	446.5692136	178.4292449	1386.977904	mV	EM61MKII	N		1
39	496610.7	4559063.1	34.63825226	21.83518982	10.015625	69.84179688	mV	EM61MKII	N		1
44	496611.2	4559075	9.064805988	10.44468308	8 636779906	35.33409453	mV	EM61MKII	N		1
54	496612.8	4559051.8	205.9837036	149.9207001	94.41261291	502.6363831	mV	EM61MKII	N	cf ?	1
55	496612.9	4559068.2	1526.644775	1059.235717	612.4717405	3507.706054	mV	EM61MKII	N		1
66	496614	4559058.1	221.8054505	146.0917206	77 35557557	480.1045227	mV	EM61MKII	N		1
84	496615.5	4559061.6	1230.691772	792.3666381	370.7805175	2528.660888	mV	EM61MKII	N		1
86	496615.7	4559073.6	424.7832337	283.9680786	149.0791321	927.5325318	mV	EM61MKII	N		1
89	496616	4559103.3	22.05605125	13.73823547	6.612099171	44.62131119	mV	EM61MKII	N	cf ?	1
110	496617.2	4559069.5	132.1842803	86.05187222	46.92004011	287.0001525	mV	EM61MKII	N		1
115	496617.5	4559071.5	59.96257778	49.5192947	33.19471357	163.508026	mV	EM61MKII	N		1
121	496618.2	4559088.1	190.9024963	131.8578339	69.32213593	419.936676	mV	EM61MKII	N		1
130	496619.1	4559062.8	106.7501144	75.99641418	45.17155456	250.652771	mV	EM61MKII	N		1
136	496619.7	4559072.4	219.5398255	140.315094	69.44573212	456.3558045	mV	EM61MKII	N		1
155	496621.2	4559075.6	83.19036103	51.76716614	24.23649597	168.0266724	mV	EM61MKII	N		1
156	496621.3	4559104.5	57.20178984	39.75144194	23.89012145	133.5512695	mV	EM61MKII	N		1
160	496621.9	4559067.6	29.33028219	17.69546507	8.042701714	57.89813609	mV	EM61MKII	N		1
172	496623.3	4559085.2	215.2825317	155.9586792	96.39829251	526.981201	mV	EM61MKII	N		1
186	496625.1	4559050	11.83301352	8.257492053	4.017776958	25.41803165	mV	EM61MKII	N		1
190	496625.3	4559074.7	80.9080734	45.95468901	18.5689621	152.2806091	mV	EM61MKII	N		1
200	496626.3	4559054.9	73.56352996	44.8255539	25.12239075	155.6473999	mV	EM61MKII	N		1
201	496626.5	4559070.8	2540.606445	1814.759155	1114.022827	6091.399414	mV	EM61MKII	N		1
203	496626.7	4559056.2	89.77866362	58.98802184	29.82860183	191.3426208	mV	EM61MKII	N		1
214	496627.9	4559049.6	27.56575586	21.85359193	13.96244812	71.85073855	mV	EM61MKII	N		1
238	496631.2	4559053.3	824.786499	522.7097778	252.230484	1696.928711	mV	EM61MKII	N		1
243	496632.2	4559051.9	131.34346	83.4032058	43.15738674	276.632324	mV	EM61MKII	N		1
246	496632.4	4559103.1	532.127014	357.8280028	174.4634551	1128.994506	mV	EM61MKII	N		1
252	496633.5	4559088.2	1000.901672	593.2912596	257.1430053	1941.238036	mV	EM61MKII	N		1
257	496633.7	4559105.3	12.00562096	8.705627441	4.959694385	28.02166939	mV	EM61MKII	N		1
264	496634.8	4559112	12.7185955	9.79733276	5.700176713	31.46628092	mV	EM61MKII	N	cf ?	1
280	496636.4	4559054	124.5047378	104.5154648	80.7289276	357.7191467	mV	EM61MKII	N		1
286	496637.1	4559056.3	1978.98584	1225.936768	625 237793	4092.976318	mV	EM61MKII	N		1
304	496638.8	4559105.6	766.1731567	470.8976745	198.175888	1491.380005	mV	EM61MKII	N		1
317	496640.1	4559055	61.72002404	57.17540734	43 69861216	190.8690183	mV	EM61MKII	N		1
331	496641	4559102.7	168.637909	118.5154343	70 63570406	398.781891	mV	EM61MKII	N		1
340	496642	4559055	206.1773528	146.8368835	85.57326505	482.3981627	mV	EM61MKII	N		1
359	496643.7	4559099.9	43.54549408	29.6372757	14 38459015	92.79556275	mV	EM61MKII	N		1
367	496644.8	4559086.1	428.5402832	273.9433899	135.5653839	891.0560912	mV	EM61MKII	N		1
369	496644.9	4559092.7	30.12605856	14.92062377	4.777466295	51.94943615	mV	EM61MKII	N		1
370	496644.9	4559103.6	111.0529098	84.05356595	52.81944655	278.8342284	mV	EM61MKII	N		1
382	496646.6	4559110.9	36.25978853	25.10432435	14.48150635	83.17001346	mV	EM61MKII	N		1
393	496647.8	4559098.3	3520.901855	2441.225098	1376.698853	8008.450195	mV	EM61MKII	N		1
397	496648	4559088.8	87.96138763	58.39403534	31.16879272	192.3957825	mV	EM61MKII	N		1
412	496649.2	4559059.8	425.8022766	308.7419739	196.2716827	1042.93811	mV	EM61MKII	N		1

413	496649.3	4559080.1	154.0441132	99.09835054	50.53696824	327.6160889	mV	EM61MKII	N		1
416	496649.9	4559062.6	32.26414399	24.73792271	11.80274608	73.32112325	mV	EM61MKII	N		1
419	496650.2	4559101.8	208.5911255	121.078331	48.68064117	393.2951355	mV	EM61MKII	N		1
422	496650.4	4559112.9	17.40265464	13.59909057	8.422019954	43.67123792	mV	EM61MKII	N		1
426	496650.7	4559063.1	190.6407622	123.5698547	59.14053723	392.190399	mV	EM61MKII	N		1
429	496650.8	4559057.7	129.0528717	89.92514036	49.25680922	293.7393188	mV	EM61MKII	N		1
431	496650.9	4559107.1	67.74788665	43.89754485	22.27124023	142.4273071	mV	EM61MKII	N		1
439	496651.5	4559107.9	83.20124051	56.67335508	31.97316359	187.4112548	mV	EM61MKII	N		1
446	496652.4	4559098.8	314.1949158	201.6880341	113.6294556	691.4153442	mV	EM61MKII	N		1
449	496652.4	4559105.2	785.591065	314.9837954	70.85835273	1210.878541	mV	EM61MKII	N		1
453	496652.7	4559084.5	112.7221908	78.64328002	39.401165	245.4759216	mV	EM61MKII	N		1
463	496653.9	4559087.3	263.9429626	175.2964783	92.57204437	570.5551147	mV	EM61MKII	N		1
464	496654	4559119.5	40.11272431	27.73841667	14.91106796	89.40855408	mV	EM61MKII	N	cf ?	1
483	496655.4	4559060.7	86.07588954	58.47420498	31.99921797	192.3611449	mV	EM61MKII	N		1
489	496655.8	4559087.6	36.6206436	23.40586852	12.78839111	78.58825681	mV	EM61MKII	N		1
493	496656.1	4559095	187.4530029	124.8802642	62.9024162	399.1481932	mV	EM61MKII	N		1
498	496656.5	4559065.5	500.5689082	358.0241696	207.2798612	1185.119017	mV	EM61MKII	N		1
501	496656.8	4559100.9	2062.687256	1475.477661	942.8947753	5025.325195	mV	EM61MKII	N		1
503	496657.1	4559109.5	128.4360656	88.01578519	47.72821044	287.3357848	mV	EM61MKII	N		1
510	496657.5	4559073.6	57.93063357	40.50341036	19.01887894	123.515503	mV	EM61MKII	N		1
516	496658	4559084	140.8072814	105.8638305	62.01383207	339.3317565	mV	EM61MKII	N		1
541	496660.1	4559086.8	226.3292084	150.6176605	79.62488556	491.62677	mV	EM61MKII	N		1
547	496660.4	4559064.7	407.6636657	324.9064635	222.4283599	1096.445923	mV	EM61MKII	N		1
549	496660.6	4559108.7	15.53702355	10.79174804	5.966179364	34.51282119	mV	EM61MKII	N		1
555	496661.1	4559072.5	115.3455505	69.75477597	33.54882811	232.0658568	mV	EM61MKII	N		1
560	496661.3	4559111.5	36.67803192	21.8125	9.573982237	71.24972534	mV	EM61MKII	N		1
561	496661.4	4559074.9	349.144348	228.5894164	119.6520004	759.2896116	mV	EM61MKII	N		1
564	496661.9	4559090.5	116.9070053	70.4978561	31.25427625	231.7999571	mV	EM61MKII	N		1
572	496662.7	4559099.3	106.5392303	64.16812897	28.50531006	207.9712219	mV	EM61MKII	N		1
576	496662.9	4559097.7	36.57997893	19.76518249	7.184319016	65.43115231	mV	EM61MKII	N		1
587	496664	4559090	112.6619415	77.68850708	43.66521454	254.2732849	mV	EM61MKII	N		1
598	496664.9	4559092.1	207.8253173	121.4365157	45.17175291	387.3703001	mV	EM61MKII	N		1
609	496665.6	4559123.6	23.49612234	16.1300125	9 25860595	53.29841991	mV	EM61MKII	N	cf ?	1
616	496666.1	4559104.8	52.37180328	32.15856171	12.9797821	103.5317078	mV	EM61MKII	N		1
621	496667.1	4559109.5	56.50025176	37.49185942	20.33154296	124.7017211	mV	EM61MKII	N		1
626	496667.6	4559106.4	147.4877014	84.88795471	36.65922547	276.7512207	mV	EM61MKII	N		1
627	496667.6	4559093.6	130.138855	78.46360015	36.20188904	256.1511535	mV	EM61MKII	N		1
628	496667.8	4559088.5	380.0216369	259.3205261	132.1620941	826.0187376	mV	EM61MKII	N		1
636	496668.6	4559125.3	39.92111969	27.77192688	14.05068207	88.8921814	mV	EM61MKII	N	cf ?	1
640	496669	4559100.3	53.06755829	33.15777588	13.96953583	103.6423645	mV	EM61MKII	N		1
646	496669.7	4559111.3	224.3276367	160.2658539	94.36460113	532.5407104	mV	EM61MKII	N		1
648	496670.2	4559065.8	290.5142822	198.9095001	107.6857681	643.4772339	mV	EM61MKII	N		1
652	496670.9	4559101.1	174.3027801	119.8094025	63.64329147	385.9778137	mV	EM61MKII	N		1
656	496671.4	4559126.3	19.00006676	13.79144287	7.404129506	43.46170426	mV	EM61MKII	N	cf ?	1
659	496671.7	4559112.2	1153.614502	837.3984983	521.4800413	2805.531005	mV	EM61MKII	N		1
679	496674.1	4559110.4	744.4146728	532.6014404	316.9022827	1754.372803	mV	EM61MKII	N		1
680	496674.2	4559096.2	149.2614593	94.15918726	28.92918775	278.07489	mV	EM61MKII	N		1
709	496676.4	4559110.9	985.3368528	717.5839232	446.7786254	2390.185058	mV	EM61MKII	N		1
710	496676.5	4559114.4	222.4600677	152.7343445	79.1754074	482.8434448	mV	EM61MKII	N		1

720	496678.4	4559106.8	957.3427735	687.4250489	429.2763367	2300.921875	mV	EM61MKII	N		1
724	496678.7	4559098.6	77.57840727	54.81467436	30.11032104	175.8502807	mV	EM61MKII	N		1
725	496678.8	4559100.8	15.5405941	10.71365356	5.135559559	33.40201187	mV	EM61MKII	N		1
739	496681.1	4559121.1	27.55280112	17.30859374	7 67772722	54.18759535	mV	EM61MKII	N		1
742	496681.3	4559115	814.2984009	579.9637451	333.7427979	1892.623901	mV	EM61MKII	N		1
748	496681.7	4559107.2	970.2330323	694.9436646	410.6336975	2272.195801	mV	EM61MKII	N		1
750	496682.3	4559122.6	2025.872559	1308.943482	569.1298219	4025.776368	mV	EM61MKII	N		1
757	496683.8	4559131	18.95372581	13.50318908	7.067215439	42.63046644	mV	EM61MKII	N	cf ?	1
772	496685.2	4559113.9	197.3206787	136.6089172	80.83930205	454.6258544	mV	EM61MKII	N		1
774	496685.5	4559106.6	18.69034385	13.39793396	7.368164537	42.55307387	mV	EM61MKII	N		1
787	496686.8	4559122.3	18.99121666	14.34339905	9.016479492	47.51401138	mV	EM61MKII	N		1
798	496688.3	4559124.9	986.7942509	630.4572146	304.8903505	2031.450929	mV	EM61MKII	N		1
801	496688.6	4559117.9	507.7653503	356.6684265	220.2797699	1209.153931	mV	EM61MKII	N		1
807	496689.1	4559116.5	261.8652038	174.7827759	92.4322052	571.1268921	mV	EM61MKII	N		1
810	496689.4	4559114.8	46.16774749	38.14530182	24.6197052	123.9075012	mV	EM61MKII	N		1
825	496691.9	4559115	78.84146886	58.80900578	39.56385424	198.1561586	mV	EM61MKII	N		1
836	496693.7	4559124.9	67.17670439	49.59705352	30.68241882	163.9546508	mV	EM61MKII	N		1
845	496695.9	4559126.4	278.4275512	198.5601959	119.5964431	661.1726073	mV	EM61MKII	N		1
848	496696.3	4559124.6	72.61148835	38.08663941	12.58636475	124.9708862	mV	EM61MKII	N		1
857	496698.2	4559126.7	91.13898463	58.71730038	26.86484526	184.4002684	mV	EM61MKII	N		1
866	496699.3	4559110.4	20.09885214	13.59794616	7.093460555	43.95056531	mV	EM61MKII	N		1
867	496699.6	4559132.7	47.55362699	34.55146025	19.92871856	112.6789245	mV	EM61MKII	N		1
868	496700.2	4559127.6	21.32584189	16.47952269	9.862030022	53.07696911	mV	EM61MKII	N		1
871	496700.5	4559139.8	641.9353027	415.1777954	221.7895355	1377.944092	mV	EM61MKII	N		1
874	496701.4	4559137.6	28.26669882	20.10972594	10.13380432	62.18808362	mV	EM61MKII	N		1
878	496701.9	4559078.3	498.0941161	368.1895141	230.6080474	1227.317505	mV	EM61MKII	N		1
880	496702.5	4559127.6	520.0300902	328.6474913	163.5709533	1081.962646	mV	EM61MKII	N		1
883	496702.8	4559109.2	76.41826627	45.90135954	24.80976867	159.4444885	mV	EM61MKII	N		1
895	496705.7	4559113.3	13.40057945	8.446151733	4.196297169	27.48559761	mV	EM61MKII	N		1
899	496706.1	4559130.3	1910.984253	1291.405029	713.3972778	4246.473633	mV	EM61MKII	N		1
903	496706.7	4559090.4	57.81893157	39.51985931	22.23166656	130.48526	mV	EM61MKII	N		1
906	496707.3	4559080.1	80.10100552	49.10509489	24.57048034	164.3771362	mV	EM61MKII	N		1
907	496707.5	4559116.6	807.603363	582.4386596	363.663971	1914.9599	mV	EM61MKII	N		1
913	496708.3	4559118.1	195.3725624	128.0180969	65.68118096	407.9649277	mV	EM61MKII	N		1
919	496710.3	4559091.1	35.24845122	20.50439452	8.734977719	67.73434446	mV	EM61MKII	N		1
925	496711	4559109.5	61.34700773	39.69724272	18.22468566	127.8847656	mV	EM61MKII	N		1
927	496711.5	4559081.3	166.8760834	128.4425354	86.86756897	426.4422302	mV	EM61MKII	N		1
935	496713	4559096.8	17.55183983	11.35160828	3.962021112	33.93066788	mV	EM61MKII	N		1
940	496713.6	4559109.4	62.79912566	45.88133239	28.54959869	152.7557678	mV	EM61MKII	N		1
945	496714.8	4559111.4	26.7732296	15.13821411	5 98769617	49.61623763	mV	EM61MKII	N		1
951	496715.7	4559084	110.4771652	74.77816773	41.67585373	246.1428528	mV	EM61MKII	N		1
952	496715.9	4559145.1	16.72521019	8.784301759	2.758873225	28.89758492	mV	EM61MKII	N		1
957	496716.3	4559121.6	237.015808	157.6394805	81.38283535	512.2312009	mV	EM61MKII	N		1
971	496717.6	4559113	21.80322838	14.49113464	7.705566882	46.59109878	mV	EM61MKII	N		1
987	496718.9	4559119.8	94.28392792	60.80502319	29.72103882	197.2556152	mV	EM61MKII	N		1
1003	496720.7	4559108.4	33.25833891	23.20903014	13.29758453	76.5941467	mV	EM61MKII	N		1
1008	496721.4	4559129.4	63.24088285	41.36652373	20.7787857	133.2830505	mV	EM61MKII	N		1
1019	496722.8	4559102.7	44.21921539	28.99845886	14.70535278	93.41351319	mV	EM61MKII	N		1
1031	496724	4559122.4	148.9359436	97.91552731	52.66394804	322.6954955	mV	EM61MKII	N		1

1034	496724.6	4559110.8	124.5336609	79.73906707	39.905056	259.8020935	mV	EM61MKII	N		1
1046	496725.3	4559142.8	42.96881866	18.98097229	5.738205433	66.30987549	mV	EM61MKII	N		1
1057	496726.1	4559112.5	20.67156028	18.70924376	12.84468841	60.07788464	mV	EM61MKII	N		1
1058	496726.2	4559134.9	288.9602966	201.9729309	103.4638443	631.7562865	mV	EM61MKII	N		1
1060	496726.4	4559107.2	20.53240395	14.32959747	6 91575861	45.09972	mV	EM61MKII	N		1
1062	496726.4	4559138.1	7151.177733	4741.395507	2340.279785	15059.54296	mV	EM61MKII	N		1
1067	496726.8	4559115.1	110.7989121	85.80818177	55.74829865	284.7735596	mV	EM61MKII	N		1
1073	496727.1	4559125.2	136.1293029	95.48856351	54.16643141	311.5288085	mV	EM61MKII	N		1
1087	496727.9	4559118.9	35.81304168	14.92698669	1.844871878	53.04559706	mV	EM61MKII	N		1
1097	496728.8	4559106.5	173.5097351	84.16214753	28.48935317	296.9334412	mV	EM61MKII	N		1
1102	496728.9	4559095.8	29.45605278	17.09249878	7.831463097	56.64404677	mV	EM61MKII	N		1
1105	496729	4559089	336.5278319	252.1795348	163.3716735	845.6859128	mV	EM61MKII	N		1
1112	496729.5	4559137.1	1191.36145	786.7054442	392.605255	2520.808593	mV	EM61MKII	N		1
1117	496730	4559120.9	194.9020691	76.51250458	15.48248291	288.3296509	mV	EM61MKII	N		1
1124	496730.5	4559089.7	301.8720092	210.8081207	123.6153488	700.7660521	mV	EM61MKII	N		1
1131	496731.2	4559097.5	216.6717987	138.4960175	69.00389099	451.0508423	mV	EM61MKII	N		1
1132	496731.2	4559149.5	11.00490379	8.035568234	4.495689867	25.49194525	mV	EM61MKII	N		1
1133	496731.3	4559131	27.04871176	21.47100829	13.98381805	70.59194943	mV	EM61MKII	N		1
1134	496731.3	4559116.4	51.95023346	21.90106201	7.523567677	84.31567383	mV	EM61MKII	N		1
1148	496732.5	4559139.4	1226.703003	875.5104369	514.1179809	2856.380859	mV	EM61MKII	N		1
1149	496732.6	4559105.2	78.23422999	42.18015286	11.66854857	133.2319945	mV	EM61MKII	N		1
1159	496733.8	4559114.9	11.78986168	8.371704103	3 69241357	25.93899727	mV	EM61MKII	N		1
1161	496734	4559091.1	108.9415817	84.60473632	51.91249466	275.1539612	mV	EM61MKII	N		1
1165	496734.2	4559093.2	164.4676513	109.5511093	58.78165434	359.6777343	mV	EM61MKII	N		1
1170	496734.6	4559150.4	22.81259728	14.27688599	5.996147631	45.22177505	mV	EM61MKII	N		1
1178	496735.4	4559096	1071.958374	614.2976072	240.1591949	1994.020629	mV	EM61MKII	N		1
1179	496735.4	4559117.8	749.2180176	478.7780762	218.1042938	1521.405518	mV	EM61MKII	N	cf ?	1
1182	496735.6	4559141.7	1481.734496	891.6317133	336.443054	2772.577147	mV	EM61MKII	N		1
1187	496736	4559105.6	621.0114136	390.3053132	179.1263809	1243.12146	mV	EM61MKII	N		1
1189	496736.4	4559114.9	1122.833496	734.8383785	333.7767332	2304.591307	mV	EM61MKII	N	cf ?	1
1201	496737.7	4559110.8	2482.462158	1581.169312	723.600708	5042.772949	mV	EM61MKII	N	cf ?	1
1206	496738.4	4559096.9	360.8197021	243.5589447	139.0844421	807.1067505	mV	EM61MKII	N		1
1207	496738.5	4559114.4	1663.380615	1073.702759	552.9108276	3532.470215	mV	EM61MKII	N		1
1210	496738.7	4559098.6	32.98850251	19.46356202	8.6570282	64.88366701	mV	EM61MKII	N		1
1213	496739.1	4559144.9	67.40401456	45.46308897	24.8709793	149.7156371	mV	EM61MKII	N		1
1219	496739.6	4559142.9	29.98741721	19.89553833	10.15990448	63.89807509	mV	EM61MKII	N		1
1220	496739.9	4559136.5	21.96823691	12.64781188	5.778061388	42.39200209	mV	EM61MKII	N		1
1222	496739.9	4559102.7	857.7072749	570.7983395	267.4488524	1793.018798	mV	EM61MKII	N		1
1230	496740.4	4559116.7	42.41590119	29.58566285	17.58015442	97.67443849	mV	EM61MKII	N		1
1233	496740.7	4559113.4	309.1958923	182.2427368	75.94776152	591.5147094	mV	EM61MKII	N		1
1236	496741	4559110.6	17.1459713	9.307418824	3 86692834	31.34759712	mV	EM61MKII	N		1
1240	496741.5	4559148.2	26.37384605	12.83981323	4.962677478	45.52643203	mV	EM61MKII	N		1
1244	496741.9	4559136.3	38.11147308	22.78359985	9.479446411	73.06448364	mV	EM61MKII	N		1
1247	496742.2	4559129.6	22.26065635	14.56129455	7.326790332	46.81924819	mV	EM61MKII	N		1
1249	496742.3	4559115.9	117.9615173	73.94157409	36.14708709	243.7460632	mV	EM61MKII	N		1
1256	496742.8	4559156.1	26.46214866	17.93682861	10.24528503	59.76013564	mV	EM61MKII	N		1
1258	496742.9	4559147.9	20.12662315	10.91992187	4.282997607	36.5121498	mV	EM61MKII	N		1
1266	496743.5	4559103.1	2578.29541	1182.429443	351.1437683	4184.120117	mV	EM61MKII	N		1
1267	496743.5	4559142.7	20.96695518	14.20146179	7.496002672	46.36114882	mV	EM61MKII	N		1

1270	496743.8	4559151.5	108.0145492	78.48332212	45.74930952	252.6088256	mV	EM61MKII	N		1
1271	496743.8	4559124.7	19.92790795	12.06840515	4.886627673	38.45505142	mV	EM61MKII	N		1
1277	496744.1	4559145.3	10.97555733	7.673465728	4.590666294	25.68184853	mV	EM61MKII	N		1
1296	496745.2	4559136.7	15.22047996	9.552734373	3.790268183	30.15075874	mV	EM61MKII	N		1
1305	496746	4559105	194.673828	138.6386718	64.65653989	416.6155393	mV	EM61MKII	N		1
1307	496746.1	4559113	284.7817992	186.3351745	96.27452084	607.0325926	mV	EM61MKII	N		1
1324	496747.2	4559152.7	38.55101774	29.41900634	18.49617003	97.50906368	mV	EM61MKII	N		1
1329	496747.4	4559148.9	151.3317108	110.473236	70.35622403	373.4593504	mV	EM61MKII	N		1
1331	496747.5	4559137.6	30.68176841	18.47760009	9.130538939	62.22613906	mV	EM61MKII	N		1
1344	496748.5	4559133	16.47276878	9.857833859	4.564713	32.52261733	mV	EM61MKII	N		1
1348	496748.8	4559124.9	346.5699157	216.7859802	103.7390747	707.8602904	mV	EM61MKII	N		1
1349	496748.9	4559150.8	38.35094452	25.95266724	13.77095032	83.81588746	mV	EM61MKII	N		1
1351	496749	4559152.2	67.96453093	44.81210326	23.97886657	148.0449829	mV	EM61MKII	N		1
1354	496749.2	4559101.6	239.7891998	142.9237976	64.82862853	468.9962157	mV	EM61MKII	N		1
1356	496749.3	4559157.6	32.64517973	20.76365661	10.58732605	68.90002438	mV	EM61MKII	N		1
1370	496750.1	4559134.7	78.65544888	60.10174558	35.85329817	195.8460082	mV	EM61MKII	N		1
1373	496750.4	4559114.8	1569.593018	951.9967651	467.0710449	3158.171875	mV	EM61MKII	N		1
1378	496750.9	4559111.8	493.8948974	344.8334961	182.6121673	1095.611816	mV	EM61MKII	N		1
1383	496751.1	4559103.5	194.6075592	130.1966553	69.19470026	421.5079652	mV	EM61MKII	N		1
1395	496751.9	4559108.9	1045.386962	767.9152828	471.1960752	2559.882079	mV	EM61MKII	N		1
1399	496752	4559132.1	18.31757163	12.55607604	6 64267778	40.41070936	mV	EM61MKII	N		1
1419	496753.8	4559153.8	212.0887299	147.9978485	88.19194031	494.3440552	mV	EM61MKII	N		1
1420	496753.9	4559143.5	244.7177581	168.0805969	97.72869871	559.3691405	mV	EM61MKII	N		1
1432	496755.1	4559130.1	165.3901519	104.3660202	52.28466033	343.9009704	mV	EM61MKII	N		1
1441	496756	4559163.4	17.78914451	12.72584533	6.916840075	41.30350112	mV	EM61MKII	N		1
1442	496756.1	4559114	3502.605956	2248.815673	1211.159424	7519.162108	mV	EM61MKII	N		1
1452	496756.7	4559144.4	76.47631834	51.78333663	37.97897719	167.7049713	mV	EM61MKII	N		1
1460	496757.3	4559141.8	28.54765892	12.68338013	3.246093988	44.99972916	mV	EM61MKII	N		1
1462	496757.5	4559151.3	44.50415802	30.3551712	16.89117432	98.41140747	mV	EM61MKII	N		1
1463	496757.5	4559130.5	32.65276337	21.28961182	10.53264618	68.40234376	mV	EM61MKII	N		1
1466	496757.8	4559107.1	269.4342346	185.7875061	96.13156126	588.8720092	mV	EM61MKII	N		1
1474	496758.4	4559129.6	139.6694488	51.88546751	9.335571288	202.3790893	mV	EM61MKII	N		1
1476	496758.4	4559131.1	21.06120872	14.48896789	7.45986223	45.50583266	mV	EM61MKII	N		1
1483	496758.7	4559141.4	44.85219573	28.313385	13.78912353	93.08312986	mV	EM61MKII	N		1
1486	496759	4559126.7	42.49112701	20.65167236	4.829933643	68.80587768	mV	EM61MKII	N		1
1491	496759.5	4559117.7	778.9072872	570.182922	330.4111021	1823.652221	mV	EM61MKII	N		1
1509	496760.8	4559122.9	51.60730741	38.88735198	23.5265808	126.2793884	mV	EM61MKII	N		1
1513	496761	4559126.5	213.846939	145.4219055	82.48521421	481.0404662	mV	EM61MKII	N		1
1520	496761.6	4559124.8	143.1246033	91.00769805	47.31017685	301.2151184	mV	EM61MKII	N		1
1529	496762.2	4559113	1712.757812	1032.107422	418.7913206	3263.451659	mV	EM61MKII	N		1
1533	496762.7	4559118.3	91.86299896	50.99436951	21.65646362	171.9465942	mV	EM61MKII	N		1
1541	496763.5	4559109.3	244.9454955	173.5424652	98.32173157	559.3189696	mV	EM61MKII	N		1
1545	496764.1	4559145.6	26.61244774	18.24121094	10.59489441	59.11258316	mV	EM61MKII	N		1
1550	496764.5	4559119.9	534.0165405	363.0783386	200.8295441	1188.062988	mV	EM61MKII	N		1
1554	496764.7	4559115.8	42.52779389	18.99993897	5 35946703	67.79901123	mV	EM61MKII	N		1
1556	496764.9	4559106.9	1108.183838	689.611389	324.4771117	2231.314697	mV	EM61MKII	N		1
1557	496764.9	4559116.9	199.8279724	110.1724167	46.6024475	373.2486266	mV	EM61MKII	N		1
1588	496768.2	4559112.2	461.7621459	285.5311889	124.824089	905.3616331	mV	EM61MKII	N		1
1610	496771.4	4559110.2	728.2621458	463.2384337	229.004074	1499.814208	mV	EM61MKII	N		1

1611	496771.9	4559125.1	79.09157562	52.31105041	27.7791214	171.3388672	mV	EM61MKII	N		1
1636	496775.7	4559110.6	6012.562988	3929.006836	2168.558105	13057.14844	mV	EM61MKII	N	cf ?	1
1640	496723.8	4559097.1	3965.81726	2776.038208	1677.734619	9299.155761	mV	EM61MKII	N	cf ?	1
1641	496731.2	4559093.5	800.9988404	577.7564698	363.4039917	1946.839478	mV	EM61MKII	N	cf ?	1
1	496596.6	4559090	76.03798674	28.86657715	6.294189931	112.3114014	mV	EM61MKII	N		
2	496597.1	4559094.1	18.68919945	13.00108338	7.911880972	43.769413	mV	EM61MKII	N		
3	496599.3	4559097.7	19.20744895	14.43618774	8.659622188	46.88315198	mV	EM61MKII	N		
4	496599.7	4559083.3	58.61704254	27.03651428	9.061325073	97.12789917	mV	EM61MKII	N		
5	496600.8	4559085.7	71.90346524	51.27825925	28.76122282	165.004486	mV	EM61MKII	N		
6	496601.8	4559076	27.60082053	18.18432616	9.922866815	60.5062904	mV	EM61MKII	N		
7	496602.7	4559093.1	1589.614868	1045.766235	442.5660094	3211.258544	mV	EM61MKII	N		
8	496603.1	4559095.2	12.25105094	7.998817442	3.986751913	26.34832954	mV	EM61MKII	N		
9	496603.5	4559085.2	25.68111229	17.59208679	9.549560543	57.3782997	mV	EM61MKII	N		
10	496603.7	4559076.6	66.43943023	43.0163269	22.03834533	140.856781	mV	EM61MKII	N		
11	496603.9	4559071.7	34.03731535	22.49493407	12.12960815	73.84262081	mV	EM61MKII	N		
13	496604.4	4559073.3	89.45015716	61.91051483	34.40896606	202.6383362	mV	EM61MKII	N		
16	496605.4	4559088.8	668.0154419	461.9161682	233.4929047	1453.566773	mV	EM61MKII	N		
17	496605.5	4559099.7	17.63820456	12.67810058	7.745247359	41.00299451	mV	EM61MKII	N		
18	496605.7	4559065.5	31.25568199	16.57754517	6.385368824	56.17801285	mV	EM61MKII	N		
19	496605.9	4559087.5	188.1425628	102.4866104	34.16553878	332.094757	mV	EM61MKII	N		
20	496605.9	4559066.7	25.72307396	19.47198486	12.37844848	64.67913818	mV	EM61MKII	N		
21	496606	4559070.2	98.78179931	52.33205414	17.90688324	173.0396423	mV	EM61MKII	N		
22	496606.9	4559085.4	552.5499263	364.8741757	177.7199553	1158.93164	mV	EM61MKII	N		
23	496607.2	4559062	16.82922936	10.98060608	5.750137806	35.76935196	mV	EM61MKII	N		
25	496607.6	4559065.7	14.03317832	8.686187739	4.351768968	28.72180365	mV	EM61MKII	N		
26	496607.6	4559085	1122.254272	745.0534665	345.9390257	2335.034911	mV	EM61MKII	N		
27	496607.7	4559069	61.11470795	35.15637207	15.73368835	116.8202515	mV	EM61MKII	N		
28	496607.8	4559066.9	46.92215728	32.40930175	18.80582428	107.4507751	mV	EM61MKII	N		
29	496608.1	4559073.5	15.40251731	9.736801146	4 39308977	30.81790351	mV	EM61MKII	N		
30	496608.2	4559077.3	30.29439354	19.71946716	9.138244629	65.21347046	mV	EM61MKII	N		
31	496608.7	4559081.8	424.1083064	282.3352047	160.9033506	923.529784	mV	EM61MKII	N		
33	496609.5	4559061.2	37.28971099	20.63775634	7.268478868	66.42001341	mV	EM61MKII	N		
34	496610.2	4559069.8	1420.306396	944.1854858	529.2832031	3148.335693	mV	EM61MKII	N		
35	496610.3	4559082.6	19.2844448	12.09300231	5.379768846	38.67972182	mV	EM61MKII	N		
36	496610.3	4559088.1	126.0267944	62.90383912	17.72301483	210.0064392	mV	EM61MKII	N		
37	496610.3	4559097.9	11.39354515	9.082702636	5 88453722	29.26242256	mV	EM61MKII	N		
38	496610.4	4559096.2	625.2921137	489.8147579	273.8428038	1510.529906	mV	EM61MKII	N		
40	496610.9	4559083.4	19.77254295	9.194061275	1.382889151	30.65963935	mV	EM61MKII	N		
41	496611	4559067.2	122.5983276	91.97053527	59.12570571	308.2695312	mV	EM61MKII	N		
42	496611	4559078	507.1218565	376.0821532	211.0802764	1181.367187	mV	EM61MKII	N		
43	496611.1	4559058.9	114.227951	75.45892333	36.84972763	239.6087646	mV	EM61MKII	N		
45	496611.2	4559096.7	255.2991791	198.401825	116.072052	621.1235352	mV	EM61MKII	N		
46	496611.3	4559060.6	22.08759117	13.75158691	7 62506151	45.97970962	mV	EM61MKII	N		
47	496611.3	4559080.3	28.75998497	11.96200561	1.730751395	42.51169204	mV	EM61MKII	N		
48	496611.5	4559058.2	95.34328461	61.50244904	29.71422577	196.7211914	mV	EM61MKII	N		
49	496611.7	4559051.4	236.4938355	175.0900879	106.6312409	576.7639771	mV	EM61MKII	N		
50	496612.1	4559078.3	468.3966743	335.8242798	204.2494931	1093.262858	mV	EM61MKII	N		
51	496612.5	4559093	14.10431479	8.998092644	4.062706466	28.42578313	mV	EM61MKII	N		
52	496612.6	4559061.2	338.203186	226.5010681	126.625	751.6768188	mV	EM61MKII	N		

53	496612.6	4559062.9	203.1314697	155.524002	94.59548948	498.5585021	mV	EM61MKII	N		
56	496612.9	4559076.1	172.4282684	114.4743957	62.19192503	383.0578307	mV	EM61MKII	N		
57	496613	4559087.9	21.75354574	10.08792113	2.193908929	35.0205116	mV	EM61MKII	N		
58	496613.1	4559064.7	19.63800621	16.15644836	11.06788635	53.3461647	mV	EM61MKII	N		
59	496613.1	4559070	2893.465819	1953.68933	1097.812988	6482.356443	mV	EM61MKII	N		
60	496613.5	4559069.1	1911.33374	1277.807129	696.078186	4209.084961	mV	EM61MKII	N		
61	496613.6	4559079	168.6283263	112.1387252	48.08919141	341.4539793	mV	EM61MKII	N		
62	496613.9	4559077.8	511.54422	342.6860962	182.9507599	1123.732178	mV	EM61MKII	N		
63	496613.9	4559083.4	142.3813934	108.503128	68.48986814	360.0468444	mV	EM61MKII	N		
64	496614	4559052.1	230.9580383	162.6633911	99.35605621	545.9520263	mV	EM61MKII	N		
65	496614	4559071.4	97.03334807	48.64524078	10.47205353	155.0662842	mV	EM61MKII	N		
67	496614	4559080.8	641.4275513	410.2793884	199.4499664	1339.078247	mV	EM61MKII	N		
68	496614.3	4559088.8	38.71417889	20.25581352	5.353020052	65.93304609	mV	EM61MKII	N		
69	496614.3	4559074.2	276.1788633	178.1592711	94.36830131	594.3297724	mV	EM61MKII	N		
70	496614.3	4559051.3	394.4469604	275.5688477	162.463562	918.5551147	mV	EM61MKII	N		
71	496614.4	4559064.7	16.43390464	12.01637267	7.277885911	40.04394911	mV	EM61MKII	N		
72	496614.4	4559066.8	1315.507812	890.3654173	452.172943	2837.264404	mV	EM61MKII	N		
73	496614.4	4559052.7	264.3809204	189.877594	111.8881454	626.7307738	mV	EM61MKII	N		
74	496614.5	4559043	252.6476439	186.2483367	112.1988525	610.4347531	mV	EM61MKII	N		
75	496614.7	4559044.5	238.4302978	172.4882049	101.7551422	566.7542724	mV	EM61MKII	N		
76	496614.7	4559053.9	86.43161772	63.96172331	38.26396559	209.7003784	mV	EM61MKII	N		
77	496614.8	4559099.2	47.35125733	30.84565354	14.92063904	97.80874635	mV	EM61MKII	N		
78	496614.8	4559075.9	36.48662568	27.75320435	18.89099122	92.8015137	mV	EM61MKII	N		
79	496615	4559077.3	340.6794434	240.2300415	134.9741821	781.3638306	mV	EM61MKII	N		
80	496615.1	4559067.9	151.187561	109.098236	53.68447873	334.2131956	mV	EM61MKII	N		
81	496615.1	4559085.8	41.899971	12.46881103	0.908783257	55.39648818	mV	EM61MKII	N		
82	496615.4	4559059.2	77.08216095	49.74920655	27.17827988	166.2261963	mV	EM61MKII	N		
83	496615.4	4559063.5	745.2249143	496.651245	245.4322051	1579.72583	mV	EM61MKII	N		
85	496615.6	4559100.7	12.85246848	8.883087153	4.792168137	28.12018011	mV	EM61MKII	N		
87	496615.8	4559044.8	225.0228577	166.8111877	100.7318115	546.8244018	mV	EM61MKII	N		
88	496616	4559089.9	157.7623292	57.40581512	13.08821868	233.9103699	mV	EM61MKII	N		
90	496616	4559069.3	548.8764648	354.7961731	170.4858398	1133.404175	mV	EM61MKII	N		
91	496616.2	4559072.6	360.3015442	234.3852234	126.4130783	783.4421386	mV	EM61MKII	N		
92	496616.2	4559059.4	54.979393	36.86344146	20.23423004	122.0632934	mV	EM61MKII	N		
93	496616.2	4559070.5	82.39653777	62.95030974	40.93673705	210.1543274	mV	EM61MKII	N		
94	496616.2	4559054.8	72.53646088	52.84628296	32.17372131	176.293457	mV	EM61MKII	N		
95	496616.3	4559045.3	227.1817322	168.2416992	99.34420776	547.1940918	mV	EM61MKII	N		
96	496616.3	4559053.4	155.7783966	90.45375061	32.30718613	285.2704468	mV	EM61MKII	N		
97	496616.4	4559083	4232.791991	2738.595214	1407.619262	8993.547849	mV	EM61MKII	N		
98	496616.4	4559057.3	253.6282043	162.1840973	82.99163056	534.7696533	mV	EM61MKII	N		
99	496616.6	4559080.3	123.9288711	83.63502502	49.39641571	278.0517273	mV	EM61MKII	N		
100	496616.7	4559082.2	3011.129394	2054.510742	1144.23706	6767.432616	mV	EM61MKII	N		
101	496616.7	4559102.5	13.43053245	8.639907834	4.489761828	28.83102607	mV	EM61MKII	N		
102	496616.7	4559104.8	182.2069702	113.6542358	53.96432877	368.0744629	mV	EM61MKII	N		
103	496616.8	4559067.4	1592.858764	1026.063965	537.2521972	3395.947753	mV	EM61MKII	N		
104	496616.8	4559077.2	1073.012695	714.3244629	376.6644287	2337.593017	mV	EM61MKII	N		
105	496616.8	4559066	1250.719849	913.1509399	580.1676636	3069.932617	mV	EM61MKII	N		
106	496616.9	4559043.9	218.5265044	158.3051147	89.48076625	512.925659	mV	EM61MKII	N		
107	496617	4559057.9	171.2539825	102.3094406	39.45428466	323.7195433	mV	EM61MKII	N		

108	496617	4559045.3	292.8136902	212.7080688	123.3219299	692.027771	mV	EM61MKII	N		
109	496617.2	4559062.8	3304.281982	2357.848389	1341.336914	7673.791504	mV	EM61MKII	N		
111	496617.2	4559103.8	23.89513206	15.64706421	6.743698597	48.17157364	mV	EM61MKII	N		
112	496617.3	4559097.7	25.64552879	9.231307981	1.918678642	37.87530898	mV	EM61MKII	N		
113	496617.4	4559052.5	127.797348	91.55679323	55.58685303	304.0519715	mV	EM61MKII	N		
114	496617.5	4559066.7	1095.183594	778.2943115	477.2675781	2597.35791	mV	EM61MKII	N		
116	496617.5	4559055.1	783.8253784	577.5818482	379.5652466	1962.442383	mV	EM61MKII	N		
117	496617.6	4559077.4	1213.503417	802.1626583	432.4909361	2643.411132	mV	EM61MKII	N		
118	496617.7	4559053.4	121.6173782	94.82170105	63.36882019	318.1528931	mV	EM61MKII	N		
119	496617.9	4559046.3	198.0406341	141.366867	81.11087798	461.8734741	mV	EM61MKII	N		
120	496618.2	4559044.4	46.22040556	33.8165283	18.86713408	108.8320922	mV	EM61MKII	N		
122	496618.2	4559081.6	1701.257324	1099.409058	614.7640991	3719.270996	mV	EM61MKII	N		
123	496618.2	4559051.1	389.434677	257.2739715	137.1855316	827.5359801	mV	EM61MKII	N		
124	496618.3	4559089.1	246.1912384	167.6710663	86.89193726	537.706482	mV	EM61MKII	N		
125	496618.6	4559072.4	239.8064575	161.0710602	80.94971084	508.7198181	mV	EM61MKII	N		
126	496618.8	4559079.5	495.498413	343.1403503	204.6037597	1143.45105	mV	EM61MKII	N		
127	496619	4559085	1947.252319	1451.932861	917.6015011	4841.862303	mV	EM61MKII	N		
128	496619	4559099.3	51.66506195	14.73838806	1 94818151	68.94351196	mV	EM61MKII	N		
129	496619	4559097.7	1215.204834	812.7420654	380.7393494	2536.893799	mV	EM61MKII	N		
131	496619.1	4559065.1	682.1794432	445.941101	238.5290679	1479.744018	mV	EM61MKII	N		
132	496619.3	4559050.7	593.4429321	417.0584716	247.8552703	1377.283447	mV	EM61MKII	N		
133	496619.5	4559083.3	191.9003448	144.1501312	82.8117218	462.8970642	mV	EM61MKII	N		
134	496619.6	4559077.4	90.88912196	54.43744656	19.97633361	169.5480956	mV	EM61MKII	N		
135	496619.7	4559063.9	676.545471	495.1500242	301.3290709	1640.739013	mV	EM61MKII	N		
137	496619.7	4559084.6	1746.763916	1204.367676	740.354065	4069.713379	mV	EM61MKII	N		
138	496619.8	4559076.4	37.73203277	26.23144531	14.8948822	84.42791747	mV	EM61MKII	N		
139	496619.9	4559099.4	54.60959625	16.31196594	1.968483329	74.14370727	mV	EM61MKII	N		
140	496620.2	4559046.1	83.44277194	61.71700288	37.06681824	202.4080811	mV	EM61MKII	N		
141	496620.2	4559091.3	324.1030579	177.3615875	54.24421311	562.2529907	mV	EM61MKII	N		
142	496620.3	4559105.8	14.60957909	12.01817322	8.682983398	40.94314957	mV	EM61MKII	N		
143	496620.4	4559061.1	49.57007588	48.73674002	3.524093852	102.9096067	mV	EM61MKII	N		
144	496620.5	4559048.8	222.4947967	152.8379669	83.12825012	494.8995666	mV	EM61MKII	N		
145	496620.5	4559063	623.0695797	392.8479001	203.5260924	1309.925658	mV	EM61MKII	N		
146	496620.7	4559046.8	61.16127777	45.18282318	28.348629	150.7868042	mV	EM61MKII	N		
147	496620.9	4559044.8	36.97629547	26.52186584	16.07232666	87.85696411	mV	EM61MKII	N		
148	496620.9	4559081.1	5186.025878	3620.1958	2073.44873	11868.94824	mV	EM61MKII	N		
149	496621	4559087.7	73.28426366	56.00651554	35.89947512	182.3335572	mV	EM61MKII	N		
150	496621	4559064.5	194.1484375	118.1580505	55.0037651	388.1591491	mV	EM61MKII	N		
151	496621	4559085.1	590.8422852	413.9501648	218.3352967	1314.314942	mV	EM61MKII	N		
152	496621	4559059.8	62.24930572	44.04445648	23.60554504	138.2664185	mV	EM61MKII	N		
153	496621	4559106.2	24.00673484	18.21499633	11.43513488	60.18118666	mV	EM61MKII	N		
154	496621.1	4559045.7	33.62655162	24.54307937	15.75501251	81.45508668	mV	EM61MKII	N		
157	496621.4	4559048.8	369.7102965	260.5345153	156.8421935	867.0223996	mV	EM61MKII	N		
158	496621.5	4559088.8	53.39984894	38.62576294	21.81251526	123.2190552	mV	EM61MKII	N		
159	496621.8	4559085.4	481.1745911	299.4558106	126.8918686	941.2450563	mV	EM61MKII	N		
161	496621.9	4559058.2	89.25614163	59.90073393	33.45380782	200.9077453	mV	EM61MKII	N		
162	496621.9	4559072.2	328.3322142	236.8100127	151.4484557	799.0981441	mV	EM61MKII	N		
163	496622.2	4559066	16.47055624	10.75085448	5.355370038	34.80511852	mV	EM61MKII	N		
164	496622.3	4559069.5	62.6305771	45.10056306	29.65827943	154.9474793	mV	EM61MKII	N		

165	496622.4	4559045.1	16.76280787	8.9761963	3.521225216	30.57211498	mV	EM61MKII	N		
166	496622.8	4559106.4	18.02594566	12.01196289	6.095085621	39.18115616	mV	EM61MKII	N		
167	496623.1	4559085.9	231.4505309	166.3362426	104.3936538	566.7147825	mV	EM61MKII	N		
168	496623.1	4559101.4	21.48743244	10.26171873	2.112701644	33.85379403	mV	EM61MKII	N		
169	496623.1	4559047.7	59.46785731	43.44409939	26.96313856	144.4653624	mV	EM61MKII	N		
170	496623.2	4559070.5	324.3150938	237.335678	145.9858855	781.0304561	mV	EM61MKII	N		
171	496623.2	4559074.8	13.97298241	9.286102295	4.799797535	30.98953438	mV	EM61MKII	N		
173	496623.3	4559068.1	402.2047118	290.8945312	183.5489349	978.4003293	mV	EM61MKII	N		
174	496623.4	4559059.2	92.70488734	63.55261227	32.82872771	202.2170714	mV	EM61MKII	N		
175	496623.9	4559101.5	124.0808792	73.2593765	27.9480934	231.6340331	mV	EM61MKII	N		
176	496624	4559047.6	128.5023651	92.88555904	56.4053726	307.1922606	mV	EM61MKII	N		
177	496624.2	4559046.9	120.1073151	82.65254213	48.69962692	275.782898	mV	EM61MKII	N		
178	496624.2	4559079.2	5404.306151	3709.510253	2096.410156	12198.87695	mV	EM61MKII	N		
179	496624.3	4559095	17.72926903	11.30889893	6.987640858	39.83002091	mV	EM61MKII	N		
180	496624.5	4559070.8	1120.132324	820.1385498	528.5414429	2749.419922	mV	EM61MKII	N		
181	496624.7	4559072.8	1491.375366	1026.098877	589.8920288	3390.472168	mV	EM61MKII	N		
182	496624.7	4559101.7	13.92374228	9.576751702	4.349838731	29.65588568	mV	EM61MKII	N		
183	496624.9	4559089.9	340.1624756	217.350357	110.1736068	717.1126708	mV	EM61MKII	N		
184	496625	4559059.9	994.1002195	639.842285	327.1719054	2102.16333	mV	EM61MKII	N		
185	496625.1	4559047.8	94.91861726	68.29441071	43.24269486	229.0663147	mV	EM61MKII	N		
187	496625.1	4559096.1	35.77387233	21.99963376	11.61051176	73.56454459	mV	EM61MKII	N		
188	496625.2	4559088.1	10825.66309	11431.32422	8466.649415	32060.32422	mV	EM61MKII	N		
189	496625.2	4559094.1	25.56027794	19.89857483	14.02146912	69.55023194	mV	EM61MKII	N		
191	496625.5	4559051.4	282.5982971	169.7324677	66.78491211	534.8545532	mV	EM61MKII	N		
192	496625.6	4559086.3	1200.333496	816.1043701	441.1989746	2656.884521	mV	EM61MKII	N		
193	496625.6	4559066.6	217.2484283	157.0455016	93.58561703	516.1432493	mV	EM61MKII	N		
194	496625.7	4559048.7	105.4561615	78.69683072	49.36767958	260.5620421	mV	EM61MKII	N		
195	496625.9	4559057.6	75.04691316	48.22171021	24.0014534	156.9905091	mV	EM61MKII	N		
196	496625.9	4559069.9	2248.193115	1558.997681	935.0126953	5224.870117	mV	EM61MKII	N		
197	496625.9	4559092.8	94.83374785	53.83420562	20.98395538	174.1074524	mV	EM61MKII	N		
198	496626	4559069.2	2247.042481	1594.939697	975.2496339	5346.641114	mV	EM61MKII	N		
199	496626.1	4559046.7	73.45932763	41.3973312	14.31127928	131.491516	mV	EM61MKII	N		
202	496626.7	4559092.2	92.67264553	53.66909788	19.44628142	171.022766	mV	EM61MKII	N		
204	496626.8	4559084.3	216.6051178	153.7181549	81.66377258	486.0235596	mV	EM61MKII	N		
205	496627	4559083.4	260.8793335	178.0589447	96.19565582	579.6677246	mV	EM61MKII	N		
206	496627.3	4559048.1	91.87964631	69.0485077	44.66534424	229.3947449	mV	EM61MKII	N		
207	496627.3	4559109.1	161.4118957	95.89513395	41.59712981	313.220581	mV	EM61MKII	N		
208	496627.3	4559097.1	54.41316983	41.9680023	28.51667402	142.9330749	mV	EM61MKII	N		
209	496627.4	4559054	13.92853355	11.1437683	7.803070539	36.79315564	mV	EM61MKII	N		
210	496627.5	4559067.3	708.5698242	440.0661316	219.1031342	1456.800049	mV	EM61MKII	N		
211	496627.5	4559070.4	2431.123046	1716.223388	1020.779174	5704.740721	mV	EM61MKII	N		
212	496627.6	4559054.7	13.03198814	9.909317014	5.789276599	31.72366523	mV	EM61MKII	N		
213	496627.7	4559050.3	54.14080048	39.5430069	24.0748291	130.6775208	mV	EM61MKII	N		
215	496628	4559056.7	131.656311	85.88275142	41.5964546	276.5238036	mV	EM61MKII	N		
216	496628	4559048.3	92.07605743	69.32810211	44.06529236	229.5623474	mV	EM61MKII	N		
217	496628	4559109.1	168.0756836	89.54339601	30.55228806	292.7063294	mV	EM61MKII	N		
218	496628.3	4559088.4	1235.113403	827.850891	462.0682983	2736.037597	mV	EM61MKII	N		
219	496628.4	4559097.1	75.13219454	60.13275147	39.36479188	199.246521	mV	EM61MKII	N		
220	496628.4	4559052.8	150.4003143	97.84449004	46.5567131	312.9929504	mV	EM61MKII	N		

221	496628.4	4559089.1	877.7790526	583.4923705	324.2081603	1930.08313	mV	EM61MKII	N		
222	496628.5	4559055.4	3.317831078	1.834487879	0.231357897	6.133226476	mV	EM61MKII	N		
223	496628.5	4559087.3	2289.906982	1480.12915	831.3259277	4993.540039	mV	EM61MKII	N		
224	496628.6	4559071.1	146.2315674	117.8651886	72.38134766	371.9617309	mV	EM61MKII	N		
225	496628.9	4559070.1	78.16579431	49.37753292	25.56537626	162.5903624	mV	EM61MKII	N		
226	496629.3	4559082.5	42.13296509	26.28819275	13.30722046	87.44831848	mV	EM61MKII	N		
227	496629.4	4559049.8	436.2959594	263.7846374	123.1940842	870.3952026	mV	EM61MKII	N		
228	496629.6	4559054.9	198.4309081	145.3205718	77.7709808	447.7436216	mV	EM61MKII	N		
229	496629.7	4559109.8	15.94152634	14.11790461	7.379280537	41.28854735	mV	EM61MKII	N		
230	496629.7	4559052.3	545.0270386	375.2014465	183.9794769	1160.734253	mV	EM61MKII	N		
231	496630.2	4559056	149.1227875	89.08524324	41.22583008	295.0090943	mV	EM61MKII	N		
232	496630.2	4559084.6	107.6915436	71.10039519	34.75955963	227.9816284	mV	EM61MKII	N		
233	496630.4	4559092.1	157.7245483	104.8673477	61.86409757	353.7919615	mV	EM61MKII	N		
234	496630.5	4559054.6	68.51020044	40.74532314	15.48321532	128.7930297	mV	EM61MKII	N		
235	496630.5	4559102.3	503.752655	263.336792	80.93512726	852.5141601	mV	EM61MKII	N		
236	496630.7	4559090.7	175.2345733	121.2775268	67.59529112	396.8376159	mV	EM61MKII	N		
237	496631	4559055.7	138.0819854	82.55316921	39.54029081	275.1944884	mV	EM61MKII	N		
239	496631.6	4559057.2	422.2685851	305.9270934	189.1491851	1030.040039	mV	EM61MKII	N		
240	496631.8	4559086.4	438.5424803	265.3459167	126.0907592	877.3159787	mV	EM61MKII	N		
241	496631.9	4559100.3	25.70934105	16.26539612	6.361839771	52.46500015	mV	EM61MKII	N		
242	496632.2	4559088.7	865.7662352	597.8316038	347.2165831	1990.975463	mV	EM61MKII	N		
244	496632.3	4559110.5	13.26305198	9.169876095	4.807655809	29.12735175	mV	EM61MKII	N		
245	496632.3	4559098.9	10.07140159	8.073043824	5.739540579	29.58468819	mV	EM61MKII	N		
247	496632.4	4559084.1	21.55412863	13.02027892	5.261040209	41.58349989	mV	EM61MKII	N		
248	496632.9	4559091	37.28528593	25.07179259	11.1133194	79.63220211	mV	EM61MKII	N		
249	496632.9	4559055.4	91.97409825	68.51716616	42.57008363	227.6403199	mV	EM61MKII	N		
250	496633.1	4559104.8	15.41152	11.8944397	7.269577503	38.10617447	mV	EM61MKII	N		
251	496633.3	4559052.5	374.1917419	242.1300201	130.4753418	801.7763061	mV	EM61MKII	N		
253	496633.5	4559111.4	19.6012325	16.83251951	9.209754934	49.2247352	mV	EM61MKII	N		
254	496633.6	4559061	1231.483154	810.6279908	415.7601014	2643.543946	mV	EM61MKII	N		
255	496633.6	4559051.5	114.5292434	84.18181606	51.7244911	278.0668029	mV	EM61MKII	N		
256	496633.6	4559103.6	521.7942502	364.8483579	170.3796081	1106.901367	mV	EM61MKII	N		
258	496633.7	4559097.6	147.5121917	108.7546463	65.03947445	357.1974486	mV	EM61MKII	N		
259	496633.7	4559092.4	20.59801296	15.70025635	9.486335759	56.99878314	mV	EM61MKII	N		
260	496633.9	4559058.9	899.9790646	610.4935911	346.5555114	2037.894775	mV	EM61MKII	N		
261	496634	4559057.4	658.5755614	456.9161376	262.4402466	1506.990112	mV	EM61MKII	N		
262	496634.1	4559099.8	13.47920798	8.928375241	5.594776631	31.46187114	mV	EM61MKII	N		
263	496634.3	4559060.2	593.1211548	373.7192993	178.3033142	1219.52478	mV	EM61MKII	N		
265	496634.9	4559099.5	10.09247398	8.25939941	8.015876765	33.00467299	mV	EM61MKII	N		
266	496635	4559056	307.7705383	220.3287964	133.6369018	736.8183593	mV	EM61MKII	N		
267	496635.1	4559106.1	100.847763	58.00350188	21.03017425	183.7034912	mV	EM61MKII	N		
268	496635.1	4559053.8	518.0639038	346.3235779	195.6064758	1148.511475	mV	EM61MKII	N		
269	496635.2	4559052.8	1015.456482	735.2097778	397.9315186	2318.954102	mV	EM61MKII	N		
270	496635.3	4559092.9	125.9048291	79.62709621	46.28621866	275.6799317	mV	EM61MKII	N		
271	496635.3	4559095.7	5006.112304	2989.640136	1184.501465	9468.017577	mV	EM61MKII	N		
272	496635.4	4559091.5	249.3859405	157.3774871	75.70619961	513.2078856	mV	EM61MKII	N		
273	496635.8	4559092.2	170.028122	101.2080765	46.11260224	336.6264649	mV	EM61MKII	N		
274	496635.9	4559112.5	34.19644927	24.70458983	14.65889739	79.9226379	mV	EM61MKII	N		
275	496636	4559106.1	295.8972469	165.9521635	56.96267693	530.1713861	mV	EM61MKII	N		

276	496636.1	4559107.4	631.7501219	471.1801756	307.1743773	1589.344116	mV	EM61MKII	N		
277	496636.3	4559098.2	90.59813689	50.28179168	17.86920929	162.6091003	mV	EM61MKII	N		
278	496636.3	4559104.6	364.120117	249.3350676	126.4255447	788.3989253	mV	EM61MKII	N		
279	496636.3	4559085.1	16.14835933	9.623123185	4.190506347	30.90823656	mV	EM61MKII	N		
281	496636.4	4559087.1	90.45862579	60.19751739	32.16180038	197.186615	mV	EM61MKII	N		
282	496636.6	4559059.8	1945.272461	1370.463013	781.3272705	4461.003906	mV	EM61MKII	N		
283	496636.6	4559103.5	34.60166169	26.6222229	16.82604981	87.92730714	mV	EM61MKII	N		
284	496636.8	4559097.1	22.49489399	17.89865109	9.17198943	52.89096441	mV	EM61MKII	N		
285	496637	4559100.9	43.70507048	25.53787231	10.86634826	83.90176389	mV	EM61MKII	N		
287	496637.4	4559108	389.3215179	287.86026	188.3020019	974.4289092	mV	EM61MKII	N		
288	496637.4	4559092.8	302.3628235	193.8726959	97.21361541	633.2127685	mV	EM61MKII	N		
289	496637.6	4559061.4	721.3643797	453.4691771	223.5428161	1485.08789	mV	EM61MKII	N		
290	496637.6	4559102	24.24007224	18.9477539	10.50086212	59.88965222	mV	EM61MKII	N		
291	496637.7	4559063.6	2472.653564	1599.994263	880.5996703	5361.262695	mV	EM61MKII	N		
292	496637.7	4559104.6	134.2643127	71.0479202	18.657341	225.5382079	mV	EM61MKII	N		
293	496637.7	4559096.6	113.9770508	76.8123093	37.48143007	237.3096315	mV	EM61MKII	N		
294	496637.8	4559086.3	33.95641327	21.1022644	9.819252014	67.57778931	mV	EM61MKII	N		
295	496637.8	4559058.3	136.9320679	123.4192352	90.93800354	402.1214905	mV	EM61MKII	N		
296	496638	4559054	114.8655472	74.97939299	38.02663039	245.144104	mV	EM61MKII	N		
297	496638.1	4559113.5	76.66751098	50.88613509	28.04406928	168.2153473	mV	EM61MKII	N		
298	496638.4	4559089.8	127.0795364	87.11545945	48.31086923	284.9176789	mV	EM61MKII	N		
299	496638.4	4559102.5	15.20004845	12.4559021	7.432045459	39.68170547	mV	EM61MKII	N		
300	496638.5	4559056	355.210083	231.281311	119.321701	755.1639403	mV	EM61MKII	N		
301	496638.5	4559057	592.8366697	442.4227903	284.6296996	1487.526855	mV	EM61MKII	N		
302	496638.6	4559096.8	41.68666838	31.05922316	19.21860503	101.509613	mV	EM61MKII	N		
303	496638.7	4559103.8	32.01293182	23.16937256	12.45501709	72.34332275	mV	EM61MKII	N		
305	496638.9	4559053.2	112.90036	76.70263666	41.28769681	250.7514036	mV	EM61MKII	N		
306	496639	4559055.2	418.7706608	301.2895205	185.5892488	1012.720338	mV	EM61MKII	N		
307	496639	4559096	107.9811707	84.41814426	56.2705002	283.5827943	mV	EM61MKII	N		
308	496639.1	4559058.1	125.9067459	79.01035306	40.3112831	262.374298	mV	EM61MKII	N		
309	496639.1	4559093.6	106.5560455	65.70948791	29.77309418	213.7874145	mV	EM61MKII	N		
310	496639.3	4559088.3	82.08568573	47.60866547	19.67533112	154.5560303	mV	EM61MKII	N		
311	496639.4	4559090.6	123.2181167	82.48577115	45.71428297	275.6690673	mV	EM61MKII	N		
312	496639.5	4559098	95.39665982	66.59132383	36.60580443	216.1560058	mV	EM61MKII	N		
313	496639.6	4559095	175.062973	104.4062042	45.68615341	339.0610046	mV	EM61MKII	N		
314	496639.9	4559109.6	18.61824607	13.55717467	8.50269317	45.20032117	mV	EM61MKII	N		
315	496640	4559113	12.8480587	9.184082028	5.416725635	30.42663764	mV	EM61MKII	N		
316	496640.1	4559097.3	80.75690472	50.67027291	30.08447651	174.1649478	mV	EM61MKII	N		
318	496640.1	4559099.9	258.7070923	163.0042267	75.76470946	520.3645019	mV	EM61MKII	N		
319	496640.1	4559105.9	745.9296262	521.3776853	265.0417174	1636.163329	mV	EM61MKII	N		
320	496640.2	4559085.9	185.4448853	116.3769836	59.47676468	387.2607422	mV	EM61MKII	N		
321	496640.2	4559061.4	247.1673889	199.1208648	134.8696289	667.9401854	mV	EM61MKII	N		
322	496640.2	4559104.6	239.3851469	132.348175	41.46184156	417.1241452	mV	EM61MKII	N		
323	496640.3	4559057.3	4754.719238	3270.053711	1783.004639	10681.54199	mV	EM61MKII	N		
324	496640.3	4559111.9	13.78482627	10.45172118	5.891037459	32.60635755	mV	EM61MKII	N		
325	496640.4	4559103.2	317.0543517	172.6503295	57.20167157	556.6835935	mV	EM61MKII	N		
326	496640.4	4559053.9	361.8817137	265.5043639	162.3665161	879.8241574	mV	EM61MKII	N		
327	496640.4	4559094.5	177.3327789	105.3780746	43.21391295	339.9442138	mV	EM61MKII	N		
328	496640.7	4559109.6	17.67603111	12.1414032	7.111744404	41.10136795	mV	EM61MKII	N		

329	496640.7	4559055.6	101.0063781	72.58358758	41.32434842	237.3239439	mV	EM61MKII	N		
330	496640.8	4559099.4	238.0779419	151.7282867	75.35327911	494.7039795	mV	EM61MKII	N		
332	496641.1	4559095.6	66.06996917	34.01467895	11.27683258	113.7152405	mV	EM61MKII	N		
333	496641.1	4559088.8	103.3293533	67.28272247	35.278862	220.2870178	mV	EM61MKII	N		
334	496641.5	4559096.5	68.61971281	47.68151854	25.82984541	153.6130371	mV	EM61MKII	N		
335	496641.6	4559083.7	58.38826751	42.79631042	26.07913208	141.1853332	mV	EM61MKII	N		
336	496641.7	4559060.2	2107.882447	1418.702698	901.9776614	4898.395754	mV	EM61MKII	N		
337	496641.7	4559087.4	146.8224334	102.0363769	55.69860074	332.2989195	mV	EM61MKII	N		
338	496641.8	4559059.2	2151.094237	1603.39746	996.5561519	5345.669919	mV	EM61MKII	N		
339	496641.9	4559098.3	45.91718292	25.17938232	9.062767029	83.31259156	mV	EM61MKII	N		
341	496642.1	4559057.5	223.6108399	154.721283	80.33473207	499.0404664	mV	EM61MKII	N		
342	496642.2	4559064.2	51.2023239	37.38649748	17.50786589	112.1110534	mV	EM61MKII	N		
343	496642.2	4559091.4	348.0039978	230.0414734	117.8654556	743.3225708	mV	EM61MKII	N		
344	496642.4	4559085.5	578.2424926	437.9437561	283.1431579	1467.046631	mV	EM61MKII	N		
345	496642.5	4559082.6	245.6500548	184.3437499	114.3248138	613.0485837	mV	EM61MKII	N		
346	496642.5	4559055.9	242.362854	147.6065369	72.25351715	490.1927185	mV	EM61MKII	N		
347	496642.6	4559109.4	159.1166533	87.60188285	30.11560056	280.7542112	mV	EM61MKII	N		
348	496642.6	4559058.2	357.7132263	246.3686218	141.7984161	815.416748	mV	EM61MKII	N		
349	496642.7	4559104	8450.248045	6097.067381	3493.823974	19700.5996	mV	EM61MKII	N		
350	496642.8	4559097.2	189.0876312	119.7876434	53.19925687	379.9789122	mV	EM61MKII	N		
351	496642.8	4559114.1	12.56949424	8.606246945	4.900337694	28.43661688	mV	EM61MKII	N		
352	496642.8	4559095.2	45.6041336	36.2120285	24.76895141	120.7419128	mV	EM61MKII	N		
353	496642.9	4559100.9	75.31116484	50.24713896	27.18141173	164.6624145	mV	EM61MKII	N		
354	496643.1	4559056.7	327.6371762	226.2832487	136.7878722	761.2342522	mV	EM61MKII	N		
355	496643.3	4559083.5	420.2486266	288.4630431	151.4521026	928.2294919	mV	EM61MKII	N		
356	496643.3	4559113.1	35.52368925	17.44833373	4.76882219	58.29910656	mV	EM61MKII	N		
357	496643.4	4559089.3	600.1956787	343.0431824	126.3146515	1096.469727	mV	EM61MKII	N		
358	496643.6	4559093.6	881.9140011	626.4245603	318.3625792	1939.24768	mV	EM61MKII	N		
360	496643.8	4559101.9	157.1293488	113.0099564	69.07545472	378.4118958	mV	EM61MKII	N		
361	496644.1	4559055.2	104.5886841	76.86812589	48.28275298	255.4062194	mV	EM61MKII	N		
362	496644.2	4559091.8	206.6277618	142.8177185	78.85480499	461.7846069	mV	EM61MKII	N		
363	496644.3	4559087.5	206.0806427	140.1885834	76.68094635	456.1816407	mV	EM61MKII	N		
364	496644.4	4559088.2	195.3082275	133.2494049	75.98118589	440.3104552	mV	EM61MKII	N		
365	496644.4	4559056.9	12.4913082	9.232498162	6.578140731	31.73175237	mV	EM61MKII	N		
366	496644.5	4559084	60.85144806	42.32329559	21.2328186	131.7421265	mV	EM61MKII	N		
368	496644.9	4559116	46.44181059	32.53312682	17.26912688	103.7750854	mV	EM61MKII	N		
371	496645	4559100.1	164.529419	107.4790077	59.05225179	358.4235993	mV	EM61MKII	N		
372	496645.2	4559058	254.6967773	175.044281	99.95018767	578.9451903	mV	EM61MKII	N		
373	496645.3	4559095.7	421.6588744	280.0989074	143.3257903	909.7674558	mV	EM61MKII	N		
374	496645.4	4559061.4	79.6227799	49.64968875	24.95514681	167.9513246	mV	EM61MKII	N		
375	496645.5	4559094.2	157.8339385	82.62811275	21.19249724	261.7229308	mV	EM61MKII	N		
376	496645.7	4559096.3	397.4960022	266.1072388	148.2742157	881.2766724	mV	EM61MKII	N		
377	496645.9	4559105.3	60.00597382	38.20429993	18.98816681	126.1690369	mV	EM61MKII	N		
378	496646.2	4559102	29.68083095	19.04193878	9.929069516	62.33320806	mV	EM61MKII	N		
379	496646.2	4559061.9	1411.175659	903.3031615	429.7315063	2876.603759	mV	EM61MKII	N		
380	496646.5	4559094.1	142.1826477	87.92114257	42.27264022	289.3399658	mV	EM61MKII	N		
381	496646.5	4559056.6	125.4482879	90.06977078	54.09981535	297.7809447	mV	EM61MKII	N		
383	496646.7	4559096.5	385.4822388	239.732666	113.1750488	778.4620972	mV	EM61MKII	N		
384	496646.8	4559058.7	2351.514404	1594.512573	918.4270629	5321.017089	mV	EM61MKII	N		

385	496646.8	4559088.3	88.54181671	54.72180939	25.41508484	178.1403503	mV	EM61MKII	N		
386	496647.1	4559061.3	34.11847686	25.35307311	13.18455505	78.76785277	mV	EM61MKII	N		
387	496647.1	4559101.2	40.30785368	26.58264159	11.66580199	81.88287349	mV	EM61MKII	N		
388	496647.4	4559084.3	205.384964	133.4687347	70.21485138	438.8630981	mV	EM61MKII	N		
389	496647.5	4559060.7	97.89040368	59.14887996	29.28603743	197.6645506	mV	EM61MKII	N		
390	496647.5	4559095.1	438.7898254	290.0295715	143.3780365	927.2025146	mV	EM61MKII	N		
391	496647.5	4559116.5	16.43053245	10.16966247	5.160027023	33.82135389	mV	EM61MKII	N		
392	496647.6	4559111.3	20.47415733	12.6799469	6.557838917	42.75043106	mV	EM61MKII	N		
394	496647.9	4559084.8	200.6674957	134.3432007	73.46128845	440.9290771	mV	EM61MKII	N		
395	496647.9	4559093.3	39.23303985	28.72247314	17.79263306	95.57940673	mV	EM61MKII	N		
396	496647.9	4559091.3	281.4734802	185.0241547	95.78714752	604.9306641	mV	EM61MKII	N		
398	496648.1	4559057.3	228.4008484	161.5664673	96.26286316	534.4172363	mV	EM61MKII	N		
399	496648.1	4559062.9	28.61209676	17.18168639	7 30105638	55.82342906	mV	EM61MKII	N		
400	496648.3	4559083.5	114.9281921	76.85561372	38.73402405	244.8056031	mV	EM61MKII	N		
401	496648.3	4559106.2	112.8679733	80.70922088	47.64151	264.8862304	mV	EM61MKII	N		
402	496648.5	4559103.2	107.8253097	69.0629196	33.9636917	226.6569213	mV	EM61MKII	N		
403	496648.6	4559061	165.6435851	112.0756759	62.36233518	369.2991331	mV	EM61MKII	N		
404	496648.7	4559088.6	121.5515594	81.66516873	45.41981886	270.2817687	mV	EM61MKII	N		
405	496648.7	4559098.1	2671.187987	1893.719604	1167.657226	6359.080565	mV	EM61MKII	N		
406	496648.7	4559107.6	27.84810448	17.60806275	8.681777956	57.21850968	mV	EM61MKII	N		
407	496648.8	4559086.7	381.9832762	247.5226897	125.8880996	806.0484616	mV	EM61MKII	N		
408	496648.8	4559105	60.07826995	44.47430419	27.12802505	147.3511963	mV	EM61MKII	N		
409	496648.8	4559112.3	14.13509178	8.783813476	3.404861689	27.17938423	mV	EM61MKII	N		
410	496649	4559100.2	107.8895645	72.60341645	33.16252518	223.9562378	mV	EM61MKII	N		
411	496649.1	4559085.9	174.6801148	113.5964279	55.59265138	367.8327332	mV	EM61MKII	N		
414	496649.4	4559103.5	148.4266052	101.0792465	55.70444486	331.1557006	mV	EM61MKII	N		
415	496649.6	4559096.7	208.1174927	162.8156891	109.9020767	550.1970826	mV	EM61MKII	N		
417	496650	4559090.6	15.50786399	9.439300531	4.266884323	30.74066351	mV	EM61MKII	N		
418	496650	4559084	1161.968872	762.4191281	390.2872008	2486.323485	mV	EM61MKII	N		
420	496650.3	4559094.9	24.37347984	13.05253601	4.455063341	42.74341201	mV	EM61MKII	N		
421	496650.4	4559087.3	188.0795593	128.7934418	68.27416992	411.7795105	mV	EM61MKII	N		
423	496650.4	4559059.7	581.7259521	403.0002746	235.8914184	1332.5979	mV	EM61MKII	N		
424	496650.5	4559117.7	22.70573996	14.66284179	7.187263962	47.12405775	mV	EM61MKII	N		
425	496650.7	4559100.6	225.8239554	139.5030249	70.41766351	459.9612652	mV	EM61MKII	N		
427	496650.7	4559092.1	343.7507933	250.0871886	145.134735	812.1956173	mV	EM61MKII	N		
428	496650.8	4559108.4	56.27465056	38.22612762	19.90193939	122.1323852	mV	EM61MKII	N		
430	496650.9	4559088	153.7655487	100.2265243	50.75970839	324.7721557	mV	EM61MKII	N		
432	496650.9	4559097.1	134.4528656	101.8254357	69.66448595	349.8094788	mV	EM61MKII	N		
433	496651	4559112.3	62.42345428	37.1119461	13.62728119	115.6150513	mV	EM61MKII	N		
434	496651.2	4559102.3	229.6194763	148.9957428	72.618927	477.4034424	mV	EM61MKII	N		
435	496651.2	4559100	179.3640137	114.2559509	54.86610414	373.9977417	mV	EM61MKII	N		
436	496651.3	4559064.2	411.3816832	277.9040221	150.096939	905.2973018	mV	EM61MKII	N		
437	496651.4	4559060.4	986.288269	661.1750488	374.2403564	2211.469482	mV	EM61MKII	N		
438	496651.4	4559089.6	34.52889251	23.12191772	12.19185638	74.38757323	mV	EM61MKII	N		
440	496651.5	4559092.5	327.152069	238.5980682	147.0157318	789.0341185	mV	EM61MKII	N		
441	496651.7	4559103.1	378.1619566	249.2639159	124.5790633	796.0031734	mV	EM61MKII	N		
442	496651.9	4559086.9	191.5221558	138.9270783	74.57968906	437.3204652	mV	EM61MKII	N		
443	496652.2	4559083.6	213.1183013	139.9825744	69.66021726	454.6064757	mV	EM61MKII	N		
444	496652.2	4559100.4	328.6862487	187.5241699	71.54959866	604.1845701	mV	EM61MKII	N		

445	496652.3	4559097.5	245.91362	129.8905945	51.58913803	446.723175	mV	EM61MKII	N		
447	496652.4	4559102.7	340.1822203	217.079254	103.2289123	697.1643063	mV	EM61MKII	N		
448	496652.4	4559081.8	133.1742706	83.79951477	34.29276657	261.1482849	mV	EM61MKII	N		
450	496652.5	4559087.9	180.1390076	123.7741775	70.17131805	409.5457764	mV	EM61MKII	N		
451	496652.6	4559107.2	28.63336753	17.65866088	8.734207149	58.30292127	mV	EM61MKII	N		
452	496652.6	4559061.3	1352.038086	956.9245605	578.4501953	3188.232422	mV	EM61MKII	N		
454	496652.8	4559085.7	77.20781708	44.02709961	18.08301544	144.3800354	mV	EM61MKII	N		
455	496652.8	4559088.7	121.3415756	90.37155149	57.42339705	301.8085326	mV	EM61MKII	N		
456	496653.1	4559082.9	155.7567596	95.54186248	41.15097045	305.8749084	mV	EM61MKII	N		
457	496653.1	4559081.6	159.7472381	95.71823882	39.13939285	306.377716	mV	EM61MKII	N		
458	496653.4	4559080.8	186.1608276	117.7041855	61.09899139	387.9614563	mV	EM61MKII	N		
459	496653.4	4559104.4	289.0483092	188.0444182	97.70046993	615.5817868	mV	EM61MKII	N		
460	496653.6	4559084.2	155.7789001	104.2593307	59.58491133	355.3970031	mV	EM61MKII	N		
461	496653.7	4559092.1	55.96190644	38.48880005	21.20944214	124.7408447	mV	EM61MKII	N		
462	496653.8	4559063.1	433.1455687	309.48703	180.2176056	1012.388	mV	EM61MKII	N		
465	496654	4559095.8	896.5126343	515.5350342	226.9393005	1717.254395	mV	EM61MKII	N		
466	496654.1	4559090.3	43.24085235	29.28622436	14.12388611	91.65213013	mV	EM61MKII	N		
467	496654.2	4559102.6	95.56810757	52.38920592	16.16310882	165.4761657	mV	EM61MKII	N		
468	496654.2	4559101	1842.328002	1229.561279	631.3199461	3917.554931	mV	EM61MKII	N		
469	496654.4	4559119.6	40.28214261	26.60841368	13.69545745	86.73617548	mV	EM61MKII	N		
470	496654.5	4559088.4	289.212738	210.3223419	125.6731109	699.1124877	mV	EM61MKII	N		
471	496654.5	4559103.3	130.1242371	74.66381073	26.47253799	237.0634766	mV	EM61MKII	N		
472	496654.7	4559114.8	89.61370087	67.55715942	41.5379982	222.6810303	mV	EM61MKII	N		
473	496654.7	4559091	25.03713034	15.66166686	7.817169662	50.98279187	mV	EM61MKII	N		
474	496654.8	4559106.8	117.8287964	75.07496643	36.83000565	246.1968079	mV	EM61MKII	N		
475	496654.9	4559074	102.8768234	62.00928496	29.44543075	207.7582397	mV	EM61MKII	N		
476	496654.9	4559089.9	44.15235138	26.26541138	11.41707611	84.11877441	mV	EM61MKII	N		
477	496655.1	4559059.6	72.37679288	46.16306303	24.51339721	154.035675	mV	EM61MKII	N		
478	496655.1	4559063.6	272.6737366	181.1137695	106.578598	619.9660034	mV	EM61MKII	N		
479	496655.2	4559093.7	123.7695923	87.03978727	47.42646025	281.0426025	mV	EM61MKII	N		
480	496655.3	4559105.3	268.446106	177.6311645	87.68580627	564.8914185	mV	EM61MKII	N		
481	496655.3	4559098.8	66.04833221	34.88719177	13.19525909	118.5732117	mV	EM61MKII	N		
482	496655.3	4559082.5	330.9982605	220.6893921	119.8787231	727.8136596	mV	EM61MKII	N		
484	496655.5	4559074.9	199.2434845	129.17099	65.78414155	422.3669129	mV	EM61MKII	N		
485	496655.6	4559061.8	112.8493805	69.9512558	32.62589264	227.7470398	mV	EM61MKII	N		
486	496655.6	4559085.6	57.77948758	36.24685667	13.94521331	110.7528991	mV	EM61MKII	N		
487	496655.7	4559081.2	431.0631102	296.0196227	152.6557159	943.670532	mV	EM61MKII	N		
488	496655.8	4559091.1	51.28369902	35.20697021	19.83371734	116.1348266	mV	EM61MKII	N		
490	496655.8	4559090	39.00243378	23.22711182	9.439849853	74.4151001	mV	EM61MKII	N		
491	496655.9	4559063.8	129.6117859	101.4830475	67.22367096	340.4285279	mV	EM61MKII	N		
492	496655.9	4559103.2	119.021698	79.31870269	41.35988617	256.7095642	mV	EM61MKII	N		
494	496656.2	4559098.4	107.1156387	72.41752622	42.06983183	246.6783751	mV	EM61MKII	N		
495	496656.3	4559091.7	49.11573028	33.0790863	19.23219299	110.7160644	mV	EM61MKII	N		
496	496656.3	4559062.7	162.4339447	119.7702102	70.71180724	391.9009094	mV	EM61MKII	N		
497	496656.3	4559085	56.97821808	38.04623413	18.73195648	122.8092346	mV	EM61MKII	N		
499	496656.5	4559106.3	238.3934326	159.4851074	74.82398224	498.4548645	mV	EM61MKII	N		
500	496656.6	4559072.9	200.300476	148.7591552	93.41242213	494.2932737	mV	EM61MKII	N		
502	496656.8	4559071.3	168.3615875	123.2928009	71.25492096	397.7996826	mV	EM61MKII	N		
504	496657.1	4559062.7	187.946762	128.2291717	73.16843413	425.8613891	mV	EM61MKII	N		

505	496657.2	4559062	179.2136841	135.2512818	85.0329056	447.4181824	mV	EM61MKII	N		
506	496657.2	4559086.8	300.2912903	195.3704224	95.37549591	631.8478393	mV	EM61MKII	N		
507	496657.3	4559090.1	80.75969692	50.972702	25.23489378	168.1403808	mV	EM61MKII	N		
508	496657.3	4559064.5	204.7942352	143.2099151	74.89704893	453.7023314	mV	EM61MKII	N		
509	496657.3	4559097.4	73.62155915	47.57390595	23.72447205	155.7877503	mV	EM61MKII	N		
511	496657.6	4559089.3	53.7987442	37.54860687	22.03198242	125.6011658	mV	EM61MKII	N		
512	496657.7	4559080.2	244.2985533	187.0265197	119.7043685	620.6320187	mV	EM61MKII	N		
513	496657.8	4559105.9	29.46368977	16.63403318	6.024948588	53.76297372	mV	EM61MKII	N		
514	496657.8	4559117.6	14.48254967	10.02005005	5.902496815	33.10678482	mV	EM61MKII	N		
515	496657.9	4559090.6	75.3509445	46.37707519	22.3846817	153.0896606	mV	EM61MKII	N		
517	496658	4559078.6	216.8827209	171.0823364	93.14727018	523.5563963	mV	EM61MKII	N		
518	496658.3	4559071.4	187.9873504	136.3736267	77.8657684	440.2909239	mV	EM61MKII	N		
519	496658.4	4559081.4	227.4723282	146.9571571	73.64039993	478.7799682	mV	EM61MKII	N		
520	496658.4	4559080.6	192.635971	109.1789703	42.7527275	355.4160156	mV	EM61MKII	N		
521	496658.4	4559100.5	2293.912842	1546.118286	849.360962	5116.849121	mV	EM61MKII	N		
522	496658.5	4559099.3	269.9240417	167.6292877	75.54399109	537.6016846	mV	EM61MKII	N		
523	496658.6	4559085.9	341.4669953	210.9406281	104.9685746	690.2330324	mV	EM61MKII	N		
524	496658.6	4559103.1	1401.859131	972.0112916	567.5726318	3236.791748	mV	EM61MKII	N		
525	496658.6	4559107.5	26.99025534	19.46836852	10.66795348	62.05102917	mV	EM61MKII	N		
526	496658.7	4559082.5	323.037628	198.5792998	82.30457302	626.7173459	mV	EM61MKII	N		
527	496658.7	4559074.6	198.3524932	143.3552245	80.36399837	464.1253049	mV	EM61MKII	N		
528	496658.9	4559076.9	279.130249	180.159256	90.38586424	587.4437865	mV	EM61MKII	N		
529	496659	4559096	23.99695396	14.7778778	7.580002305	49.73801039	mV	EM61MKII	N		
530	496659	4559078.9	416.7168578	271.7306213	135.1281585	887.8790891	mV	EM61MKII	N		
531	496659	4559119.4	20.14229393	12.13594055	5.616569996	39.58169938	mV	EM61MKII	N		
532	496659.1	4559062	186.0829315	117.3595199	56.84105681	383.488861	mV	EM61MKII	N		
533	496659.1	4559091.2	89.36334989	52.16741942	23.71240997	173.0090026	mV	EM61MKII	N		
534	496659.6	4559063.8	507.0163267	369.3912962	227.0950774	1226.516418	mV	EM61MKII	N		
535	496659.7	4559092.8	70.348198	46.20232779	27.98187641	156.9963076	mV	EM61MKII	N		
536	496659.7	4559084.9	288.4520569	199.8701935	104.3025589	635.2335206	mV	EM61MKII	N		
537	496659.8	4559061.3	101.4693222	63.97554016	31.99234009	212.2062378	mV	EM61MKII	N		
538	496659.8	4559097.4	126.9235992	61.4385452	13.88761901	202.5777587	mV	EM61MKII	N		
539	496660	4559074.4	93.55181119	72.87294766	42.76214216	230.41687	mV	EM61MKII	N		
540	496660	4559072.4	74.65483852	49.44290921	26.4478607	163.0542602	mV	EM61MKII	N		
542	496660.1	4559107.3	9372.581052	9257.774411	6765.14697	27886.51757	mV	EM61MKII	N		
543	496660.2	4559066.3	1616.230103	934.3300781	374.20578	3019.116211	mV	EM61MKII	N		
544	496660.2	4559098.2	41.05426788	22.7753601	8.969467158	74.3991699	mV	EM61MKII	N		
545	496660.4	4559079.6	658.8435056	448.01947	235.7317504	1457.514892	mV	EM61MKII	N		
546	496660.4	4559100.1	544.100891	350.9307555	175.2695007	1145.711548	mV	EM61MKII	N		
548	496660.6	4559091	59.31261442	30.29636382	11.12350463	103.995697	mV	EM61MKII	N		
550	496660.8	4559062.8	158.9831085	103.2896576	56.27620029	343.2190933	mV	EM61MKII	N		
551	496660.8	4559084.8	140.09758	93.60639954	45.87456131	296.2345276	mV	EM61MKII	N		
552	496660.8	4559077.8	112.8232498	68.51071167	32.9757309	229.4286499	mV	EM61MKII	N		
553	496661	4559088	71.79245759	41.49281311	18.99295807	139.912323	mV	EM61MKII	N		
554	496661	4559107.8	44.6618576	64.26916504	82.44103241	191.5646057	mV	EM61MKII	N		
556	496661.2	4559102.7	3728.851561	2778.645262	1746.083007	9315.604487	mV	EM61MKII	N		
557	496661.2	4559064.3	595.9557495	443.5717773	285.6714477	1496.235718	mV	EM61MKII	N		
558	496661.3	4559100.5	398.5653685	268.1186828	146.3260803	883.2935788	mV	EM61MKII	N		
559	496661.3	4559076.5	57.09009551	43.90944672	25.31359101	139.4066162	mV	EM61MKII	N		

562	496661.4	4559089	118.0365982	70.92687226	36.52032853	242.730774	mV	EM61MKII	N		
563	496661.8	4559104.1	10561.13867	7986.645508	4450.837402	25129.54883	mV	EM61MKII	N		
565	496661.9	4559068.5	160.5227966	114.6193314	69.91792299	384.6077576	mV	EM61MKII	N		
566	496662	4559065.6	357.1545105	270.6218872	175.4555359	901.2793578	mV	EM61MKII	N		
567	496662	4559073	135.2145996	93.74266051	55.43815612	313.7200622	mV	EM61MKII	N		
568	496662.4	4559108	231.9215774	153.0211716	87.59086228	520.5657043	mV	EM61MKII	N		
569	496662.4	4559101.9	57.60237882	36.72364043	18.00611114	119.3538818	mV	EM61MKII	N		
570	496662.5	4559085.4	173.7653655	116.4956283	58.99163433	374.1338499	mV	EM61MKII	N		
571	496662.7	4559088.4	139.2789612	86.00115966	36.3432579	272.888916	mV	EM61MKII	N		
573	496662.8	4559091.2	52.69155118	37.32932279	21.44950103	123.3531799	mV	EM61MKII	N		
574	496662.8	4559086.1	190.3971711	132.3473359	69.77796175	427.9187929	mV	EM61MKII	N		
575	496662.9	4559067.9	399.9295042	262.6246184	141.0276717	869.8450008	mV	EM61MKII	N		
577	496663	4559109.3	65.65251923	41.40921783	20.59033966	136.7009583	mV	EM61MKII	N		
578	496663.1	4559063.5	308.6171568	221.5993651	128.7100982	727.3278195	mV	EM61MKII	N		
579	496663.1	4559066.7	215.9118803	160.9041136	94.58675378	524.6898189	mV	EM61MKII	N		
580	496663.1	4559110.9	13.98015404	9.261489866	4.745705126	30.12826728	mV	EM61MKII	N		
581	496663.3	4559070.5	3049.22876	2084.005859	1159.941772	6814.337402	mV	EM61MKII	N		
582	496663.3	4559065.1	653.3027342	421.1054991	210.6525878	1362.953979	mV	EM61MKII	N		
583	496663.6	4559121.6	14.35840416	9.269180296	4.912491321	30.26226997	mV	EM61MKII	N		
584	496663.6	4559104.6	153.9181976	108.4897308	65.11708067	358.7268065	mV	EM61MKII	N		
585	496663.6	4559072.5	184.3003234	117.5752258	49.56848906	362.0344236	mV	EM61MKII	N		
586	496663.7	4559113.9	50.83522795	29.36326217	12.93391037	97.15321347	mV	EM61MKII	N		
588	496664	4559091.1	119.227684	87.39227294	52.66281128	286.8951416	mV	EM61MKII	N		
589	496664	4559102.7	246.4955444	165.0653534	92.21935273	547.5703125	mV	EM61MKII	N		
590	496664.1	4559075	341.0440978	249.7399291	146.6759032	813.7127072	mV	EM61MKII	N		
591	496664.1	4559063.1	132.6424255	95.01213834	58.61997221	318.2488403	mV	EM61MKII	N		
592	496664.2	4559073.2	189.9683074	142.2649993	85.68386074	464.4227903	mV	EM61MKII	N		
593	496664.3	4559121.7	12.3172512	8.195877074	4.541512012	26.7251606	mV	EM61MKII	N		
594	496664.5	4559106.7	115.8591995	81.42717743	44.52745056	260.8409119	mV	EM61MKII	N		
595	496664.8	4559110.9	28.32140159	20.41726684	11.37071991	65.97863768	mV	EM61MKII	N		
596	496664.8	4559123.2	26.26691245	18.00450134	10.87004852	60.3404579	mV	EM61MKII	N		
597	496664.8	4559102.5	146.1359711	104.616211	64.26049042	347.8279419	mV	EM61MKII	N		
599	496664.9	4559069.2	133.9204253	91.11222833	50.63605114	297.7350462	mV	EM61MKII	N		
600	496665	4559071.2	1089.169189	753.4288939	411.5433654	2424.457031	mV	EM61MKII	N		
601	496665	4559087	260.1745605	171.8618927	87.85070799	550.7010497	mV	EM61MKII	N		
602	496665.1	4559100.2	389.5289611	232.3029784	108.3116302	772.0059202	mV	EM61MKII	N		
603	496665.1	4559121.6	15.08420372	10.00119019	5.573570729	32.88861466	mV	EM61MKII	N		
604	496665.1	4559089.9	258.2460021	186.0461883	92.66921992	566.1240231	mV	EM61MKII	N		
605	496665.1	4559087.9	251.2560501	165.1821899	86.91261672	537.6589966	mV	EM61MKII	N		
606	496665.1	4559065.5	112.5909577	60.70246889	24.04262543	203.5039368	mV	EM61MKII	N		
607	496665.4	4559113.8	17.88106346	15.92192077	11.8180542	53.37118911	mV	EM61MKII	N		
608	496665.5	4559074.8	208.8339996	153.2290039	91.93635559	505.3253479	mV	EM61MKII	N		
610	496665.6	4559066	118.777893	86.88354488	51.66706465	287.5889586	mV	EM61MKII	N		
611	496665.6	4559065	89.92572777	64.08849329	34.40623852	204.5051573	mV	EM61MKII	N		
612	496665.7	4559068.7	167.916931	121.678276	69.21093746	388.7250669	mV	EM61MKII	N		
613	496665.8	4559106.2	61.16944117	46.09471127	25.47935484	144.625122	mV	EM61MKII	N		
614	496665.8	4559108	42.6857376	29.17985534	15.15486908	93.35153196	mV	EM61MKII	N		
615	496665.9	4559121.6	14.92856407	9.526977539	4.847916126	30.99899483	mV	EM61MKII	N		
617	496666.1	4559090.8	195.6400604	157.088089	99.75928496	506.075592	mV	EM61MKII	N		

618	496666.2	4559114	7.284597388	8.10916137	6.663994306	27.00729558	mV	EM61MKII	N		
619	496666.6	4559099.3	51.50540924	26.51519775	8.106330872	89.40185546	mV	EM61MKII	N		
620	496666.8	4559064.7	188.6011353	134.6226501	80.15344239	445.4295044	mV	EM61MKII	N		
622	496667.2	4559110.2	81.34229279	55.37181092	31.19323349	183.712616	mV	EM61MKII	N		
623	496667.3	4559095.8	124.8281174	81.08901597	44.62029744	269.3835449	mV	EM61MKII	N		
624	496667.3	4559092.4	110.1991882	70.58679199	35.35380173	232.0601807	mV	EM61MKII	N		
625	496667.4	4559090.2	16.45999717	11.48025512	6.386673452	36.87808608	mV	EM61MKII	N		
629	496667.8	4559123.8	25.28888512	18.15406799	11.133255	60.72311783	mV	EM61MKII	N		
630	496668	4559111.8	768.0592041	539.3598022	290.6120911	1712.834473	mV	EM61MKII	N		
631	496668	4559098.8	19.02916527	9.991378784	4.470787525	34.87894058	mV	EM61MKII	N		
632	496668.1	4559076.7	102.0285339	85.80115507	60.69563673	288.6665038	mV	EM61MKII	N		
633	496668.1	4559064.5	14.59218405	15.60954283	11.92554473	50.15851207	mV	EM61MKII	N		
634	496668.2	4559065.6	57.16924279	42.26553339	25.92213818	139.822296	mV	EM61MKII	N		
635	496668.4	4559122.9	15.69644737	11.87818908	8.277542113	41.08102798	mV	EM61MKII	N		
637	496668.6	4559109.9	72.06720729	47.0059509	23.60984038	149.8654479	mV	EM61MKII	N		
638	496668.7	4559104.5	58.00376128	31.89803314	12.59899139	107.7351074	mV	EM61MKII	N		
639	496668.7	4559077.8	78.51648712	52.16027832	27.71440506	171.784668	mV	EM61MKII	N		
641	496669.1	4559121.9	14.72641564	8.846649171	3.7149508	28.51529122	mV	EM61MKII	N		
642	496669.4	4559101.2	118.6411438	78.24900054	41.64946365	256.7107544	mV	EM61MKII	N		
643	496669.6	4559107.2	277.0189819	197.9561157	118.0143356	658.0806274	mV	EM61MKII	N		
644	496669.7	4559103.4	95.24807358	52.03230286	20.16074181	172.4430466	mV	EM61MKII	N		
645	496669.7	4559099.5	17.51445578	12.06779479	6.985695357	39.82513806	mV	EM61MKII	N		
647	496670	4559109.1	244.6982728	157.5234528	80.60799411	517.9055177	mV	EM61MKII	N		
649	496670.3	4559109.9	440.3110046	315.6393432	194.3974304	1065.581054	mV	EM61MKII	N		
650	496670.3	4559103	103.6387786	58.06418607	24.8643875	192.670227	mV	EM61MKII	N		
651	496670.5	4559108	44.76029202	39.64609525	28.11960981	132.4426879	mV	EM61MKII	N		
653	496671.1	4559100.1	46.39308927	30.0875778	13.50875854	94.69110101	mV	EM61MKII	N		
654	496671.1	4559105.8	89.13333893	60.76994324	33.78598022	199.6503296	mV	EM61MKII	N		
655	496671.4	4559116.4	2106.089356	1352.861817	689.2895814	4400.647218	mV	EM61MKII	N		
657	496671.4	4559113.6	185.4382629	125.6695251	66.75435635	408.6272886	mV	EM61MKII	N		
658	496671.6	4559109.6	338.5210725	204.9783784	97.72821428	685.0048525	mV	EM61MKII	N		
660	496671.7	4559104.5	77.22661589	55.00682067	34.1047821	182.91333	mV	EM61MKII	N		
661	496671.8	4559107.8	38.23300934	25.09133911	12.81601715	82.30145264	mV	EM61MKII	N		
662	496672	4559105.5	84.55347443	57.23052979	30.00360107	185.5640259	mV	EM61MKII	N		
663	496672.2	4559120.1	17.00017357	12.24299621	7.952293869	42.00125502	mV	EM61MKII	N		
664	496672.2	4559111.1	866.2338865	560.5474241	281.8424377	1815.596313	mV	EM61MKII	N		
665	496672.6	4559103.3	97.11425781	68.29769897	38.74822235	220.992279	mV	EM61MKII	N		
666	496672.8	4559110.3	297.3469699	222.5896913	146.9354172	746.5132756	mV	EM61MKII	N		
667	496672.8	4559107.3	23.69826317	15.01145935	7.176285266	48.6508522	mV	EM61MKII	N		
668	496673.1	4559113.6	373.3246763	277.2084349	168.6385345	912.8525996	mV	EM61MKII	N		
669	496673.2	4559108.9	1259.387573	915.5285643	551.8695067	3022.08081	mV	EM61MKII	N		
670	496673.2	4559118.7	37.51905058	27.02586364	15.48171234	88.612915	mV	EM61MKII	N		
671	496673.2	4559120	560.1699825	398.7540586	240.8542174	1327.630858	mV	EM61MKII	N		
672	496673.3	4559121.6	28.45186423	19.72714233	11.85432434	65.53887937	mV	EM61MKII	N		
673	496673.5	4559127.1	14.1276226	9.612182612	4.708874223	32.11183451	mV	EM61MKII	N		
674	496673.7	4559100.8	12.75411034	8.929626465	4.521820545	28.29910469	mV	EM61MKII	N		
675	496673.8	4559107.8	119.9104614	83.37744903	49.51513672	275.6121521	mV	EM61MKII	N		
676	496673.9	4559067.5	63.98807521	43.89743039	22.3933792	140.8619384	mV	EM61MKII	N		
677	496674	4559080	337.8039551	229.758667	119.8289795	737.7055664	mV	EM61MKII	N		

678	496674.1	4559068.7	36.10338587	24.05541988	13.41810606	80.21887194	mV	EM61MKII	N			
681	496674.3	4559097.2	64.97052765	34.42517852	13.8665924	117.785614	mV	EM61MKII	N			
682	496674.4	4559127.5	10.02218437	12.73149871	6.871162888	34.18718289	mV	EM61MKII	N			
683	496674.4	4559112.3	1283.598022	828.982605	414.6709595	2685.010742	mV	EM61MKII	N			
684	496674.5	4559104	16.30910299	11.33557127	5 83310746	35.77099985	mV	EM61MKII	N			
685	496674.6	4559105.1	34.97057344	28.60298157	19.18821715	93.8381958	mV	EM61MKII	N			
686	496674.6	4559101.8	175.3403015	118.8658981	66.99672699	395.8607788	mV	EM61MKII	N			
687	496674.6	4559115.6	513.1831052	382.3794554	228.9471892	1251.41101	mV	EM61MKII	N			
688	496674.7	4559080.3	314.0596313	233.3314514	144.61409	765.9810791	mV	EM61MKII	N			
689	496674.7	4559117.3	62.84270477	42.09384918	20.68849945	131.4015503	mV	EM61MKII	N			
690	496674.7	4559106.6	596.2433461	439.9976188	276.2789607	1466.147702	mV	EM61MKII	N			
691	496674.8	4559095.1	30.76965902	12.36206054	-1.148780462	38.19086073	mV	EM61MKII	N			
692	496674.8	4559109.2	178.9276122	134.6312255	76.1499023	430.4793089	mV	EM61MKII	N			
693	496675	4559108.2	462.2380063	331.4530637	199.2492522	1099.487182	mV	EM61MKII	N			
694	496675.1	4559127.7	12.32243919	14.07575988	7.266941542	37.37253186	mV	EM61MKII	N			
695	496675.1	4559113.2	433.4241026	312.4687804	182.2240447	1027.264526	mV	EM61MKII	N			
696	496675.2	4559068.6	142.0931243	104.0683288	63.38145826	344.536621	mV	EM61MKII	N			
697	496675.2	4559119.4	462.8068847	309.6820678	155.0983276	983.660217	mV	EM61MKII	N			
698	496675.3	4559102.8	300.3220978	204.3446274	121.2607002	684.9067993	mV	EM61MKII	N			
699	496675.3	4559098.3	15.90447044	8.685760498	3 685142755	29.48935127	mV	EM61MKII	N			
700	496675.3	4559104.4	44.4201431	31.43611906	18.55387114	102.3576659	mV	EM61MKII	N			
701	496675.4	4559080.5	238.6231231	167.0972137	101.4342804	561.314636	mV	EM61MKII	N			
702	496675.4	4559116	577.2458495	419.8998413	253.6565704	1384.616577	mV	EM61MKII	N			
703	496675.9	4559115	282.059967	199.517868	112.6434936	645.0655517	mV	EM61MKII	N			
704	496676	4559120	892.8702388	600.7963864	292.9721678	1874.249755	mV	EM61MKII	N			
705	496676.2	4559116.3	612.3995972	449.8896179	275.9654236	1484.984619	mV	EM61MKII	N			
706	496676.3	4559098.7	13.40416526	8.077713009	3.055519341	25.27841376	mV	EM61MKII	N			
707	496676.3	4559104.7	195.191574	122.2121734	55.71091459	390.937805	mV	EM61MKII	N			
708	496676.4	4559109.7	974.6450195	717.0337524	426.7667236	2350.835937	mV	EM61MKII	N			
711	496676.7	4559103.2	51.24897004	28.39450074	12.06049347	94.63073732	mV	EM61MKII	N			
712	496676.8	4559128.1	20.45409202	14.09616089	7.808411119	45.92267226	mV	EM61MKII	N			
713	496676.9	4559109	1115.431519	819.4212647	503.4698486	2708.155273	mV	EM61MKII	N			
714	496677	4559101.5	19.87973591	14.15493772	8.103095991	45.60647955	mV	EM61MKII	N			
715	496677.4	4559113.7	322.4547119	227.8707733	135.1468048	756.4771118	mV	EM61MKII	N			
716	496677.6	4559098.1	26.94383813	16.8757782	6.700317862	53.33084489	mV	EM61MKII	N			
717	496677.7	4559110.8	220.9520111	139.9809265	63.11274338	448.28302	mV	EM61MKII	N			
718	496678	4559102.6	11.5639553	8.705459588	4.175644394	26.26776312	mV	EM61MKII	N			
719	496678.4	4559111.9	201.9493409	141.6679535	79.36023334	460.6267397	mV	EM61MKII	N			
721	496678.6	4559108.4	1121.262146	683.276703	327.6519776	2228.046875	mV	EM61MKII	N			
722	496678.6	4559109.9	574.9044799	409.2879943	234 8361205	1335.192871	mV	EM61MKII	N			
723	496678.7	4559115.3	204.4193268	145.0922241	85.08312988	476.738739	mV	EM61MKII	N			
726	496678.9	4559113.2	118.6892318	78.32656095	39.37005614	255.5111083	mV	EM61MKII	N			
727	496679.3	4559121.1	644.6102904	431.6995849	217.782135	1374.991699	mV	EM61MKII	N			
728	496679.5	4559111.6	230.9272309	187.939148	134 3375244	640.2974244	mV	EM61MKII	N			
729	496679.7	4559112.7	62.61441802	50.0372467	30.45602798	159.3866272	mV	EM61MKII	N			
730	496679.7	4559117	59.39322658	46.76392362	31.19791792	157.4569396	mV	EM61MKII	N			
731	496679.7	4559105	1041.677734	672.104309	347.6956176	2209.472412	mV	EM61MKII	N			
732	496679.8	4559070.5	81.07263945	52.06344603	23.92338561	166.5978698	mV	EM61MKII	N			
733	496679.9	4559107.2	112.5411911	84.00349425	48.09500121	271.457489	mV	EM61MKII	N			

734	496680.3	4559119	149.8014068	95.74009704	47.36177444	310.4953003	mV	EM61MKII	N		
735	496680.4	4559070.9	80.45732875	53.58900448	28.29019163	175.9845885	mV	EM61MKII	N		
736	496680.5	4559130	21.36723898	15.6600952	9.156494135	50.1908302	mV	EM61MKII	N		
737	496680.5	4559111.3	161.8497467	128.5141296	90.94133758	441.2250366	mV	EM61MKII	N		
738	496680.5	4559120.5	32.26755523	20.53529358	8.839157103	63.88702773	mV	EM61MKII	N		
740	496681.1	4559110.7	360.716583	271.9975584	165.4773406	889.6118768	mV	EM61MKII	N		
741	496681.2	4559071.7	5.657857888	9.100906365	2.021240462	29.90689275	mV	EM61MKII	N		
743	496681.3	4559115.7	1000.863037	733.6544187	443.2576292	2402.868163	mV	EM61MKII	N		
744	496681.4	4559117.5	214.0876005	154.0675505	95.67243947	517.8626093	mV	EM61MKII	N		
745	496681.4	4559070.8	59.19316862	43.78783416	28.3292694	145.8205261	mV	EM61MKII	N		
746	496681.6	4559123.1	2509.340819	1587.975829	711.8309932	5009.248532	mV	EM61MKII	N		
747	496681.7	4559109.5	187.1247558	144.5927124	89.08168026	472.0473631	mV	EM61MKII	N		
749	496681.9	4559099.5	216.2375184	154.2902375	98.97291567	516.9865114	mV	EM61MKII	N		
751	496682.4	4559071.7	174.520233	118.4267196	69.22762292	398.2002255	mV	EM61MKII	N		
752	496682.4	4559112.6	330.4958801	196.3443756	86.95446775	642.9434813	mV	EM61MKII	N		
753	496682.9	4559110.7	1500.293945	1114.278076	693.8302001	3691.864745	mV	EM61MKII	N		
754	496683	4559105.7	579.7068481	419.1040039	251.4512634	1379.568237	mV	EM61MKII	N		
755	496683.1	4559125.3	695.7272949	454.9228821	231.8609161	1476.428589	mV	EM61MKII	N		
756	496683.2	4559098.5	15.56686972	13.27149962	4.496429913	36.1083717	mV	EM61MKII	N		
758	496683.9	4559115.7	768.6221923	576.3182983	362.2530822	1912.423096	mV	EM61MKII	N		
759	496684	4559120.5	56.7065048	42.94548033	26.71183776	141.4075622	mV	EM61MKII	N		
760	496684	4559117.4	437.2675169	298.3361205	165.2758178	983.8964839	mV	EM61MKII	N		
761	496684	4559123	701.9871823	478.7577818	231.7487487	1502.980224	mV	EM61MKII	N		
762	496684.1	4559109.4	219.1922606	161.6824798	96.59336845	530.1770626	mV	EM61MKII	N		
763	496684.1	4559100.4	1046.573486	689.6638792	388.1287841	2319.130859	mV	EM61MKII	N		
764	496684.2	4559108.3	611.4252319	433.4780579	256.7338562	1428.786621	mV	EM61MKII	N		
765	496684.4	4559101.1	708.1585693	473.643219	279.4217834	1605.028809	mV	EM61MKII	N		
766	496684.5	4559071.8	112.4321823	80.96000671	47.00831604	264.6487427	mV	EM61MKII	N		
767	496684.8	4559103.9	34.49913788	22.90782166	12.28291893	74.40307617	mV	EM61MKII	N		
768	496684.9	4559112.2	194.4197845	130.8448333	67.66927335	418.2507018	mV	EM61MKII	N		
769	496684.9	4559120.1	35.47306061	25.33444213	15.95568847	85.72991942	mV	EM61MKII	N		
770	496685.2	4559115	191.9067231	143.3729553	88.65380098	472.4758607	mV	EM61MKII	N		
771	496685.2	4559073.4	83.05295555	50.22595211	3.019638318	143.5325927	mV	EM61MKII	N		
773	496685.3	4559129.6	31.55602073	20.96643066	11.73590088	70.09786987	mV	EM61MKII	N		
775	496685.5	4559115.8	416.8461304	310.4521179	186.4565887	1011.292236	mV	EM61MKII	N		
776	496685.6	4559126.2	19.45131491	13.32542418	7.853996748	44.48709485	mV	EM61MKII	N		
777	496685.6	4559111.7	266.9994507	185.474884	100.5881272	603.0626221	mV	EM61MKII	N		
778	496685.7	4559117.4	88.3806075	68.37718193	44.2400474	224.3198545	mV	EM61MKII	N		
779	496685.7	4559107.5	19.84717368	13.82626342	8.064399713	44.45087048	mV	EM61MKII	N		
780	496685.8	4559119.4	17.44708824	12.14289856	6.386475085	38.66952896	mV	EM61MKII	N		
781	496686.1	4559122	17.31775473	13.46496581	8.528747553	44.24966809	mV	EM61MKII	N		
782	496686.2	4559101.3	33.58690596	25.1639061	16.07197952	83.19958497	mV	EM61MKII	N		
783	496686.4	4559112.8	740.8336791	543.0550536	341.3908081	1816.357422	mV	EM61MKII	N		
784	496686.4	4559126.7	20.12030602	11.77684021	5.564163685	39.47235489	mV	EM61MKII	N		
785	496686.5	4559130.5	15.39980126	10.01264954	5.361656666	33.24829483	mV	EM61MKII	N		
786	496686.5	4559113.6	481.3760375	369.4256896	236.6431121	1223.179931	mV	EM61MKII	N		
788	496686.8	4559118.1	80.9197311	57.38529202	28.51937483	177.5721129	mV	EM61MKII	N		
789	496687	4559107.5	53.96305084	36.15761566	19.76810455	119.2523498	mV	EM61MKII	N		
790	496687	4559071.6	372.1210022	276.382843	172.4990539	916.3366699	mV	EM61MKII	N		

791	496687.3	4559130.8	16.3161068	10.44979858	5.573883533	35.0699501	mV	EM61MKII	N		
792	496687.3	4559116.7	199.486908	137.7439346	81.00118637	455.9908905	mV	EM61MKII	N		
793	496687.6	4559103.3	46.40296173	25.89595031	10.07731628	85.07373046	mV	EM61MKII	N		
794	496687.8	4559105.1	29.51602746	19.00811768	8.902809145	60.58063127	mV	EM61MKII	N		
795	496688	4559116	222.9379425	163.8960724	95.44396211	532.7254029	mV	EM61MKII	N		
796	496688.1	4559106	33.68558501	21.13746642	10.5458374	69.38558957	mV	EM61MKII	N		
797	496688.3	4559073.5	165.5802155	120.1152268	74.23856354	397.5829163	mV	EM61MKII	N		
799	496688.4	4559107	35.81909941	23.24084471	11.6120758	75.44888302	mV	EM61MKII	N		
800	496688.5	4559102.1	43.25167083	24.41792297	10.7437973	82.17401121	mV	EM61MKII	N		
802	496688.6	4559113.8	115.5513535	54.81967163	16.36435699	189.6752624	mV	EM61MKII	N		
803	496688.7	4559121.8	321.5201721	155.6836853	37.73364639	519.0113525	mV	EM61MKII	N		
804	496688.8	4559109.2	67.60431669	44.35895537	29.52010153	156.5399169	mV	EM61MKII	N		
805	496688.8	4559120.5	102.1719055	67.58872221	38.02778624	228.5238952	mV	EM61MKII	N		
806	496689	4559131.5	27.48375511	16.35357665	7.763115403	54.68405531	mV	EM61MKII	N		
808	496689.2	4559112	1284.87915	901.3920287	529.982788	2990.514404	mV	EM61MKII	N		
809	496689.2	4559132.9	83.72785186	56.17328644	31.31632232	185.9838715	mV	EM61MKII	N		
811	496689.4	4559125.8	175.6526794	133.0686493	90.40385436	448.6334533	mV	EM61MKII	N		
812	496689.6	4559119.2	129.9136199	85.57065578	40.89166257	269.9514769	mV	EM61MKII	N		
813	496689.8	4559073.8	348.3153686	261.7568359	171.9430695	883.7849731	mV	EM61MKII	N		
814	496690	4559102.6	18.66428183	14.30068969	9.180145264	47.23718641	mV	EM61MKII	N		
815	496690	4559110.9	445.1452637	302.622467	165.140152	992.3916626	mV	EM61MKII	N		
816	496690.1	4559122.9	89.91796107	41.77896879	11.25839996	145.4729613	mV	EM61MKII	N		
817	496690.1	4559127.1	48.01683799	23.69697565	5.948006125	78.41253644	mV	EM61MKII	N		
818	496690.8	4559113.8	375.828949	248.4263306	127.1199417	807.4549561	mV	EM61MKII	N		
819	496690.9	4559116.3	76.37210846	52.23644257	32.45715332	179.3368225	mV	EM61MKII	N		
820	496691	4559108.1	57.26717376	37.10525513	18.16819	118.669281	mV	EM61MKII	N		
821	496691.1	4559135.5	1137.555297	803.0760492	455.8036801	2590.98535	mV	EM61MKII	N		
822	496691.3	4559115.5	91.82913971	63.35391235	39.21354675	214.7242126	mV	EM61MKII	N		
823	496691.5	4559117.3	179.3969269	105.3488388	41.37657165	337.1313782	mV	EM61MKII	N		
824	496691.9	4559129	40.09400178	25.34606934	10.6474495	78.49755862	mV	EM61MKII	N		
826	496692.4	4559112.2	41.11264799	30.61563872	16.69548034	94.77200313	mV	EM61MKII	N		
827	496692.4	4559118.7	113.83358	78.11640168	37.84662629	241.7215882	mV	EM61MKII	N		
828	496692.5	4559126.6	1546.095947	1012.13916	495.879547	3236.094238	mV	EM61MKII	N		
829	496692.6	4559119.7	50.75193024	34.33545685	15.85185242	106.2659302	mV	EM61MKII	N		
830	496692.7	4559106.8	16.80563927	10.81210327	4.764786243	33.77136612	mV	EM61MKII	N		
831	496693	4559076.4	241.3534087	166.1480559	93.40273279	544.7205197	mV	EM61MKII	N		
832	496693.1	4559121.1	300.2479857	193.9490051	91.46057889	612.0585325	mV	EM61MKII	N		
833	496693.1	4559074.4	16.48628805	15.26811217	10.12324523	46.94260021	mV	EM61MKII	N		
834	496693.6	4559106.4	22.67149925	14.07385254	5.959969044	44.58633805	mV	EM61MKII	N		
835	496693.7	4559136.4	877.9911481	624.3429247	320.4847482	1930.170803	mV	EM61MKII	N	noise?	
837	496694	4559076.8	202.5341034	98.69428253	28.54495239	333.176239	mV	EM61MKII	N		
838	496694.1	4559127.2	795.0550539	451.6596986	157.2968445	1435.64148	mV	EM61MKII	N		
839	496694.2	4559127.9	1019.542785	593.3168334	233.5016021	1898.41101	mV	EM61MKII	N		
840	496694.9	4559135.6	35.80301664	25.5036621	14.36211394	84.20755	mV	EM61MKII	N		
841	496695	4559124.4	111.7242928	62.96343231	25.30090904	205.2221069	mV	EM61MKII	N		
842	496695.3	4559075.3	227.8779297	117.3241425	43.6137619	400.6344299	mV	EM61MKII	N		
843	496695.4	4559108	123.5108337	83.35582731	42.09034728	263.0876769	mV	EM61MKII	N		
844	496695.5	4559120.6	887.8334347	589.8148801	324.1601561	1965.484862	mV	EM61MKII	N		
846	496696	4559137.4	30.44814109	20.40060424	10.98237609	66.76443478	mV	EM61MKII	N		

847	496696.2	4559105.1	137.9634704	90.95895383	45.68163679	291.0437621	mV	EM61MKII	N		
849	496696.6	4559126.2	293.212921	208.270584	125.0315856	693.4845578	mV	EM61MKII	N		
850	496696.6	4559076.6	137.8347625	94.35512539	54.55206679	314.222351	mV	EM61MKII	N		
851	496696.7	4559106.8	99.1749649	61.96800995	27.69438553	196.9095154	mV	EM61MKII	N		
852	496696.8	4559128	425.7369385	284.5366516	141.9397736	907.0874024	mV	EM61MKII	N		
853	496697.4	4559106.2	59.03199005	39.51260376	19.26142883	123.681366	mV	EM61MKII	N		
854	496697.7	4559110	32.70151518	22.39634703	11.91843414	72.1922607	mV	EM61MKII	N		
855	496697.9	4559124.5	118.6799774	82.8301315	46.8243141	271.7048034	mV	EM61MKII	N		
856	496698.1	4559137.5	33.01392363	19.70248412	8.875617977	65.08322141	mV	EM61MKII	N		
858	496698.2	4559108.2	47.5166092	32.10407257	15.97315979	101.9046936	mV	EM61MKII	N		
859	496698.4	4559130.7	16.94170188	8.538299555	2.888038873	29.38989447	mV	EM61MKII	N		
860	496698.6	4559079.6	416.0475161	313.5963441	196.8756562	1023.933411	mV	EM61MKII	N		
861	496698.6	4559109.5	17.5489254	12.16983032	5.995262623	38.24121476	mV	EM61MKII	N		
862	496698.7	4559080.4	2786.661138	2368.69434	1735.068485	8033.253922	mV	EM61MKII	N		
863	496699	4559126.2	51.87305449	35.38947295	18.45306396	112.288208	mV	EM61MKII	N		
864	496699	4559078.7	176.0741423	128.5406188	76.3315124	419.0937497	mV	EM61MKII	N		
865	496699.1	4559133.5	38.94284819	29.14031981	17.41757202	95.16152951	mV	EM61MKII	N		
869	496700.2	4559110.1	65.32993316	41.76922607	16.11860656	126.6723327	mV	EM61MKII	N		
870	496700.4	4559092.5	75.94770052	53.43650056	29.23756409	168.7009583	mV	EM61MKII	N		
872	496700.8	4559128.2	11.47867393	8.530685421	5.261497973	28.05420111	mV	EM61MKII	N		
873	496701.1	4559092.7	89.07947545	72.2913132	40.61383822	215.3630982	mV	EM61MKII	N		
875	496701.4	4559079.7	741.5473633	496.688385	258.6455689	1610.223022	mV	EM61MKII	N		
876	496701.5	4559113.1	48.16424559	29.48309707	13.24303246	96.55303954	mV	EM61MKII	N		
877	496701.5	4559108.7	107.039772	75.26376342	37.95800399	232.1005859	mV	EM61MKII	N		
879	496702.2	4559115	518.5250243	316.823822	151.56781	1042.418945	mV	EM61MKII	N		
881	496702.6	4559111.9	19.944952	10.79916381	3.639221428	35.04800794	mV	EM61MKII	N		
882	496702.8	4559080.3	328.254303	182.1039124	72.64151001	601.1307983	mV	EM61MKII	N		
884	496703.4	4559108.6	102.6498718	71.07061004	41.15223312	234.3797912	mV	EM61MKII	N		
885	496703.4	4559138.4	80.25559229	58.22963711	34.26118085	191.6036986	mV	EM61MKII	N		
886	496703.7	4559089.2	177.1864013	144.1201629	94.34772489	466.2905882	mV	EM61MKII	N		
887	496704.4	4559079.5	197.1235657	144.5	87.42388155	476.2648011	mV	EM61MKII	N		
888	496704.4	4559115.3	494.3823547	316.1502075	155.1906433	1030.115234	mV	EM61MKII	N		
889	496704.5	4559109.9	11.70125388	8.415039058	3.928787469	26.51324652	mV	EM61MKII	N		
890	496704.6	4559141.3	85.18140411	57.46987152	33.29513931	192.2373047	mV	EM61MKII	N		
891	496704.7	4559112.8	20.65375333	13.74118046	9.552742017	46.80411158	mV	EM61MKII	N		
892	496704.8	4559080.4	356.9831847	280.2784423	185.0384215	927.3370967	mV	EM61MKII	N		
893	496704.9	4559127.8	195.369873	150.0413361	94.90900421	492.7876282	mV	EM61MKII	N		
894	496705.2	4559139.7	13.76543235	8.740249627	3.822937247	27.44696234	mV	EM61MKII	N		
896	496705.9	4559142.2	37.25151823	27.13970946	16.87312316	89.74383541	mV	EM61MKII	N		
897	496705.9	4559089.5	87.3936386	62.24708555	35.44313429	202.903717	mV	EM61MKII	N		
898	496706	4559141.5	47.63874055	32.13722993	19.05138397	107.5659485	mV	EM61MKII	N		
900	496706.3	4559091.2	72.84570313	46.56647874	20.71108628	147.0341492	mV	EM61MKII	N		
901	496706.4	4559094	59.88271328	44.46371457	22.25918578	135.3595885	mV	EM61MKII	N		
902	496706.5	4559081.1	126.4184875	89.5673599	52.18643187	294.6025695	mV	EM61MKII	N		
904	496706.7	4559110.7	116.0584792	87.89810938	54.36921689	290.1858824	mV	EM61MKII	N		
905	496706.9	4559141.5	36.24839019	25.07801818	14.31208038	83.09371946	mV	EM61MKII	N		
908	496707.6	4559114.2	84.2304916	58.01956174	33.53622053	190.8472899	mV	EM61MKII	N		
909	496707.6	4559115.6	1025.739868	725.013672	408.6816101	2336.247315	mV	EM61MKII	N		
910	496707.9	4559128.5	1761.621826	1165.571411	657.8813476	3900.942627	mV	EM61MKII	N		

911	496707.9	4559142.4	14.78520775	8.979583742	4.555099965	30.05923653	mV	EM61MKII	N		
912	496708.1	4559090.4	133.0361938	79.84465785	35.41833113	262.3733519	mV	EM61MKII	N		
914	496708.6	4559136.2	47.30564114	35.81293485	20.8940811	115.6239623	mV	EM61MKII	N		
915	496709.1	4559113.7	35.81388091	20.13839721	6.971634385	63.96969983	mV	EM61MKII	N		
916	496709.8	4559121.1	1646.077026	1176.56897	660.3215331	3775.773925	mV	EM61MKII	N		
917	496709.8	4559116	48.56951141	32.48633575	18.95820618	109.2236328	mV	EM61MKII	N		
918	496710.1	4559112.2	69.29819488	40.53668976	17.37446594	132.5045776	mV	EM61MKII	N		
920	496710.5	4559117.6	76.41721344	51.20142365	27.93363571	168.0363464	mV	EM61MKII	N		
921	496710.5	4559110.9	106.1877746	61.51512142	22.86776732	195.6434935	mV	EM61MKII	N		
922	496710.6	4559143.2	23.07896994	14.48825072	5.8609395	44.98614881	mV	EM61MKII	N		
923	496710.8	4559139.8	47.31092071	30.13368988	15.34955597	99.13418579	mV	EM61MKII	N		
924	496710.8	4559130	99.38640591	61.71360777	30.11072158	203.9820861	mV	EM61MKII	N		
926	496711.3	4559108.4	122.7803192	77.69731901	39.57643889	256.9126281	mV	EM61MKII	N		
928	496711.5	4559121.7	871.3698729	604.9986572	331.0295105	1943.576294	mV	EM61MKII	N		
929	496712	4559114	50.85219573	36.0268936	20.88639068	119.0808105	mV	EM61MKII	N		
930	496712	4559107.9	157.96315	99.24423976	51.4049072	333.4764098	mV	EM61MKII	N		
931	496712.3	4559122.4	808.1194454	574.703735	323.9060973	1848.566039	mV	EM61MKII	N		
932	496712.7	4559116.3	66.10250092	40.90694427	19.64440918	134.1042175	mV	EM61MKII	N		
933	496712.8	4559109.1	65.28517913	42.38497924	24.24829864	143.2793884	mV	EM61MKII	N		
934	496712.8	4559142.7	38.83396148	27.53060913	16.42810058	91.53945922	mV	EM61MKII	N		
936	496713.1	4559138.8	15.62833214	9.435119629	4.236549854	31.167696	mV	EM61MKII	N		
937	496713.1	4559110.4	317.6233519	192.3232574	93.26645656	640.1394651	mV	EM61MKII	N		
938	496713.3	4559082.6	47.39336395	36.51560211	23.08227539	120.9272461	mV	EM61MKII	N		
939	496713.6	4559116.3	60.31702423	37.35597229	18.29838562	123.666626	mV	EM61MKII	N		
941	496714	4559099.1	134.3195495	99.26931756	53.15931697	307.5343626	mV	EM61MKII	N		
942	496714.1	4559132.3	20.34810448	8.491348267	1.568687797	30.06225777	mV	EM61MKII	N		
943	496714.3	4559092.8	80.3816452	54.57151032	34.54833603	189.796875	mV	EM61MKII	N		
944	496714.4	4559145.7	83.39322662	60.36303711	36.19000244	199.9028625	mV	EM61MKII	N		
946	496714.9	4559120	80.66002653	49.79709624	24.34388732	164.6854858	mV	EM61MKII	N		
947	496715.3	4559108.1	86.26517482	61.1282272	31.46728132	193.0981139	mV	EM61MKII	N		
948	496715.4	4559101.3	64.87741851	43.41284942	18.95189667	137.1925659	mV	EM61MKII	N		
949	496715.6	4559113.8	22.24660301	15.82177734	9 28426361	51.97400284	mV	EM61MKII	N		
950	496715.7	4559108.8	34.29177094	23.6615448	13.33696747	77.94869995	mV	EM61MKII	N		
953	496715.9	4559133.7	124.8558807	72.9972	28.56838989	233.4949645	mV	EM61MKII	N		
954	496716	4559109.6	16.58670615	11.04145813	6.240837573	37.08008192	mV	EM61MKII	N		
955	496716.1	4559123	110.6456451	78.52261351	47.63873671	262.1200866	mV	EM61MKII	N		
956	496716.1	4559134.5	109.4957122	64.62180326	26.92100905	207.4727172	mV	EM61MKII	N		
958	496716.4	4559129.4	18.62711142	13.45204161	7.733299726	43.62790295	mV	EM61MKII	N		
959	496716.4	4559131.8	33.71651459	27.18258667	18.54647827	90.48678588	mV	EM61MKII	N		
960	496716.6	4559145.4	15.6023922	9.72454834	4.756592274	32.19348526	mV	EM61MKII	N		
961	496716.7	4559141.5	21.34860802	11.62055969	4.752937795	39.43329239	mV	EM61MKII	N		
962	496716.7	4559100.2	468.1820982	284.301361	107.803154	881.2512204	mV	EM61MKII	N		
963	496716.8	4559111.1	40.73122404	27.04870604	14.342247	88.77001948	mV	EM61MKII	N		
964	496716.9	4559106.1	145.4060516	101.6053238	57.24858856	333.4599609	mV	EM61MKII	N		
965	496717.2	4559131.2	41.83179855	29.01338767	13.97830009	92.85778806	mV	EM61MKII	N		
966	496717.2	4559125.7	23.55669212	14.30317688	6.590347767	46.71713638	mV	EM61MKII	N		
967	496717.3	4559098.3	85.25205231	51.22023773	20.75330353	163.6458435	mV	EM61MKII	N		
968	496717.3	4559108.7	337.7064208	228.9018706	126.0157241	753.8618161	mV	EM61MKII	N		
969	496717.3	4559146.9	45.20244597	27.39460754	13.58994293	91.42187498	mV	EM61MKII	N		

970	496717.3	4559127	116.8552247	60.5542145	21.25548554	202.908783	mV	EM61MKII	N		
972	496717.6	4559101.6	162.0616607	89.03820799	31.4676361	289.6746826	mV	EM61MKII	N		
973	496717.8	4559128.9	1030.558472	753.6108398	430.0375977	2416.887695	mV	EM61MKII	N		
974	496717.9	4559129.8	418.2168368	321.6646436	195.4642074	1031.234837	mV	EM61MKII	N		
975	496717.9	4559119.2	12.71083641	8.312622068	3.750923394	25.70132636	mV	EM61MKII	N		
976	496717.9	4559133.7	2889.236083	1862.678832	1006.484375	6227.826169	mV	EM61MKII	N		
977	496717.9	4559110.3	184.2161255	119.9801178	61.57195663	391.1211243	mV	EM61MKII	N		
978	496718.2	4559117.1	22.36385154	14.345047	6.909470082	45.30640029	mV	EM61MKII	N		
979	496718.2	4559146.6	59.90409089	41.8856888	25.0531006	139.0405579	mV	EM61MKII	N		
980	496718.2	4559108	462.5357665	308.2290954	165.7701721	1015.301575	mV	EM61MKII	N		
981	496718.4	4559120.3	90.73749543	56.10708618	28.24889374	186.6462097	mV	EM61MKII	N		
982	496718.5	4559111.4	127.650917	81.97676085	41.09973144	266.1176757	mV	EM61MKII	N		
983	496718.5	4559131.9	135.2389527	92.19575503	51.54795838	299.536255	mV	EM61MKII	N		
984	496718.6	4559092.6	271.7190244	175.8403013	94.03987112	584.7687982	mV	EM61MKII	N		
985	496718.7	4559139.4	102.7698135	77.10828397	48.89548872	257.6697692	mV	EM61MKII	N		
986	496718.8	4559113.9	13.9193325	9.446609499	4 80291796	29.64297677	mV	EM61MKII	N		
988	496719	4559116.9	20.42015646	11.33119201	4.796127792	37.79996106	mV	EM61MKII	N		
989	496719.1	4559107.6	350.7944946	232.9174652	134.5678863	788.0546264	mV	EM61MKII	N		
990	496719.3	4559131.2	286.8012388	149.1315764	45.1334457	491.3571469	mV	EM61MKII	N		
991	496719.6	4559127.7	20.9442501	14.08824157	6.877014633	43.92261121	mV	EM61MKII	N		
992	496719.7	4559118.3	34.07782745	21.37232971	10.47229004	69.85671997	mV	EM61MKII	N		
993	496719.7	4559100.7	514.2692871	339.7357483	180.0792694	1107.262451	mV	EM61MKII	N		
994	496719.8	4559113.4	11.01840782	8.814727781	5.518112655	27.40442085	mV	EM61MKII	N		
995	496719.9	4559093.9	182.4520264	126.6504899	76.11706547	426.6666262	mV	EM61MKII	N		
996	496720.1	4559120.1	67.56514738	44.77023314	24.15000915	146.3384094	mV	EM61MKII	N		
997	496720.1	4559122.3	17.07657432	10.9776001	5.488632678	35.97275161	mV	EM61MKII	N		
998	496720.2	4559145	29.03911399	22.50138855	14.35506439	74.06658934	mV	EM61MKII	N		
999	496720.2	4559108.9	40.16896819	29.50587462	17.03249359	95.33645627	mV	EM61MKII	N		
1000	496720.6	4559128.3	41.42673492	29.38801574	14.28414154	91.75833129	mV	EM61MKII	N		
1001	496720.6	4559118.5	30.96906089	19.45089721	9.793106077	63.90951918	mV	EM61MKII	N		
1002	496720.6	4559145.8	35.68816376	26.59324646	16.84710693	88.03799438	mV	EM61MKII	N		
1004	496720.8	4559131.8	23.27217674	15.08633423	6.998581409	47.70389175	mV	EM61MKII	N		
1005	496721	4559094.7	99.95027156	68.55241391	36.54141234	220.7591857	mV	EM61MKII	N		
1006	496721.2	4559115.3	18.56795311	12.84780884	6.040886402	40.42728043	mV	EM61MKII	N		
1007	496721.3	4559093.1	21.64211084	13.31941987	6.734882825	45.04037858	mV	EM61MKII	N		
1009	496721.5	4559134.6	10717.38476	10589.69433	7118.783691	31665.80078	mV	EM61MKII	N		
1010	496721.7	4559109.8	51.70858002	32.88706207	16.32542419	107.3958435	mV	EM61MKII	N		
1011	496721.8	4559106.5	42.10422515	23.12809753	8.833137511	76.74545287	mV	EM61MKII	N		
1012	496721.9	4559096.6	264.6615294	177.8350677	93.53173063	579.482971	mV	EM61MKII	N		
1013	496722.2	4559112.8	40.63666536	24.11408998	10.72719575	79.44293217	mV	EM61MKII	N		
1014	496722.5	4559116.4	28.87698937	15.80430603	6.633240223	52.4382515	mV	EM61MKII	N		
1015	496722.6	4559105.9	63.87445829	38.11757658	17.04878997	124.3075866	mV	EM61MKII	N		
1016	496722.6	4559132.9	95.48963164	56.05200957	24.67987823	185.52005	mV	EM61MKII	N		
1017	496722.7	4559094.3	92.37810516	55.22347259	24.87598419	181.555542	mV	EM61MKII	N		
1018	496722.8	4559119.3	35.86206818	22.39395142	9.464195252	70.2197876	mV	EM61MKII	N		
1020	496722.9	4559131.4	19.42731285	14.24684143	8.618568421	46.50021744	mV	EM61MKII	N		
1021	496723	4559103.6	41.39708709	23.96154785	10.74867248	79.71084593	mV	EM61MKII	N		
1022	496723.1	4559129.9	18.20137596	11.10119629	5.531662463	37.18857193	mV	EM61MKII	N		
1023	496723.2	4559105.4	108.6083908	64.07181547	28.17583465	209.437622	mV	EM61MKII	N		

1024	496723.3	4559118	55.24214934	36.37327575	18.60482025	117.0998535	mV	EM61MKII	N		
1025	496723.6	4559129.4	23.99028587	14.18170166	7.368935105	49.0043373	mV	EM61MKII	N		
1026	496723.6	4559124.5	44.29642486	29.95211791	15.59077454	95.95214843	mV	EM61MKII	N		
1027	496723.8	4559128.7	20.40003014	11.46961975	4.696579456	38.25143814	mV	EM61MKII	N		
1028	496723.9	4559125.8	26.88332176	19.411026	11.71838379	64.29867554	mV	EM61MKII	N		
1029	496723.9	4559134.3	44.51627349	32.15268707	18.93225097	105.5631409	mV	EM61MKII	N		
1030	496723.9	4559137.3	65.51268768	46.12979126	27.40147781	151.0935974	mV	EM61MKII	N		
1032	496724.1	4559103.7	35.5793228	24.84246825	13.56445312	80.34548946	mV	EM61MKII	N		
1033	496724.2	4559126.7	60.94983674	39.9098816	15.6244812	120.315979	mV	EM61MKII	N		
1035	496724.6	4559145.8	38.02830505	24.2996521	15.15874863	85.10803222	mV	EM61MKII	N		
1036	496724.6	4559120.3	103.8418045	67.56601715	31.67311859	213.5172729	mV	EM61MKII	N		
1037	496724.8	4559123.8	96.63288878	66.53546523	37.36229515	218.6633911	mV	EM61MKII	N		
1038	496724.8	4559133.6	22.70009423	9.449905396	0.711113273	30.67675972	mV	EM61MKII	N		
1039	496724.9	4559113.4	37.33397674	26.09530639	16.29302978	87.64730833	mV	EM61MKII	N		
1040	496724.9	4559129.9	19.58157921	10.21841431	4.319336413	35.41391372	mV	EM61MKII	N		
1041	496725	4559088.4	129.3908386	98.07925411	56.54242704	312.4057311	mV	EM61MKII	N		
1042	496725	4559122.3	132.9087982	83.1042633	40.89564133	273.8113403	mV	EM61MKII	N		
1043	496725	4559112.7	48.37598418	32.20304107	18.15277862	108.3934936	mV	EM61MKII	N		
1044	496725	4559101.1	19.64331627	8.855560301	3.118393182	31.98782539	mV	EM61MKII	N		
1045	496725.3	4559105.1	75.39270781	40.44333648	15.95875549	137.2622986	mV	EM61MKII	N		
1047	496725.4	4559102.8	21.49998029	12.13314311	5.720800241	40.9602801	mV	EM61MKII	N		
1048	496725.4	4559114.9	85.16686248	62.66642761	38.63419723	207.4283447	mV	EM61MKII	N		
1049	496725.7	4559144.2	20.74899864	12.84301757	5.890327929	41.46408462	mV	EM61MKII	N		
1050	496725.9	4559099.4	32.4814377	16.53431702	5.931755545	55.67779925	mV	EM61MKII	N		
1051	496725.9	4559127.2	69.87310026	44.81597136	21.28424071	145.106018	mV	EM61MKII	N		
1052	496725.9	4559104.1	33.23618316	24.59562682	13.90010833	78.91818235	mV	EM61MKII	N		
1053	496725.9	4559135.8	143.1668854	100.3672028	56.82540512	327.8347778	mV	EM61MKII	N		
1054	496726	4559102.6	22.53191185	15.42095948	9.047241214	50.90872575	mV	EM61MKII	N		
1055	496726.1	4559095.8	12.82177896	12.38600522	10.96182059	45.8517236	mV	EM61MKII	N		
1056	496726.1	4559147.6	91.50170136	60.74925995	33.47823715	202.7202454	mV	EM61MKII	N		
1059	496726.3	4559113.2	13.51622581	12.94491577	11.73662567	43.98685072	mV	EM61MKII	N		
1061	496726.4	4559093.7	176.0822144	119.8962708	95.81448364	436.7668763	mV	EM61MKII	N		
1063	496726.4	4559101.2	40.70522307	24.33314514	10.59262085	79.28201293	mV	EM61MKII	N		
1064	496726.5	4559117.6	95.56908413	57.59501646	27.36307525	192.6581725	mV	EM61MKII	N		
1065	496726.6	4559100.4	38.62703708	25.63319399	11.82978059	80.71957405	mV	EM61MKII	N		
1066	496726.7	4559136.1	42.38996123	30.73031615	18.22819518	100.222229	mV	EM61MKII	N		
1068	496726.8	4559088.2	16.21370502	18.15104672	11.64012145	54.67447271	mV	EM61MKII	N		
1069	496726.9	4559121.1	24.31882285	20.67123412	14.62934112	68.66024778	mV	EM61MKII	N		
1070	496727	4559098.7	16.47862817	9.133911139	4.290382864	31.57357981	mV	EM61MKII	N		
1071	496727	4559123.7	85.29077911	44.36119079	18.38728332	155.157959	mV	EM61MKII	N		
1072	496727.1	4559134	392.9901123	269.71698	148.2805252	875.2739564	mV	EM61MKII	N		
1074	496727.1	4559095.1	18.69638634	11.50933838	5.975304128	38.6527443	mV	EM61MKII	N		
1075	496727.2	4559089.6	100.5880814	66.65066528	35.2496643	217.1757507	mV	EM61MKII	N		
1076	496727.3	4559133.2	335.2734375	241.7621155	141.2772522	780.8024903	mV	EM61MKII	N		
1077	496727.4	4559113	17.26289939	15.9956665	9.204933164	46.93210219	mV	EM61MKII	N		
1078	496727.4	4559116.3	128.6944733	107.6845932	73.74824524	355.9829102	mV	EM61MKII	N		
1079	496727.4	4559109.6	578.9553831	390.5519102	197.2467803	1241.660034	mV	EM61MKII	N		
1080	496727.5	4559099.8	18.83009911	11.28092957	4.835373402	36.69247818	mV	EM61MKII	N		
1081	496727.5	4559112.1	11.26257897	9.541458128	3.799286126	27.46158028	mV	EM61MKII	N		

1082	496727.5	4559094.4	30.25794792	17.39772034	7.773632526	58.42364883	mV	EM61MKII	N		
1083	496727.7	4559139.7	52.70220181	35.28308866	18.23614501	113.5353393	mV	EM61MKII	N		
1084	496727.8	4559147.5	14.13139915	9.659667967	6.046440599	32.73868178	mV	EM61MKII	N		
1085	496727.9	4559114	56.30701443	36.26499937	19.26157378	118.5568237	mV	EM61MKII	N		
1086	496727.9	4559094.6	27.31534384	15.39700317	6.364799976	51.03674696	mV	EM61MKII	N		
1088	496728	4559107.8	438.745636	288.5951233	142.5529022	926.5842895	mV	EM61MKII	N		
1089	496728.1	4559128.4	40.19621277	25.07449341	12.41012573	81.49987792	mV	EM61MKII	N		
1090	496728.2	4559097.5	112.2705306	72.43785854	29.63856505	221.4295043	mV	EM61MKII	N		
1091	496728.2	4559115.7	130.2295227	104.2996521	70.66669462	349.6080321	mV	EM61MKII	N		
1092	496728.4	4559148.1	11.42163658	8.831466675	6.091454028	30.02475166	mV	EM61MKII	N		
1093	496728.5	4559094	22.83151817	15.51382446	8.607955933	51.27432632	mV	EM61MKII	N		
1094	496728.6	4559112.7	26.6933422	9.4968338	2.291652919	38.53071975	mV	EM61MKII	N		
1095	496728.6	4559088.3	470.3085937	350.1568909	213.273468	1154.67041	mV	EM61MKII	N		
1096	496728.7	4559096.7	43.88315584	25.03947449	10.06040954	82.2050171	mV	EM61MKII	N		
1098	496728.8	4559120.9	149.3190155	78.67262266	31.57451629	272.1104125	mV	EM61MKII	N		
1099	496728.9	4559109.6	80.88040922	56.92171858	37.95308684	198.3645477	mV	EM61MKII	N		
1100	496728.9	4559132.4	341.8294372	219.4850616	115.9664688	728.5181273	mV	EM61MKII	N		
1101	496728.9	4559110.3	129.0948944	95.28504943	58.43911743	316.5310974	mV	EM61MKII	N		
1103	496728.9	4559087.6	259.1603088	180.7882232	105.0322113	598.1741941	mV	EM61MKII	N		
1104	496729	4559131.7	289.943573	186.9111175	98.84004974	619.4013061	mV	EM61MKII	N		
1106	496729	4559117.8	61.1492691	21.70237732	4.377777576	87.63580322	mV	EM61MKII	N		
1107	496729.1	4559144.7	46.3562851	29.47704315	14.0292511	94.8563385	mV	EM61MKII	N		
1108	496729.1	4559123.4	10.84384727	8.283126825	4.801384448	25.9970722	mV	EM61MKII	N		
1109	496729.3	4559105.6	142.8074951	76.09713746	27.82564927	253.9741516	mV	EM61MKII	N		
1110	496729.3	4559096.1	26.61293601	17.22004699	7.874779225	54.11572646	mV	EM61MKII	N		
1111	496729.5	4559113	55.4336166	18.39030455	2.390686272	76.08895869	mV	EM61MKII	N		
1113	496729.6	4559136.2	1184.535706	798.0235292	380.862259	2500.882081	mV	EM61MKII	N		
1114	496729.7	4559117.4	60.53643033	21.53721618	2.857994316	85.14804074	mV	EM61MKII	N		
1115	496729.8	4559103.4	1845.132446	1221.524292	613.239624	3901.4375	mV	EM61MKII	N		
1116	496729.9	4559111.5	37.35300444	18.38940429	3.442314385	59.40799329	mV	EM61MKII	N		
1118	496730	4559098.2	165.3474121	124.2911987	81.37578581	419.3181152	mV	EM61MKII	N		
1119	496730.1	4559115	34.17684172	12.46894836	1.892143607	48.63379286	mV	EM61MKII	N		
1120	496730.2	4559147.9	22.49165916	10.65029907	3.368065119	36.91778946	mV	EM61MKII	N		
1121	496730.3	4559144.3	39.76361847	30.98953247	19.24956512	101.0341187	mV	EM61MKII	N		
1122	496730.4	4559119.2	29.85822105	9.896987913	1.736465812	42.29678726	mV	EM61MKII	N		
1123	496730.4	4559124.1	522.1087038	282.2247315	88.47078707	906.3289187	mV	EM61MKII	N		
1125	496730.6	4559116.8	63.99692535	21.52398682	3.573227167	89.47610473	mV	EM61MKII	N		
1126	496730.6	4559108	55.28964994	35.9678192	18.84383392	117.9441528	mV	EM61MKII	N		
1127	496730.6	4559096.1	29.29318806	15.62541197	7.476654517	55.46472543	mV	EM61MKII	N		
1128	496731	4559100.1	1125.801209	694.8193818	320.7713471	2237.491394	mV	EM61MKII	N		
1129	496731.1	4559138.9	1849.444214	1411.258423	916.2634279	4727.566407	mV	EM61MKII	N		
1130	496731.1	4559126.3	44.35524748	27.87954711	20.49011993	100.6010131	mV	EM61MKII	N		
1135	496731.4	4559105.6	121.7943649	81.53993989	42.01361466	263.6488343	mV	EM61MKII	N		
1136	496731.5	4559090.7	91.66831207	69.59744644	47.78520202	236.5001678	mV	EM61MKII	N		
1137	496731.5	4559111.2	115.1166077	63.02566527	27.44202804	216.6621093	mV	EM61MKII	N		
1138	496731.8	4559097.3	239.7845612	143.1686096	59.3512001	458.4204101	mV	EM61MKII	N		
1139	496731.9	4559146.3	173.9127655	124.7893448	73.81636047	409.7745361	mV	EM61MKII	N		
1140	496732	4559136.1	43.83327484	27.33442688	13.22764587	90.31628417	mV	EM61MKII	N		
1141	496732	4559127.6	122.7380448	80.7668381	44.7263756	268.2351685	mV	EM61MKII	N		

1142	496732.2	4559116.7	52.37598419	23.82415771	8.338218689	87.731781	mV	EM61MKII	N		
1143	496732.2	4559119	264.0827942	104.6998596	23.08338928	397.2372742	mV	EM61MKII	N		
1144	496732.3	4559123.8	330.575592	245.7947388	157.9697113	835.7631226	mV	EM61MKII	N		
1145	496732.3	4559144.7	34.40686797	25.23893737	14.8191452	81.88375852	mV	EM61MKII	N		
1146	496732.4	4559111.6	152.0211334	95.28635405	41.89836883	300.9291687	mV	EM61MKII	N		
1147	496732.5	4559122.8	384.1228489	265.6807406	173.4349824	927.8010871	mV	EM61MKII	N		
1150	496732.7	4559130.1	41.4246292	24.13598632	10.62432861	79.28375243	mV	EM61MKII	N		
1151	496732.8	4559091.1	140.4510956	107.3967285	69.59973906	358.3504943	mV	EM61MKII	N		
1152	496732.9	4559101.7	40.81272125	22.48150634	7.933228015	74.62057494	mV	EM61MKII	N		
1153	496733.1	4559112.8	66.74942779	39.55108643	17.56430817	130.4155884	mV	EM61MKII	N		
1154	496733.4	4559148.9	15.04593467	9.331741326	3.361519095	28.33737371	mV	EM61MKII	N		
1155	496733.5	4559110.6	510.4250793	338.3528137	176.230896	1104.738647	mV	EM61MKII	N		
1156	496733.5	4559124.4	91.95943445	53.14135739	20.29377745	170.5916137	mV	EM61MKII	N		
1157	496733.6	4559097.7	314.5286254	228.2936553	140.8113861	758.4971311	mV	EM61MKII	N		
1158	496733.7	4559089.8	283.2322082	194.9137421	112.8422928	650.8362427	mV	EM61MKII	N		
1160	496734	4559132.2	16.74069786	11.6320343	5.517639635	36.14697646	mV	EM61MKII	N		
1162	496734.1	4559151.6	52.6646347	25.04937744	7.943901538	86.06991577	mV	EM61MKII	N		
1163	496734.1	4559107.9	721.3967283	439.5195006	187.9206848	1396.289672	mV	EM61MKII	N		
1164	496734.1	4559130.1	21.34873008	12.61386108	7.463547228	44.20306776	mV	EM61MKII	N		
1166	496734.2	4559124.7	65.4287338	37.74796294	15.68293762	124.1630249	mV	EM61MKII	N		
1167	496734.3	4559121.5	898.990051	585.6693113	267.8580626	1841.971313	mV	EM61MKII	N		
1168	496734.4	4559134.8	88.84677887	61.72975922	36.27654266	204.7010193	mV	EM61MKII	N		
1169	496734.4	4559138.3	19.67946434	12.86123657	5.901886463	40.3998146	mV	EM61MKII	N		
1171	496734.7	4559091.9	101.1894035	68.13538742	38.19992447	226.150528	mV	EM61MKII	N		
1172	496734.7	4559137.2	30.33627891	17.79243469	7 39016771	58.40091322	mV	EM61MKII	N		
1173	496734.8	4559119.4	362.079834	192.9806976	64.10102081	631.7408447	mV	EM61MKII	N		
1174	496734.9	4559110.5	888.4707029	471.7165221	162.1501007	1560.328491	mV	EM61MKII	N		
1175	496735	4559125	28.77492332	19.60231017	7.012619495	59.24664687	mV	EM61MKII	N		
1176	496735.1	4559109.8	782.0998535	390.576355	125.3070068	1326.121582	mV	EM61MKII	N		
1177	496735.2	4559123.6	57.75783536	33.42401121	12.98916625	107.53302	mV	EM61MKII	N		
1180	496735.6	4559110.8	834.8566894	447.3120117	155.8643646	1468.009888	mV	EM61MKII	N		
1181	496735.6	4559113.8	440.8856506	225.9542389	66.56083679	742.1924438	mV	EM61MKII	N		
1183	496735.7	4559132.9	17.69800377	11.15618896	5.747330187	36.83191299	mV	EM61MKII	N		
1184	496735.7	4559108.1	1747.966309	1036.296631	440.0539246	3351.982666	mV	EM61MKII	N		
1185	496735.8	4559103.8	829.3926392	539.6245728	271.6402893	1743.562744	mV	EM61MKII	N		
1186	496735.9	4559129.7	52.40142058	26.57258605	8.331932066	89.15979002	mV	EM61MKII	N		
1188	496736.3	4559102.9	1271.854492	835.963928	409.2538757	2667.496093	mV	EM61MKII	N		
1190	496736.4	4559094.6	111.3420944	78.94632717	49.83129118	265.9482421	mV	EM61MKII	N		
1191	496736.6	4559092.3	74.46305849	54.13860704	30.09477998	174.5591584	mV	EM61MKII	N		
1192	496736.6	4559101.4	3112.074219	2041.290283	1036.146606	6579.526855	mV	EM61MKII	N		
1193	496736.8	4559106.9	277.2432555	126.8296966	27.73612976	434.9964293	mV	EM61MKII	N		
1194	496736.9	4559136	13.42561912	8.474807739	4.302902698	27.98504829	mV	EM61MKII	N		
1195	496737.1	4559141.1	41.78945159	26.69174194	13.19205475	87.10641478	mV	EM61MKII	N		
1196	496737.2	4559132	16.78417014	11.46458434	4.178940293	33.39569471	mV	EM61MKII	N		
1197	496737.4	4559127.2	63.02588652	41.97103881	21.46366119	134.2860107	mV	EM61MKII	N		
1198	496737.5	4559097.1	176.057457	109.1197319	55.93048859	362.9434814	mV	EM61MKII	N		
1199	496737.6	4559134.4	13.69392967	9.150238036	4.735153674	29.79129219	mV	EM61MKII	N		
1200	496737.7	4559122.1	30.4512081	21.19383239	11.37828826	69.06420895	mV	EM61MKII	N		
1202	496738	4559092	167.4282074	119.4070053	71.62846373	395.4279479	mV	EM61MKII	N		

1203	496738.2	4559120	11.35704613	8.700653078	4.366440297	25.99325753	mV	EM61MKII	N		
1204	496738.2	4559136.4	14.4452877	9.725769039	4.755280016	30.24679755	mV	EM61MKII	N		
1205	496738.3	4559094.7	13.8535366	9.236633297	5.007172104	30.35208319	mV	EM61MKII	N		
1208	496738.5	4559100.2	82.27194976	59.14722061	36.17913055	194.0437469	mV	EM61MKII	N		
1209	496738.7	4559103.9	309.1882324	234.4869995	156.4722748	792.4694823	mV	EM61MKII	N		
1211	496738.9	4559093	454.6613768	326.4859313	192.5810546	1075.396118	mV	EM61MKII	N		
1212	496739.1	4559125.2	19.02118492	14.10992431	8.017089841	45.17245864	mV	EM61MKII	N		
1214	496739.2	4559105.8	784.6976929	542.1819458	283.3911743	1717.661499	mV	EM61MKII	N		
1215	496739.3	4559123.6	23.56261253	17.22212219	9.560455321	54.21899795	mV	EM61MKII	N		
1216	496739.4	4559140.5	20.54611777	17.02589416	11.88430786	56.85727308	mV	EM61MKII	N		
1217	496739.5	4559141.2	21.10234641	15.96891784	9.197738646	50.31808852	mV	EM61MKII	N		
1218	496739.5	4559116.9	44.42270659	26.80578613	14.53771209	91.00009153	mV	EM61MKII	N		
1221	496739.9	4559096.6	56.00272357	35.60512535	19.5349731	120.4137265	mV	EM61MKII	N		
1223	496740	4559155.6	320.2030639	199.1298828	98.5802078	656.493408	mV	EM61MKII	N		
1224	496740	4559156.8	123.6344528	67.47806549	24.65881348	222.2047119	mV	EM61MKII	N		
1225	496740	4559119	39.98825835	29.00154113	16.65930938	94.6269836	mV	EM61MKII	N		
1226	496740.1	4559111.7	112.8799438	78.70294188	42.00656509	251.9690856	mV	EM61MKII	N		
1227	496740.1	4559100.7	76.57863618	42.39969636	19.39196777	143.4231262	mV	EM61MKII	N		
1228	496740.3	4559102	414.3121644	292.0194092	149.369751	918.9561159	mV	EM61MKII	N		
1229	496740.4	4559093.6	68.34000398	48.66770173	27.41539383	159.1597901	mV	EM61MKII	N		
1231	496740.6	4559094.4	52.13927456	41.55241392	26.79690932	137.1453551	mV	EM61MKII	N		
1232	496740.7	4559114.2	221.3676452	142.0144653	75.10240171	471.0073547	mV	EM61MKII	N		
1234	496740.9	4559119.4	118.661972	89.99935146	56.16202924	297.8443297	mV	EM61MKII	N		
1235	496741	4559132.8	143.8265686	109.0762634	72.35341644	371.7479553	mV	EM61MKII	N		
1237	496741	4559108	109.3273468	80.3038406	43.38346098	252.4659423	mV	EM61MKII	N		
1238	496741.1	4559103.7	48.07308197	30.74747468	18.85919953	111.7358093	mV	EM61MKII	N		
1239	496741.4	4559122	121.9224319	85.84886166	49.87462232	284.0903929	mV	EM61MKII	N		
1241	496741.6	4559134.5	22.52686118	15.02760314	7.345573899	47.47250746	mV	EM61MKII	N		
1242	496741.8	4559156.3	43.01845551	28.48028564	15.00621796	92.8383789	mV	EM61MKII	N		
1243	496741.8	4559094.2	26.0841427	19.35363771	11.69155884	62.97867206	mV	EM61MKII	N		
1245	496742	4559124.6	717.0846556	479.5146178	228.553833	1494.634887	mV	EM61MKII	N		
1246	496742	4559140.9	33.23952483	19.85643005	9.269195555	65.58605956	mV	EM61MKII	N		
1248	496742.2	4559147.7	18.67369652	10.36199951	5.113976001	36.58066177	mV	EM61MKII	N		
1250	496742.3	4559104.9	475.0756837	275.3271789	130.6784515	935.7025146	mV	EM61MKII	N		
1251	496742.4	4559142.3	14.93921471	10.2872467	6.353241444	35.31262589	mV	EM61MKII	N		
1252	496742.5	4559138.2	18.58073997	12.7713623	6.260109423	39.93201064	mV	EM61MKII	N		
1253	496742.5	4559127.4	22.33051109	16.45812988	9.223442079	52.36059952	mV	EM61MKII	N		
1254	496742.5	4559096.4	70.07468409	49.08409115	29.12129972	162.6141051	mV	EM61MKII	N		
1255	496742.6	4559145.9	10.4070034	8.356231691	5.517311574	27.48340035	mV	EM61MKII	N		
1257	496742.8	4559135.9	20.71919823	12.98802185	5.596245288	40.86246109	mV	EM61MKII	N		
1259	496743	4559139.5	51.27602387	34.36738968	17.95312119	111.8217163	mV	EM61MKII	N		
1260	496743.1	4559114.5	534.7670896	345.9224242	166.8016967	1105.77539	mV	EM61MKII	N		
1261	496743.1	4559109.6	731.0677492	537.0778199	322.5927735	1768.328003	mV	EM61MKII	N		
1262	496743.2	4559095.4	697.840759	496.3991392	294.0072936	1640.52246	mV	EM61MKII	N		
1263	496743.2	4559107.9	35.3172226	20.87225342	9.005722048	68.04568482	mV	EM61MKII	N		
1264	496743.2	4559132.7	24.05473899	15.15679931	6.481880663	47.92175673	mV	EM61MKII	N		
1265	496743.3	4559150.3	51.40782928	32.66919708	18.19909668	110.1146851	mV	EM61MKII	N		
1268	496743.5	4559117.9	23.56815148	12.29855347	3.775345086	40.61041641	mV	EM61MKII	N		
1269	496743.7	4559102	2388.425537	1041.223999	273.2489929	3745.043701	mV	EM61MKII	N		

1272	496743.8	4559099.6	1049.548462	716.4420775	412.4465331	2381.574463	mV	EM61MKII	N		
1273	496743.8	4559105.5	307.027008	189.045166	93.86494444	626.9039306	mV	EM61MKII	N		
1274	496743.8	4559141.8	15.55150413	9.977294917	5.132225509	32.67193984	mV	EM61MKII	N		
1275	496744	4559127.2	43.5759506	30.67238616	17.62244414	100.9845581	mV	EM61MKII	N		
1276	496744	4559097.3	3044.412353	2167.631348	1172.883057	6849.217773	mV	EM61MKII	N		
1278	496744.1	4559138.9	43.69100189	26.30929565	11.88608551	86.17663573	mV	EM61MKII	N		
1279	496744.3	4559111.6	970.1137088	674.7388307	376.3341981	2212.463135	mV	EM61MKII	N		
1280	496744.3	4559136.4	31.89247702	23.61572265	12.55322265	74.11773679	mV	EM61MKII	N		
1281	496744.5	4559123.2	491.0635375	332.4841308	176.7062835	1080.747314	mV	EM61MKII	N		
1282	496744.5	4559151.1	125.5938186	94.97238917	56.39333341	302.789276	mV	EM61MKII	N		
1283	496744.6	4559130.8	318.1433105	230.4144745	126.4680862	722.0004883	mV	EM61MKII	N		
1284	496744.6	4559116.9	41.16817472	19.80432128	3.914077995	64.5216064	mV	EM61MKII	N		
1285	496744.6	4559131.6	325.5560607	228.178604	122.9350814	721.7310178	mV	EM61MKII	N		
1286	496744.7	4559096.1	128.9883728	86.6058197	47.40970612	285.8289795	mV	EM61MKII	N		
1287	496744.7	4559098.8	243.287384	172.0141449	105.779892	575.5373535	mV	EM61MKII	N		
1288	496744.8	4559113.5	213.4910736	131.7147522	63.88798903	435.9075622	mV	EM61MKII	N		
1289	496744.9	4559152.3	30.97447777	19.1648407	9.757225036	64.93658447	mV	EM61MKII	N		
1290	496744.9	4559154.3	49.49533843	28.1040039	10.50015259	90.62951659	mV	EM61MKII	N		
1291	496745	4559122.6	416.7769776	292.1175232	165.7800751	960.6003418	mV	EM61MKII	N		
1292	496745.1	4559157.6	46.79717252	34.48394011	20.87435149	113.2828369	mV	EM61MKII	N		
1293	496745.1	4559156.6	27.31233788	20.91494751	13.33850098	68.75772096	mV	EM61MKII	N		
1294	496745.1	4559106.1	748.111633	557.3554075	349.9664915	1859.750854	mV	EM61MKII	N		
1295	496745.2	4559139.2	93.09172818	62.26746366	30.54246138	195.8225707	mV	EM61MKII	N		
1297	496745.3	4559107.9	53.21369171	33.7530365	16.7898407	110.940033	mV	EM61MKII	N		
1298	496745.4	4559125.4	23.61477471	14.04730225	7.232624532	48.17955399	mV	EM61MKII	N		
1299	496745.4	4559142.1	21.83464621	11.7088623	4.236542223	38.72339247	mV	EM61MKII	N		
1300	496745.7	4559096	360.8095396	262.847473	160.1146239	869.8948359	mV	EM61MKII	N		
1301	496745.7	4559117.4	66.75151822	43.99356077	24.48389434	146.8699645	mV	EM61MKII	N		
1302	496745.9	4559110.5	39.73035429	26.25897216	13.03462219	84.16806026	mV	EM61MKII	N		
1303	496745.9	4559120.7	189.9239501	121.74897	63.22681425	401.7196349	mV	EM61MKII	N		
1304	496745.9	4559145.7	20.34967613	11.72004699	5 33776903	38.86853408	mV	EM61MKII	N		
1306	496746	4559138.9	68.20398713	45.03637696	20.82852936	140.4744568	mV	EM61MKII	N		
1308	496746.1	4559098.7	28.26807727	17.21841433	9.209833791	59.12427148	mV	EM61MKII	N		
1309	496746.2	4559156.7	32.6865921	22.02879333	12.84268188	73.45086669	mV	EM61MKII	N		
1310	496746.3	4559100.6	195.4790496	125.9839324	67.9902191	421.0077513	mV	EM61MKII	N		
1311	496746.4	4559155.8	46.28559112	31.4686737	17.04397583	102.3292236	mV	EM61MKII	N		
1312	496746.4	4559116.2	43.62254334	29.18951035	13.48734284	92.03012086	mV	EM61MKII	N		
1313	496746.6	4559125.9	14.36762047	8.016967773	3.186531305	26.4914875	mV	EM61MKII	N		
1314	496746.6	4559153.2	20.31638145	16.3428955	10.83073425	53.78995132	mV	EM61MKII	N		
1315	496746.6	4559157.5	40.82230376	25.87850952	12.70050812	83.97720335	mV	EM61MKII	N		
1316	496746.6	4559150.8	42.83805084	30.35858154	18.11473083	100.7671814	mV	EM61MKII	N		
1317	496746.7	4559146.6	17.82417869	8.083038327	1.676658987	27.61169623	mV	EM61MKII	N		
1318	496746.8	4559104.5	132.9178925	86.82345582	45.1269455	281.7724915	mV	EM61MKII	N		
1319	496746.9	4559156.4	60.73873135	41.98426817	23.87368773	138.1630553	mV	EM61MKII	N		
1320	496746.9	4559101.9	14.37866779	8.130386329	5.614433754	31.56537048	mV	EM61MKII	N		
1321	496746.9	4559151.8	44.89264679	33.86834716	20.95336151	111.3780212	mV	EM61MKII	N		
1322	496747.1	4559135.2	99.20700833	65.9902191	33.41351317	214.4808349	mV	EM61MKII	N		
1323	496747.2	4559123.4	19.81856346	12.92663574	6.655624864	43.64072036	mV	EM61MKII	N		
1325	496747.3	4559155.6	70.01230621	51.92050171	32.34376526	171.5031128	mV	EM61MKII	N		

1326	496747.3	4559105.5	360.0250548	241.6832427	102.0866928	729.3695065	mV	EM61MKII	N		
1327	496747.3	4559110.6	183.161026	115.9624328	57.99030684	382.0460814	mV	EM61MKII	N		
1328	496747.4	4559115.5	57.09300993	35.26589965	16.73228454	116.1759948	mV	EM61MKII	N		
1330	496747.5	4559106.9	56.56777184	34.37100215	16.1157913	113.7561034	mV	EM61MKII	N		
1332	496747.5	4559099.8	664.5258789	403.614624	182.1607971	1324.214844	mV	EM61MKII	N		
1333	496747.5	4559132	12.7267971	8.244644164	3.349983453	25.13568306	mV	EM61MKII	N		
1334	496747.6	4559159.3	165.0861664	111.6104431	63.2120285	369.5953674	mV	EM61MKII	N		
1335	496747.7	4559143.6	16.29144859	9.568603513	4.033348559	31.09015082	mV	EM61MKII	N		
1336	496747.8	4559098.5	95.78891747	69.76421351	40.54953763	227.8027342	mV	EM61MKII	N		
1337	496747.9	4559113	96.02143093	62.91255185	29.35066222	198.4942626	mV	EM61MKII	N		
1338	496748.2	4559117.3	58.52089691	39.69206238	19.37734222	124.9254456	mV	EM61MKII	N		
1339	496748.2	4559104.2	124.6277008	70.70398714	28.65678025	231.7492371	mV	EM61MKII	N		
1340	496748.2	4559105.9	108.3308105	57.71067806	23.34183501	199.0970763	mV	EM61MKII	N		
1341	496748.3	4559101.8	58.37788006	35.60923574	19.34288978	121.587799	mV	EM61MKII	N		
1342	496748.3	4559158.9	158.9812469	103.6436615	52.63855361	336.5787048	mV	EM61MKII	N		
1343	496748.4	4559155.7	71.68265531	51.50536345	29.92643737	168.4158019	mV	EM61MKII	N		
1345	496748.6	4559145.3	28.56799888	18.71809387	9.786003112	61.14868545	mV	EM61MKII	N		
1346	496748.6	4559146.8	35.37293243	22.83460998	11.80449676	74.90679931	mV	EM61MKII	N		
1347	496748.7	4559109.1	62.74346159	39.36964415	19.61091613	130.1998596	mV	EM61MKII	N		
1350	496748.9	4559098.9	74.12055202	42.4583206	16.75194549	137.1217345	mV	EM61MKII	N		
1352	496749	4559097.5	79.20198819	52.34057615	29.04774093	174.6107177	mV	EM61MKII	N		
1353	496749.2	4559137.6	15.85640526	9.899719238	5.168671131	32.90869522	mV	EM61MKII	N		
1355	496749.3	4559104.6	117.9094965	73.82534802	35.87727743	243.0622715	mV	EM61MKII	N		
1357	496749.3	4559107	333.5814818	217.6138305	109.7563705	702.6111448	mV	EM61MKII	N		
1358	496749.4	4559126.9	51.24239349	33.3050003	18.03596496	110.4660034	mV	EM61MKII	N		
1359	496749.4	4559102.5	100.6817398	56.20713041	21.81240081	183.1720275	mV	EM61MKII	N		
1360	496749.5	4559131.2	22.36028099	15.41938782	7 27011919	48.34955216	mV	EM61MKII	N		
1361	496749.5	4559144.3	53.84996796	40.99978638	26.26537704	135.8092346	mV	EM61MKII	N		
1362	496749.6	4559119.7	3649.574707	2448.611572	1315.036865	7995.256347	mV	EM61MKII	N		
1363	496749.7	4559114.5	2088.517577	1290.693603	554.8533933	4088.427733	mV	EM61MKII	N		
1364	496749.7	4559111.4	81.61348722	51.35324096	25.48432922	170.6958313	mV	EM61MKII	N		
1365	496749.8	4559127.8	55.41355133	37.72880554	20.2716217	122.1600342	mV	EM61MKII	N		
1366	496749.8	4559152.1	93.36666104	60.05702971	31.13627243	198.3973388	mV	EM61MKII	N		
1367	496750	4559148.8	16.63579369	10.67085266	4.831818104	33.40488052	mV	EM61MKII	N		
1368	496750	4559157.4	25.98926354	17.2374115	9 27140808	56.07168961	mV	EM61MKII	N		
1369	496750.1	4559151.2	73.71263885	48.25362396	26.07138061	159.8414917	mV	EM61MKII	N		
1371	496750.1	4559123.9	216.5992279	132.1537476	63.07756043	438.1817017	mV	EM61MKII	N		
1372	496750.3	4559153.3	20.10140038	11.3701477	5.528336048	39.35580826	mV	EM61MKII	N		
1374	496750.5	4559107.4	574.8577268	382.4833678	196.5245666	1225.624633	mV	EM61MKII	N		
1375	496750.8	4559130.6	18.62726401	11.10173034	6.275055407	38.75308608	mV	EM61MKII	N		
1376	496750.9	4559125.9	33.40854645	19.37512207	7.726456165	63.47525406	mV	EM61MKII	N		
1377	496750.9	4559157.5	54.21147916	37.06403349	20.51403045	121.6119079	mV	EM61MKII	N		
1379	496750.9	4559105.3	107.9404679	77.89645392	40.30063061	240.4958193	mV	EM61MKII	N		
1380	496751	4559145.9	19.26537133	12.4112854	6.636856558	41.73184587	mV	EM61MKII	N		
1381	496751	4559132.6	15.56319237	8.804626464	3.628853082	29.1883564	mV	EM61MKII	N		
1382	496751	4559101	339.7790222	234.2282562	134.0478058	778.2552491	mV	EM61MKII	N		
1384	496751.2	4559147.1	72.9432602	48.78781128	25.70561599	158.8096313	mV	EM61MKII	N		
1385	496751.2	4559151.7	92.2222824	65.60119628	40.42732238	218.2349853	mV	EM61MKII	N		
1386	496751.3	4559125.3	27.51025963	18.11105347	6 83425951	55.04019546	mV	EM61MKII	N		

1387	496751.4	4559102.8	202.5377062	144.7585767	90.52269818	480.4514811	mV	EM61MKII	N		
1388	496751.4	4559097.3	10919.52344	11266.59766	10869.87305	39194.41015	mV	EM61MKII	N		
1389	496751.4	4559128.6	87.37926478	54.47920987	24.04255675	176.533142	mV	EM61MKII	N		
1390	496751.7	4559147.7	57.68608855	38.88809203	20.72122192	125.872467	mV	EM61MKII	N		
1391	496751.7	4559118	1721.58435	1195.079468	661.7075194	3856.976806	mV	EM61MKII	N		
1392	496751.8	4559159.3	89.47441864	63.31523132	37.51292038	208.1943359	mV	EM61MKII	N		
1393	496751.8	4559122.2	42.78105925	23.37419128	10.56217956	80.45712278	mV	EM61MKII	N		
1394	496751.8	4559103.9	160.6353455	112.8694229	67.82995607	366.3963623	mV	EM61MKII	N		
1396	496751.9	4559101.5	460.6411133	306.8884277	166.582016	1010.360779	mV	EM61MKII	N		
1397	496751.9	4559123.1	61.44040678	24.11051941	6.061882498	93.31283567	mV	EM61MKII	N		
1398	496752	4559157.3	23.02357294	16.96823122	11.28665925	56.32490926	mV	EM61MKII	N		
1400	496752.2	4559103	160.2239532	112.7429809	65.19628139	370.9408262	mV	EM61MKII	N		
1401	496752.4	4559106	1613.988403	1117.203613	601.5150757	3571.531738	mV	EM61MKII	N		
1402	496752.5	4559117.6	2369.444336	1616.953003	890.4748536	5247.009278	mV	EM61MKII	N		
1403	496752.6	4559101.5	368.3486022	238.2333069	124.2995147	783.3142699	mV	EM61MKII	N		
1404	496752.8	4559160.2	96.87619779	70.10854338	42.54035567	232.6143798	mV	EM61MKII	N		
1405	496752.9	4559153.8	150.3620911	101.4903183	58.54266739	340.3789978	mV	EM61MKII	N		
1406	496752.9	4559156.8	30.75951195	24.23046875	15.07340241	78.8166504	mV	EM61MKII	N		
1407	496752.9	4559104.3	135.1890715	80.04508197	39.35182757	272.1671749	mV	EM61MKII	N		
1408	496752.9	4559152.4	20.18552206	14.19128417	8.397621147	46.91321178	mV	EM61MKII	N		
1409	496753	4559123.5	36.44135283	23.91432189	12.4882965	78.37637325	mV	EM61MKII	N		
1410	496753	4559103.4	305.8381956	194.4328002	101.3727646	646.3625485	mV	EM61MKII	N		
1411	496753.1	4559125.8	292.2103271	198.1953888	112.0198135	660.7590942	mV	EM61MKII	N		
1412	496753.2	4559112	552.8305665	379.987793	208.4303284	1225.184692	mV	EM61MKII	N		
1413	496753.3	4559098.4	90.88780972	62.74443052	36.51943206	207.8210448	mV	EM61MKII	N		
1414	496753.4	4559151.3	296.719696	161.388504	50.69613264	517.7291259	mV	EM61MKII	N		
1415	496753.4	4559116.1	2816.305176	1822.059692	930.1456298	5913.204101	mV	EM61MKII	N		
1416	496753.5	4559100.7	27.75139427	21.61148071	15.1348877	73.85736084	mV	EM61MKII	N		
1417	496753.5	4559107.2	122.2342148	81.71814726	39.78591155	257.7835082	mV	EM61MKII	N		
1418	496753.6	4559117.8	2469.259033	1612.90625	876.0531616	5353.405273	mV	EM61MKII	N		
1421	496754	4559102.5	993.6170655	652.0256958	359.0903626	2163.259522	mV	EM61MKII	N		
1422	496754	4559159.9	50.71616361	37.52732085	22.71391295	123.9256591	mV	EM61MKII	N		
1423	496754.1	4559155	284.9521789	213.6719055	142.788681	728.3486937	mV	EM61MKII	N		
1424	496754.1	4559104.9	109.6930314	63.68968966	28.51470948	208.9789735	mV	EM61MKII	N		
1425	496754.1	4559098.8	218.5640564	156.4234467	93.68332672	516.5949707	mV	EM61MKII	N		
1426	496754.3	4559111.9	608.9374389	391.7150879	197.3859863	1283.04187	mV	EM61MKII	N		
1427	496754.4	4559097.8	439.6285705	310.0873108	183.2489166	1029.106811	mV	EM61MKII	N		
1428	496754.5	4559104.2	81.93988802	44.82330323	17.4307251	147.8780823	mV	EM61MKII	N		
1429	496754.6	4559158.5	23.7537899	17.12550354	8.848709107	56.52920914	mV	EM61MKII	N		
1430	496754.9	4559133.2	18.17305564	12.75849914	6.957870954	40.83176038	mV	EM61MKII	N		
1431	496755.1	4559160.9	316.3460388	223.5940552	133.4010162	744.1171875	mV	EM61MKII	N		
1433	496755.3	4559126.2	57.06157684	32.24130249	13.0952301	107.1817932	mV	EM61MKII	N		
1434	496755.4	4559148.5	45.3175888	37.48249816	26.52556991	127.2819519	mV	EM61MKII	N		
1435	496755.4	4559099.9	202.9940185	147.2122344	90.02737423	488.5859678	mV	EM61MKII	N		
1436	496755.5	4559108.9	135.5035857	99.65611262	51.64166256	307.8163145	mV	EM61MKII	N		
1437	496755.5	4559144.1	134.2769164	93.86027522	52.16538998	303.3676756	mV	EM61MKII	N		
1438	496755.7	4559147.7	30.62595174	23.28936766	16.135643	79.99493403	mV	EM61MKII	N		
1439	496755.7	4559111.2	556.3375243	355.0257568	173.616333	1153.408081	mV	EM61MKII	N		
1440	496755.8	4559103.8	338.3166809	233.4436798	137.6191864	777.9862061	mV	EM61MKII	N		

1443	496756.2	4559150.5	19.45108604	14.18321228	8.148567199	45.30264664	mV	EM61MKII	N		
1444	496756.3	4559100.8	35.68257904	28.67340088	18.23464966	93.03985596	mV	EM61MKII	N		
1445	496756.4	4559123.2	250.2966156	159.5633087	82.62870026	526.2941284	mV	EM61MKII	N		
1446	496756.5	4559127.2	832.8940426	569.5358274	281.666046	1775.709106	mV	EM61MKII	N		
1447	496756.5	4559129	29.17096518	20.40910339	10.71003723	64.190155	mV	EM61MKII	N		
1448	496756.5	4559109.3	107.6607742	61.56261444	27.58646011	209.0757446	mV	EM61MKII	N		
1449	496756.5	4559151.7	48.45832061	34.53599547	19.87572479	111.3016662	mV	EM61MKII	N		
1450	496756.6	4559141.7	41.73203277	12.94424438	3.712654351	59.80517958	mV	EM61MKII	N		
1451	496756.7	4559101.9	38.27019499	25.50711058	12.99156951	83.03503414	mV	EM61MKII	N		
1453	496756.8	4559102.6	41.76311491	27.72746277	15.73656464	94.11175535	mV	EM61MKII	N		
1454	496757.1	4559121	157.3727264	95.80796048	44.91160582	315.2751159	mV	EM61MKII	N		
1455	496757.1	4559143	227.9851685	165.3457337	95.47191622	541.6713868	mV	EM61MKII	N		
1456	496757.1	4559111.7	228.7816162	133.3076782	56.22970199	437.5527648	mV	EM61MKII	N		
1457	496757.2	4559131.3	26.68036461	17.23023987	9.149925232	56.72534561	mV	EM61MKII	N		
1458	496757.2	4559162.1	154.2055206	109.3567657	64.02307892	357.396759	mV	EM61MKII	N		
1459	496757.2	4559100	346.0867309	253.2194366	153.2991638	834.7600096	mV	EM61MKII	N		
1461	496757.4	4559105.8	183.9657745	116.7689819	57.59666442	380.2065429	mV	EM61MKII	N		
1464	496757.6	4559136.9	14.59747887	8.909759521	4.383957385	29.69021797	mV	EM61MKII	N		
1465	496757.6	4559118.7	131.4967804	91.27311705	51.97326277	299.8473205	mV	EM61MKII	N		
1467	496757.8	4559144.2	153.6525421	104.0549698	60.74547195	350.2012634	mV	EM61MKII	N		
1468	496757.9	4559124.6	12.38435936	9.28364563	4.430824755	27.77868843	mV	EM61MKII	N		
1469	496757.9	4559117.9	183.0625762	125.0584106	67.85305783	407.7158201	mV	EM61MKII	N		
1470	496757.9	4559108.4	95.40410611	67.29397581	34.23674773	209.652008	mV	EM61MKII	N		
1471	496758	4559137.8	13.55643272	8.817581177	4.247398853	28.32565498	mV	EM61MKII	N		
1472	496758.1	4559125.4	19.98805808	12.54460144	5.455368518	40.30569838	mV	EM61MKII	N		
1473	496758.4	4559116.5	185.7637786	116.8475341	56.70102308	380.2914427	mV	EM61MKII	N		
1475	496758.4	4559119.8	44.56594086	24.13113403	8.284698486	79.68829345	mV	EM61MKII	N		
1477	496758.4	4559111.5	468.9121399	243.9001617	72.66123199	793.7207641	mV	EM61MKII	N		
1478	496758.5	4559140.1	31.50670433	21.40513611	10.90115357	67.7569275	mV	EM61MKII	N		
1479	496758.5	4559105.5	259.6335143	164.4495544	84.31638335	537.5363768	mV	EM61MKII	N		
1480	496758.6	4559104.8	278.2163391	185.8727112	92.88323975	591.902832	mV	EM61MKII	N		
1481	496758.6	4559101.7	861.9197384	588.3685911	303.9586791	1867.460326	mV	EM61MKII	N		
1482	496758.6	4559151.4	63.65840912	43.04383087	21.45928192	134.9267883	mV	EM61MKII	N		
1484	496758.9	4559150.6	26.04564476	18.73161316	11.39731598	60.97153092	mV	EM61MKII	N		
1485	496759	4559113.2	1377.807373	892.5230711	444.5362548	2880.363525	mV	EM61MKII	N		
1487	496759	4559115.1	215.9832	133.6200866	63.40858839	441.322235	mV	EM61MKII	N		
1488	496759.2	4559142.3	27.11437796	18.3031845	8.320579522	57.31161877	mV	EM61MKII	N		
1489	496759.2	4559127.4	20.60993004	12.39799499	5.736122602	42.04565809	mV	EM61MKII	N		
1490	496759.3	4559153.5	5859.121579	3709.952147	1072.127197	10861.60449	mV	EM61MKII	N		
1492	496759.5	4559120.3	130.9586029	86.81871795	45.0534668	283.052887	mV	EM61MKII	N		
1493	496759.6	4559105.1	410.1139831	246.9980926	124.0456695	836.2660521	mV	EM61MKII	N		
1494	496759.6	4559107.9	102.2586517	71.1353302	42.73600006	237.7532959	mV	EM61MKII	N		
1495	496759.7	4559118.6	657.1859128	474.7010801	264.9773253	1510.283569	mV	EM61MKII	N		
1496	496760	4559150.2	19.05885887	13.71685791	8.547409057	46.44897842	mV	EM61MKII	N		
1497	496760.1	4559110.7	940.7030634	612.8511959	282.3488462	1917.211303	mV	EM61MKII	N		
1498	496760.1	4559139.8	14.72662926	10.60162354	6.53990984	35.19675064	mV	EM61MKII	N		
1499	496760.1	4559106.2	175.7782896	114.0633696	59.82604212	379.4041134	mV	EM61MKII	N		
1500	496760.2	4559102.4	141.725586	100.535202	60.79724886	336.9510804	mV	EM61MKII	N		
1501	496760.2	4559131.3	39.8085556	28.51158142	17.00399017	94.44161987	mV	EM61MKII	N		

1502	496760.2	4559149.2	28.2160549	12.81391906	1.756935476	42.21423718	mV	EM61MKII	N		
1503	496760.3	4559127	198.1517334	133.65448	76.97068023	445.0729675	mV	EM61MKII	N		
1504	496760.4	4559151	43.70720673	27.37341309	13.58413697	90.47305299	mV	EM61MKII	N		
1505	496760.5	4559107.8	150.8271484	104.0815277	60.29352188	346.1357422	mV	EM61MKII	N		
1506	496760.5	4559143.1	23.7217617	13.1078949	5.711922167	44.89310074	mV	EM61MKII	N		
1507	496760.6	4559101.3	209.811554	152.637558	96.24197388	511.391388	mV	EM61MKII	N		
1508	496760.6	4559124.6	179.0288696	112.1531906	56.76972961	370.8848266	mV	EM61MKII	N		
1510	496760.9	4559116.8	112.2570114	83.66666412	50.32010269	269.7749328	mV	EM61MKII	N		
1511	496760.9	4559104.4	62.01848597	27.18272397	4.644585122	92.79244985	mV	EM61MKII	N		
1512	496761	4559115.1	49.99065397	21.8930664	4.764610766	77.98312375	mV	EM61MKII	N		
1514	496761	4559140.6	47.63585661	30.02091979	15.14177703	99.07580563	mV	EM61MKII	N		
1515	496761.2	4559102.3	279.9364929	193.4345093	113.0323868	645.2932739	mV	EM61MKII	N		
1516	496761.3	4559144.3	55.57898712	33.0832901	13.4544754	104.6621704	mV	EM61MKII	N		
1517	496761.5	4559114.6	33.85967255	16.95127869	5.050941949	58.04242327	mV	EM61MKII	N		
1518	496761.5	4559122.4	52.38164517	37.93949888	21.87969206	124.0954284	mV	EM61MKII	N		
1519	496761.6	4559112.4	887.7929078	544.2692872	228.4614868	1721.445191	mV	EM61MKII	N		
1521	496761.6	4559145.9	14.5982418	9.447479241	3.901184318	28.95883367	mV	EM61MKII	N		
1522	496761.7	4559115.5	142.1799775	82.21145634	31.94244768	259.1333314	mV	EM61MKII	N		
1523	496761.8	4559126.2	321.5745239	129.297348	26.31267929	479.6835022	mV	EM61MKII	N		
1524	496761.9	4559140.1	32.88140104	16.85983275	4.339630601	54.49878308	mV	EM61MKII	N		
1525	496761.9	4559116.3	408.2120971	189.5207062	41.7504158	643.4092406	mV	EM61MKII	N		
1526	496762	4559104.4	422.5761106	279.9220274	142.3956298	896.3960566	mV	EM61MKII	N		
1527	496762.1	4559105.9	396.4993286	269.712616	143.7506714	867.9837036	mV	EM61MKII	N		
1528	496762.1	4559136.2	16.83388328	10.16343689	4.099426745	31.95257758	mV	EM61MKII	N		
1530	496762.4	4559137.3	17.57463646	10.97428894	5.927048206	37.40219498	mV	EM61MKII	N		
1531	496762.5	4559108.3	25.1093502	10.24995422	0.024658523	34.74579239	mV	EM61MKII	N		
1532	496762.7	4559127.1	76.09912873	47.87420654	23.67329407	157.237854	mV	EM61MKII	N		
1534	496762.8	4559116.6	169.437748	91.3702679	38.30241586	311.6972428	mV	EM61MKII	N		
1535	496763	4559103.2	1050.348023	762.3981325	460.0866701	2516.642579	mV	EM61MKII	N		
1536	496763.3	4559117	209.8630371	108.066246	40.80765151	367.7559509	mV	EM61MKII	N		
1537	496763.3	4559139.6	58.29044337	33.46962736	13.65140533	109.7324828	mV	EM61MKII	N		
1538	496763.4	4559128.5	34.45732879	21.39334106	10.02706146	69.35482787	mV	EM61MKII	N		
1539	496763.4	4559138	35.93711091	17.75849915	4.242584706	58.61481095	mV	EM61MKII	N		
1540	496763.5	4559123.7	53.65634917	32.88876342	15.70166778	108.941864	mV	EM61MKII	N		
1542	496763.7	4559118.2	154.1931457	64.9817352	14.12300873	232.0592955	mV	EM61MKII	N		
1543	496763.8	4559115.4	74.5117874	40.46073912	14.85221862	132.5310974	mV	EM61MKII	N		
1544	496764.1	4559102.9	188.3120574	138.2997283	80.56509396	451.476898	mV	EM61MKII	N		
1546	496764.2	4559103.6	318.4801327	220.403198	122.1111525	725.8197014	mV	EM61MKII	N		
1547	496764.2	4559117	198.7239075	109.0989914	45.22631073	367.5612793	mV	EM61MKII	N		
1548	496764.2	4559105.1	1169.656371	705.4043574	345.6447751	2370.366453	mV	EM61MKII	N		
1549	496764.5	4559110.2	21.29013634	14.41731263	8.377891546	49.50171282	mV	EM61MKII	N		
1551	496764.5	4559112.3	48.47248077	29.37240601	8.319404602	88.00283813	mV	EM61MKII	N		
1552	496764.6	4559113.2	50.47043603	31.6742477	14.52011106	102.2998351	mV	EM61MKII	N		
1553	496764.7	4559122.3	751.3513183	595.8944092	395.7272644	1995.414307	mV	EM61MKII	N		
1555	496764.8	4559111	42.74213408	30.60297393	16.27312469	96.44409177	mV	EM61MKII	N		
1558	496765.2	4559114.2	340.5332336	230.2216491	133.2196655	776.5317382	mV	EM61MKII	N		
1559	496765.3	4559103.5	100.7814102	77.44236752	45.84654234	248.4033812	mV	EM61MKII	N		
1560	496765.4	4559124.7	19.33456993	8.997486115	3.342722178	32.70302916	mV	EM61MKII	N		
1561	496765.6	4559118.3	181.030014	119.350296	57.67634582	377.08255	mV	EM61MKII	N		

1562	496765.7	4559111	40.21257782	30.55827331	17.92390442	96.87561033	mV	EM61MKII	N		
1563	496765.7	4559139.5	25.21658895	13.20642089	5.057579513	45.02463146	mV	EM61MKII	N		
1564	496765.8	4559114.7	578.9884642	258.3658142	66.6567917	913.1933592	mV	EM61MKII	N		
1565	496765.8	4559116.1	112.2089615	86.2074127	47.69174957	264.2904052	mV	EM61MKII	N		
1566	496765.9	4559104.6	476.0432129	321.9793701	193.8601074	1082.87561	mV	EM61MKII	N		
1567	496766	4559105.5	296.941345	185.9483794	90.0168304	609.3498531	mV	EM61MKII	N		
1568	496766.1	4559141.4	379.7360229	194.0586547	70.91587065	662.922119	mV	EM61MKII	N		
1569	496766.1	4559137.5	13.55599022	9.546295166	5.133736134	30.90518379	mV	EM61MKII	N		
1570	496766.1	4559138.9	18.47163961	8.878341664	3.159912343	31.40765568	mV	EM61MKII	N		
1571	496766.4	4559139.6	57.61751554	29.33346556	8.729759212	97.28152462	mV	EM61MKII	N		
1572	496766.7	4559125	375.1854551	195.8126525	66.63295741	650.7963252	mV	EM61MKII	N		
1573	496766.8	4559108.6	182.2852478	126.0578079	72.19257355	414.5378418	mV	EM61MKII	N		
1574	496766.8	4559126.5	89.58905792	53.07782745	23.63719177	172.4057312	mV	EM61MKII	N		
1575	496766.9	4559118.3	34.70215607	20.16256714	8.668357849	65.78598022	mV	EM61MKII	N		
1576	496766.9	4559105.7	163.2078093	98.54434959	43.68867871	316.7646787	mV	EM61MKII	N		
1577	496767	4559104.3	171.3313371	114.1004258	61.35485751	374.7187274	mV	EM61MKII	N		
1578	496767	4559111.2	334.956848	177.2931976	53.06585309	572.0687254	mV	EM61MKII	N		
1579	496767	4559134.7	55.54393769	29.42889404	9.635009765	96.36840821	mV	EM61MKII	N		
1580	496767.4	4559109.5	178.3340301	108.4157143	48.82267284	354.4773102	mV	EM61MKII	N		
1581	496767.5	4559118.7	22.99066734	13.7293396	5.477837086	43.62854385	mV	EM61MKII	N		
1582	496767.7	4559116.5	22.78368186	19.03674316	13.25594329	64.05441282	mV	EM61MKII	N		
1583	496767.8	4559129.9	19.201025	12.25128173	6.127380846	40.3279457	mV	EM61MKII	N		
1584	496767.9	4559114.5	236.6693573	87.08158873	9.430282595	332.4964599	mV	EM61MKII	N		
1585	496767.9	4559122.3	69.75417327	43.03818512	18.89982605	137.8675842	mV	EM61MKII	N		
1586	496768.1	4559104.6	279.0059814	198.0432891	118.9732055	655.7895506	mV	EM61MKII	N		
1587	496768.1	4559107	1395.771607	1060.572632	729.2510987	3641.031983	mV	EM61MKII	N		
1589	496768.2	4559117.6	17.19357872	12.11483765	6.764435293	39.84247208	mV	EM61MKII	N		
1590	496768.5	4559127.8	46.60674286	29.8777771	15.29324341	97.81820679	mV	EM61MKII	N		
1591	496768.7	4559110.6	270.1109008	183.6308593	101.4170379	601.2341918	mV	EM61MKII	N		
1592	496768.8	4559105.2	272.7933652	196.415222	114.2721557	642.8428949	mV	EM61MKII	N		
1593	496769	4559107.3	1839.80896	1279.187622	800.8566284	4387.303711	mV	EM61MKII	N		
1594	496769.1	4559106.1	155.5905761	79.95932001	31.7488136	276.5182798	mV	EM61MKII	N		
1595	496769.3	4559123.8	19.85301781	13.35595703	6.59042406	42.6637001	mV	EM61MKII	N		
1596	496769.4	4559131.9	30.40633201	21.4208374	12.34867096	70.40890503	mV	EM61MKII	N		
1597	496769.4	4559112.7	1030.596557	720.496704	395.789978	2329.156006	mV	EM61MKII	N		
1598	496769.5	4559111.1	132.6227112	97.51149746	57.64218137	309.2738952	mV	EM61MKII	N		
1599	496769.5	4559125.7	23.74921226	15.62724304	7.671913623	49.56866836	mV	EM61MKII	N		
1600	496769.6	4559128.8	21.37033653	15.92692566	9.799362182	51.79022598	mV	EM61MKII	N		
1601	496769.9	4559122.3	452.6461791	289.1827392	135.5735321	919.6561278	mV	EM61MKII	N		
1602	496770	4559115.1	496.0025329	334.6815185	182.5057983	1089.935913	mV	EM61MKII	N		
1603	496770.1	4559105.3	256.0723266	186.0180054	109.0582428	609.8968505	mV	EM61MKII	N		
1604	496770.3	4559131.6	25.50053978	17.69906616	10.10839081	58.49457168	mV	EM61MKII	N		
1605	496770.3	4559119.6	25.64813804	19.01719665	12.15904236	63.59387587	mV	EM61MKII	N		
1606	496770.9	4559127.1	54.05759429	13.91120911	1.75828588	70.10110473	mV	EM61MKII	N		
1607	496771	4559112.7	275.0997009	184.7713623	86.22357938	570.8649901	mV	EM61MKII	N		
1608	496771.1	4559115.4	531.5699462	326.4968872	141.9994812	1037.261963	mV	EM61MKII	N		
1609	496771.2	4559108.6	498.8483275	332.9620971	166.4769287	1051.215454	mV	EM61MKII	N		
1612	496772.2	4559121.3	65.57242584	43.26074219	25.5802269	146.8259888	mV	EM61MKII	N		
1613	496772.3	4559122.7	23.94777489	17.82780456	11.29163361	59.07092666	mV	EM61MKII	N		

1614	496772.8	4559109.6	860.9895022	527.5405733	261.7365799	1752.045288	mV	EM61MKII	N		
1615	496772.9	4559108.3	132.2605591	68.72001648	26.27407455	236.0727539	mV	EM61MKII	N		
1616	496773	4559114.1	294.0924682	204.1408844	103.9920349	638.7125854	mV	EM61MKII	N		
1617	496773	4559111.3	284.2718201	182.8694611	94.40207672	601.7562866	mV	EM61MKII	N		
1618	496773.2	4559106.6	550.5416868	352.4574889	177.0414428	1155.500122	mV	EM61MKII	N		
1619	496773.5	4559121.5	54.67647553	40.6057129	24.90695191	132.0221558	mV	EM61MKII	N		
1620	496773.6	4559109.5	398.7521973	252.9735108	119.341095	814.550232	mV	EM61MKII	N		
1621	496773.9	4559107.3	212.7577967	153.0643612	103.5721891	525.0651232	mV	EM61MKII	N		
1622	496774.2	4559112.7	1317.107422	943.9953613	562.9917603	3135.961426	mV	EM61MKII	N		
1623	496774.8	4559118.6	76.24932101	38.96814729	12.49464417	130.9275208	mV	EM61MKII	N		
1624	496775	4559108.4	216.9432982	150.7839355	89.7242889	503.9547422	mV	EM61MKII	N		
1625	496776	4559108	143.4412536	108.4833907	70.66606899	359.3349607	mV	EM61MKII	N		
1626	496776	4559108.9	44.05535124	27.17915343	13.28155517	90.20431515	mV	EM61MKII	N		
1627	496776.3	4559113.4	155.6611061	103.9067631	56.05618477	347.1626816	mV	EM61MKII	N		
1628	496776.8	4559107	68.5165176	49.92666623	30.97372053	166.1932677	mV	EM61MKII	N		
1629	496777.1	4559108.4	344.2784116	256.6486204	165.3377684	858.6437371	mV	EM61MKII	N		
1630	496777.4	4559109.6	52.62427517	42.82789609	29.42826078	144.0180053	mV	EM61MKII	N		
1631	496778.2	4559111.7	389.9467161	264.4631041	144.0995483	859.8373409	mV	EM61MKII	N		
1632	496778.4	4559109.1	238.0957181	163.9248655	93.43231192	542.1291498	mV	EM61MKII	N		
1633	496778.9	4559110.1	135.0456888	89.13309875	46.25149736	289.4037175	mV	EM61MKII	N		
1634	496779	4559108	122.5999069	93.04444118	58.96990964	314.1134642	mV	EM61MKII	N		
1635	496779.2	4559108.7	61.60987091	45.97855377	27.62233734	149.6049194	mV	EM61MKII	N		
1638	496774.6	4559114.3	329.9830017	242.2782745	166.8618317	838.6506957	mV	EM61MKII	N	cf ?	
1639	496774.8	4559113.2	1843.718872	1299.456054	774.2649535	4328.082519	mV	EM61MKII	N	cf ?	
1637	496772.5	4559118.1	3978.956054	2766.913329	1552.279175	9005.216795	mV	EM61MKII	N	cf ?	

Notes:
"1" = The anomaly has been selected as a reacquisition target location
cf = potential cultural feature
mv = millivolt
N = No

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Attachment 4
Ohio EPA Correspondence

Crispo, David

From: Crispo, David
Sent: Monday, December 19, 2011 3:41 PM
To: Mohr, Eileen
Cc: Trumble, Jay N LRL; Cobb, Dave
Subject: Responses to Questions/Comments on Group 8
Attachments: Sample Sizes_hypergeometric_Group8.xlsx

Eileen – see our responses to your comments on the Group 8 site. Hopefully this clarifies things a bit (in particular the histograms and statistical package, etc).

#1: in future memos detail out what is meant by adverse conditions.
Response: We will include the details regarding adverse conditions in future memos.

#2: the response indicates that at ODA2 approx 30% of the anomalies <8mV were "no finds". What were the 70%? Or does this also tie into the last sentence of your response?
Response: The comments ties into the last sentence of the response which states that for the items below the 8 mV threshold that were investigated, none of the items were identified as MEC or MD. These "items" are considered the remaining 70%.

#3: on the revised map...
a) agree suspected culverts/interference from Siebert stakes etc. need to be field confirmed by appropriate methods (i.e. hand digging);
Response: the culverts and any other areas of interference will be confirmed either through visible confirmation or hand digging as necessary
b) confirm with RVAAP and OHARNG if the suspected utility is in actuality a utility;
Response: The suspected utility will either by investigated through hand digging or confirmation with Jim McGee or the REIMS GIS
c) consider putting two trenches in the anomaly area in the sw where you currently propose one additional trench;
Response: Agreed. As indicated on the response figure, the pink area is not as dense as it looks but we can add another trench or two for verification purposes.
d) the area on the SE where you indicate that there are really 5 anomalies vs one large due to the map scale. Please justify digging only one of the five anomalies.
Response: Since we performed 100% DGM on the site, we chose representative anomaly locations. It is expected that investigation of one of the anomalies in this area will indicate what the anomalies are in this area. As stated on the response figure, we can perform additional investigation in this area if we find anything.

Other issues we discussed:
a. better explanation of the histogram, the selection of 15%, and the statistical package
Response:
Histograms – the histograms are provided to show that the anomaly selection process is random and not biased. For a random selection process the histogram shape will be the same for a sample of a population compared to the population as a whole. The USACE Baltimore wanted to see the histograms so they had documentation that our selection process was random.

The histograms summarize the results and proposed number of targets presented in the Summary of DGM Results in the memo. The top graph shows all the anomalies that were identified (1,541) and compares them to the frequency at which they were detected to the channel 2 scale (mV). Based on the top graph, a total of 90 items (5.48% of the anomalies detected) were detected at 10 mV and 76 items (approximately 4.4% of the items) were detected at greater than 1,000 mV. The bottom graph shows the anomalies that were identified as targets (248) which was 15% of the total number of anomalies detected (see discussion below how this percent was chosen). This graph provides a comparison of the target dig list items selected to the channel 2 scale. In general, the target dig list frequency and cumulative percent for each of the mV levels matches the cumulative percent for the total number of anomalies identified in the top graph. In other words, since 5.5% of the 1,541 items detected were detected at the 10mV level, then of the 248 items selected for investigation, approximately the same percent target items (4.4%) will be investigated at the 10 mV level.

Anomaly Selection – The selection of 15% as the percentage for the number of target dig list items is based on the statistical inputs presented in the Proposed Dig Locations section of the memo (95% confidence, 2.5% error limits and a probability of 5%). Based on the HYPERGEOM program, there is a 95% probability (i.e., confidence level) that seven or more items of interest will be identified if 15% of the individual anomalies are investigated (i.e., 248 of 1,641 identified anomalies). Using this percentage, the table in the Proposed Dig Locations section of the memo gives us an indication of what we would expect to find. Based on this table, it would be expected that there is a 100% chance that at least one item of interest (MEC/MD) would be found or an approximate 60% chance that 11 or more MEC/MD items would be found.

Statistical Package - The attached Sample Size spreadsheet was used to determine the # of anomaly selections (15%) at a 95% confidence level. This spreadsheet was provided by another project from the USACE Sacramento and is considered acceptable to USACE Baltimore for anomaly selection since we performed 100% DGM of the site. "p" in the spreadsheet is the anticipated probability – i.e., how many "widgets" (or in this case MEC/MD) are expected in the population of anomalies. The "p" value is estimated based on the historical information for each MRS, and the error is usually selected as ½ "p".

The HYPERGEOM module in Excel is a standalone program and is not directly related to the attached USACE spreadsheet. The inputs are the total number of anomalies, how many you believe are "widgets" or items of interest, and how many samples you will select from the population (i.e., # of digs). It is synonymous with marbles in a jar – white marbles are non-MEC/MD and red marbles are related to MEC/MD ("widgets"). The program tells you the probability of finding "X" (i.e., 1, 2, 3, 4, etc.) red marbles based on how many marbles you actually pull out of the jar. This program is a sanity check on the USACE spreadsheet. Note that if there were only one or two red marbles in a jar of 1,000 white marbles you would have to extract virtually 100% of the marbles to find at least one red marble.

b. confirming if interference is due to controlled humidity storage

Response: Following the November 14 interference data, follow up data for the site was checked for similar noise and none was found. It is only suspected that the interference on that day was associated with the controlled humidity storage. At the Group 8 MRS there would be little affect from the interference on the overall outcome due to the very high anomaly density. Usually, the negative impact of "noise" is that targets are selected that are due to the "noise" and not actual subsurface metal, so the false positive rate increases. Due to the amount of subsurface metal at Group 8, the false positive rate will most likely be very low.

c. the ability to investigate other anomalies based upon what is

Response: Is part of this comment missing?

d. adding info to fig 2 (client etc.)

Response: This figure was prepared by our geophysical group and was presented for information purposes for the memo. All figures in the actual submittals (RI) will have the appropriate information.

Call with any questions. If we don't talk before the end of the week, have a Merry X-Mas as well.

Thanks

Dave

David Crispo, P.E.
Project Engineer
Shaw Environmental & Infrastructure, Inc.
100 Technology Center Drive
Stoughton, MA 02072
617.589.8146 direct
617.589.2160 fax

Crispo, David

From: Mohr, Eileen [eileen.mohr@epa.state.oh.us]
Sent: Friday, December 16, 2011 12:58 PM
To: Crispo, David
Cc: Cobb, Dave; Trumble, Jay N LRL; Mohr, Eileen
Subject: RE: Responses to Questions/Comments on Group 8 Memo

Hi dave:

Sorry for the delay.

#1: in future memos detail out what is meant by adverse conditions.
#2: the response indicates that at ODA2 approx 30% of the anomalies <8mV were "no finds". What were the 70%? Or does this also tie into the last sentence of your response?
#3: on the revised map... a) agree suspected culverts/interference from Siebert stakes etc. need to be field confirmed by appropriate methods (i.e. hand digging); b) confirm with RVAAP and OHARNG if the suspected utility is in actuality a utility; c) consider putting two trenches in the anomaly area in the sw where you currently propose one additional trench; d) the area on the SE where you indicate that there are really 5 anomalies vs one large due to the map scale. Please justify digging only one of the five anomalies.

Other issues we discussed:
a. better explanation of the histogram, the selection of 15%, and the statistical package
b. confirming if interference is due to controlled humidity storage
c. the ability to investigate other anomalies baed upon what is
d. adding info to fig 2 (client etc.)

That is it.

Have a great Christmas if I don;t talk to you before hand!

Eileen

From: Crispo, David [david.crispo@shawgrp.com]
Sent: Friday, December 09, 2011 11:17 AM
To: Mohr, Eileen
Cc: Cobb, Dave; Trumble, Jay N LRL
Subject: Responses to Questions/Comments on Group 8 Memo

Eileen

Per our discussion regarding the Group 8 MRS memo dated November 30, 2011, here is our responses and clarifications to your comments/questions.

1. *Comment*: Explain what the adverse surface conditions were that are discussed on page 2.
   Response: The adverse surface conditions were wet conditions and uneven ground surface (ruts, etc.); however, as noted in the memo, even with the adverse conditions, the required metrics were met.

2. *Comment:* Need to demonstrate that 8 mv is an appropriate threshold.
   Response: The proposed strategy is consistent with the results of the IVS where smaller MEC items in the near surface produced a response that exceeds 8 mv, as well as the results of the ODA2 and Ramsdell Quarry Landfill Area 2 where the excavation results indicated approximately 30% of the anomalies less than 5 mV were “no finds”. In addition, for Atlas Scrap Yard, we investigated 100% of the anomalies over 8 mV (3,023 items) and randomly selected 50% of the items less than 8 mV (174 items) for investigation. It should be noted that for all

these MRS where items below the 8 mV threshold were investigated, none of the items were identified as MEC or MD.

3. *Comment:* There were questions regarding whether various areas should be trenched, hand dug or both. *Response:* See attached figure with responses and proposed actions at these areas of question.

I think the response cover the majority of your comments/questions but let Dave or I know we missed anything or if you have additional questions or would like to discuss the responses.

Thanks
Dave

David Crispo, P.E.
Project Engineer
Shaw Environmental & Infrastructure, Inc.
100 Technology Center Drive
Stoughton, MA 02072
617.589.8146 direct
617.589.2160 fax

Appendix B
Field Documentation

Field Logs

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Shaw™ Shaw E & I

Soil / Sediment Field Logsheet

Site Name: GROUP 8 MRS

Project #: 136147

Sample ID: GR855-001M-0001-SO

Sample Type*: Incremental soil

*: SED=Sediment; SUR=Surface soil; SUB=Subsurface Soil; OTH=Other. grab=Grab, comp=Composite

Date Sampled: 2/8/12

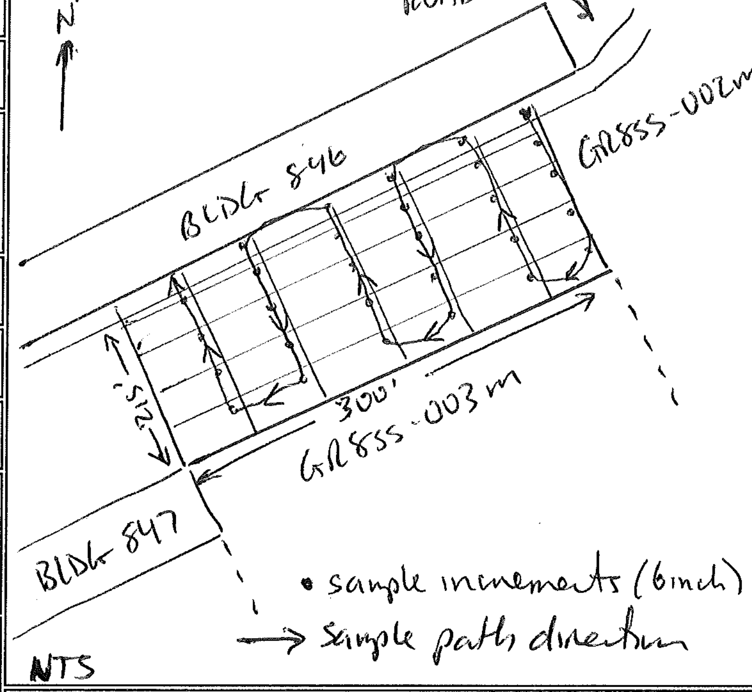
Time Sampled: 1430

Depth (ft bgs): 0.5

Physical description: soil fill material w/gravel, dark soil and metal debris. very little natural soil material

Analyses requested: MEC metals, geochem metals (Ca, Mg, Mn), explosives, PCBs, nitrocellulose, SVOCs, TOC, pH

Sample Location Sketch:



Photograph Log #:

PID: NA

Calibration Date: NA

O2/LEL: NA

Calibration Date: NA

Weather: overcast, light snow, winds to NE @ 5-10 mph

Temperature: 30 °F

Sampling Equipment: stainless steel step probe

Equipment Decontamination Technique: DI/alconox/DI, alcohol, DI water

QC Samples: NONE

Analytical Laboratory: CT Laboratories, Baraboo, WI

Comments: Area consists mostly of soil fill material

Field Technician: (Print) DAVID CRISPO

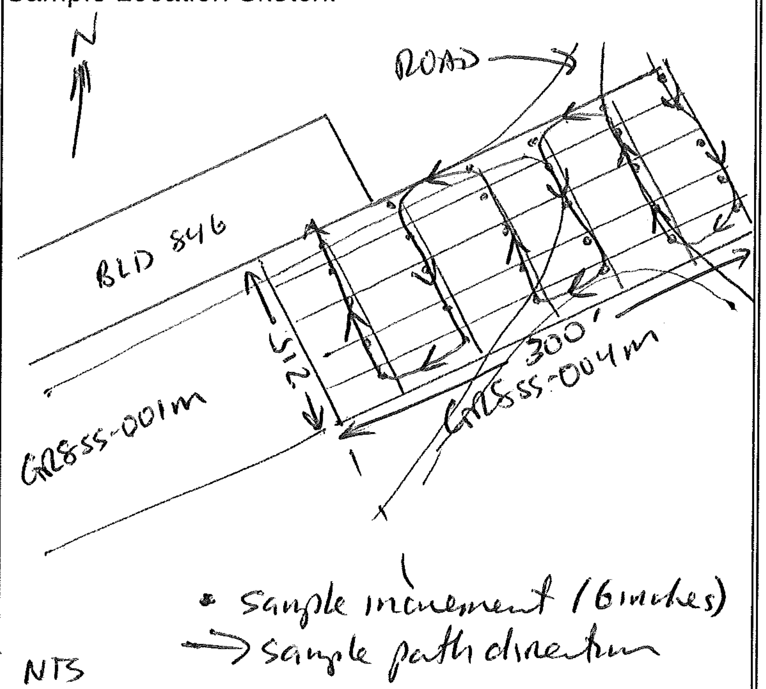
Date: 2/8/12

Soil / Sediment Field Logsheet

Shaw™ Shaw E & I

Site Name: GROUP 8 MRS

Project #: 136147

Sample ID: GR8SS-002M-0001-SO	Sample Location Sketch: 
Sample Type*: Incremental soil	
*: SED=Sediment; SUR=Surface soil; SUB=Subsurface Soil; OTH=Other. grab=Grab, comp=Composite	
Date Sampled: 2/8/12	
Time Sampled: 1240	
Depth (ft bgs): 0.5	
Physical description: soil fill material w/gravel, dark soil and metal debris, very little natural soil material	
Analyses requested: MEC metals, geochem metals (Ca, Mn, Mg), explosives, PCBs, nitrocellulose, SVOCs, TOC, pH	Photograph Log #:
PID: NA	Calibration Date: NA
O2/LEL: NA	Calibration Date: NA

Weather: overcast, light snow, winds to NE @ 5-10 mph

Temperature: 30 °F

Sampling Equipment: stainless steel step probe

Equipment Decontamination Technique: DI, alconox/DI, alcohol, DI water

QC Samples: NONE

Analytical Laboratory: CT Laboratories, Baraboo, WI

Comments: Area consists of mostly fill material

Field Technician: (Print) DAVID CRISPO

Date: 2/8/12

Shaw™ Shaw E & I

Soil / Sediment Field Logsheet

Site Name: GROUP 8MRS

Project #: 136147

Sample ID: GR855-003M-0001-SO

Sample Type*: Incremental soil

*: SED=Sediment; SUR=Surface soil; SUB=Subsurface Soil; OTH=Other. grab=Grab, comp=Composite

Date Sampled: 2/8/12

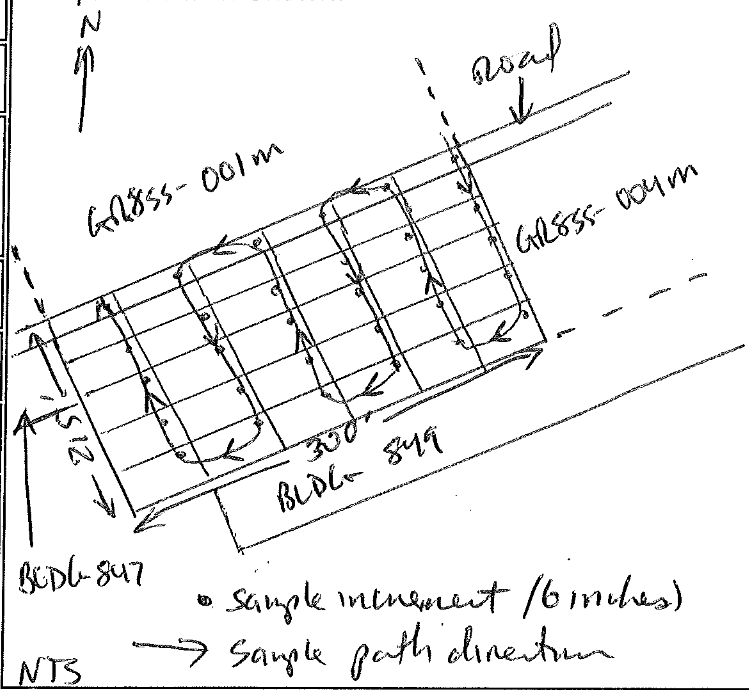
Time Sampled: 1310

Depth (ft bgs): 0.5

Physical description: soil fill material w/ gravel, dark stained soils and metal debris, very little natural soil

Analyses requested: MEC metals, geochem metals (Ca, Mn, Mg), explosives, PCBs, nitrocellulose, SVOCs, TOC, pH

Sample Location Sketch:



Photograph Log #:

PID: NA

Calibration Date: NA

O2/LEL: NA

Calibration Date: NA

Weather: overcast, light snow, winds to NE @ 5-10 mph

Temperature: 30 °F

Sampling Equipment: stainless steel step probe

Equipment Decontamination Technique: DI, alconox/DI, alcohol, DI water

QC Samples: NONE

Analytical Laboratory: CT Laboratories, Baraboo, WI

Comments: Area consists mostly of fill material

Field Technician: (Print) DAVID CRISPO

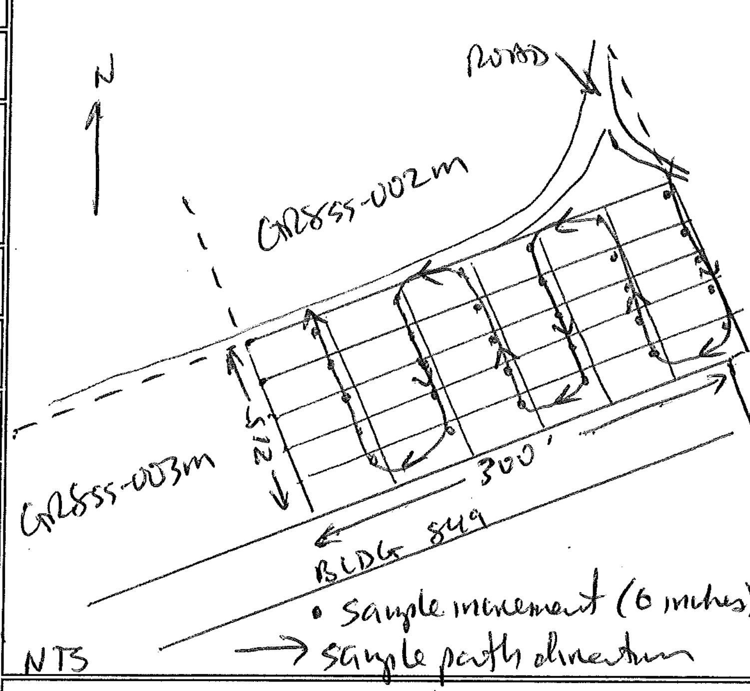
Date: 2/8/12

Shaw™ Shaw E & I

Soil / Sediment Field Logsheet

Site Name: GROUP 8 MRS

Project #: 136147

Sample ID: GR8SS-004M-0001-SO	Sample Location Sketch: 
Sample Type*: Incremental soil	
*: SED=Sediment; SUR=Surface soil; SUB=Subsurface Soil; OTH=Other. grab=Grab, comp=Composite	
Date Sampled: 2/8/12	
Time Sampled: 1400	
Depth (ft bgs): 0.5	
Physical description: soil fill material w/ gravel, dark stained soil and debris, very little natural soil	
Analyses requested: MEC metals, geochem metals (Ca, Mg, Mn), explosives, PCBs, nitrocellulose, SVOCs, TOC, pH	Photograph Log #:
PID: NA	Calibration Date: NA
O2/LEL: NA	Calibration Date: NA

Weather: overcast, light snow, winds to NE @ 5-10 mph

Temperature: 30° F

Sampling Equipment: stainless steel step probe

Equipment Decontamination Technique: DI, alconox/DI, alcohol, DI water

QC Samples: GR8SS-005M-0001-SO (field duplicate) MS/MSD sample

Analytical Laboratory: CT Laboratories, Baraboo, WI

Comments: Area consists mostly of soil fill material

Field Technician: (Print) DAVID CRISPO

Date: 2/8/12

Shaw™ Shaw E & I

Soil / Sediment Field Logsheet

Site Name: GROUP 8 MRS

Project #: 136147

Sample ID: GR8SS-005M-0001-SO

Sample Type*: Incremental soil

*: SED=Sediment; SUR=Surface soil; SUB=Subsurface Soil; OTH=Other. grab=Grab, comp=Composite

Date Sampled: 2/8/12

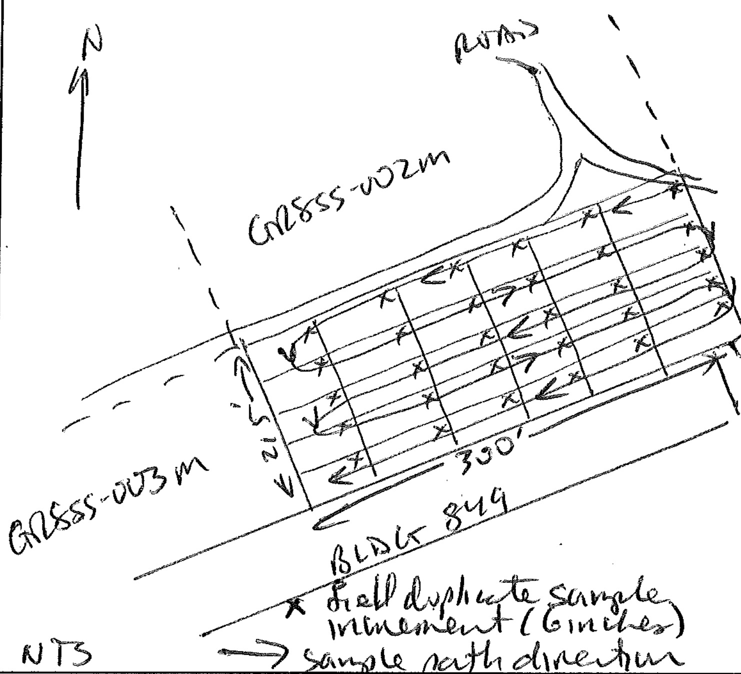
Time Sampled: 1430

Depth (ft bgs): 0.5

Physical description: soil fill material w/gravel, cloth stained soil and debris. Very little natural soil

Analyses requested: MEC metals, geochem metals (Ca, Mn, Mg), explosives, PCBs, nitrocellulose, SVOCs, TOC, pH

Sample Location Sketch:



Photograph Log #:

PID: NA

Calibration Date: NA

O2/LEL: NA

Calibration Date: NA

Weather: overcast, light snow, winds to NE @ 5-10 mph

Temperature: 30° F

Sampling Equipment: stainless steel step probe

Equipment Decontamination Technique: DI/alconox/DI, alcohol, DI water

QC Samples: field duplicate of GR8SS-004M-0001-SO

Analytical Laboratory: CT Laboratories, Baraboo, WI

Comments: Area consists of mostly soil fill material

Field Technician: (Print) DAVID CRISPO

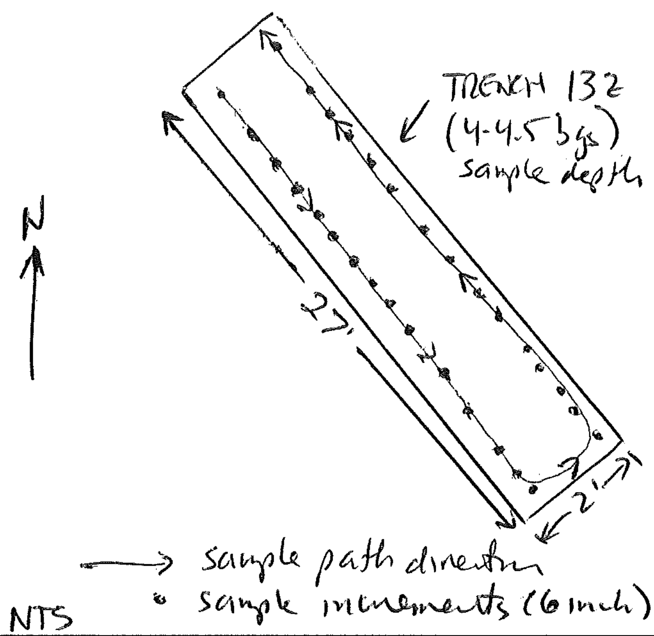
Date: 2/8/12

Shaw™ Shaw E & I

Soil / Sediment Field Logsheet

Site Name: GRAAP & MRS

Project #: 136147

Sample ID: GR8SS-006M-0001-SO	Sample Location Sketch: 
Sample Type*: Incremental soil	
*: SED=Sediment; SUR=Surface soil; SUB=Subsurface Soil, OTH=Other. grab=Grab, comp=Composite	
Date Sampled: 2/8/12	
Time Sampled: 1300	
Depth (ft bgs): 4-4.5	
Physical description: very dense light brown, clayey silty soil	
Analyses requested: MEC metals, geochem metals (Ca, Mn, Mg), explosives, PCBs, nitrocellulose, SVOCs, TOC, pH	Photograph Log #:
PID: NA	Calibration Date: NA
O2/LEL: NA	Calibration Date: NA

Weather: overcast, light snow, winds to NE @ 5-10 mph

Temperature: 30 °F

Sampling Equipment: stainless steel step probe

Equipment Decontamination Technique: DI, alconox/DI, alcohol, DI water

QC Samples: NONE

Analytical Laboratory: CT Laboratories, Baraboo, WI

Comments: IS collected from trench 13Z where MD was found at ≈ 1 foot bgs. Samples collected @ 6 inch increment depth

Field Technician: (Print) DAVID CRISPO

Date: 2/8/12

Shaw™ Shaw E & I

Soil / Sediment Field Logsheet

Site Name: GROUP 8 MRS

Project #: 136147

Sample ID: GR855-007M-0001-SO

Sample Type*: Incremental soil

*: SED=Sediment; SUR=Surface soil;
SUB=Subsurface Soil; OTH=Other.
grab=Grab, comp=Composite

Date Sampled: 2/8/12

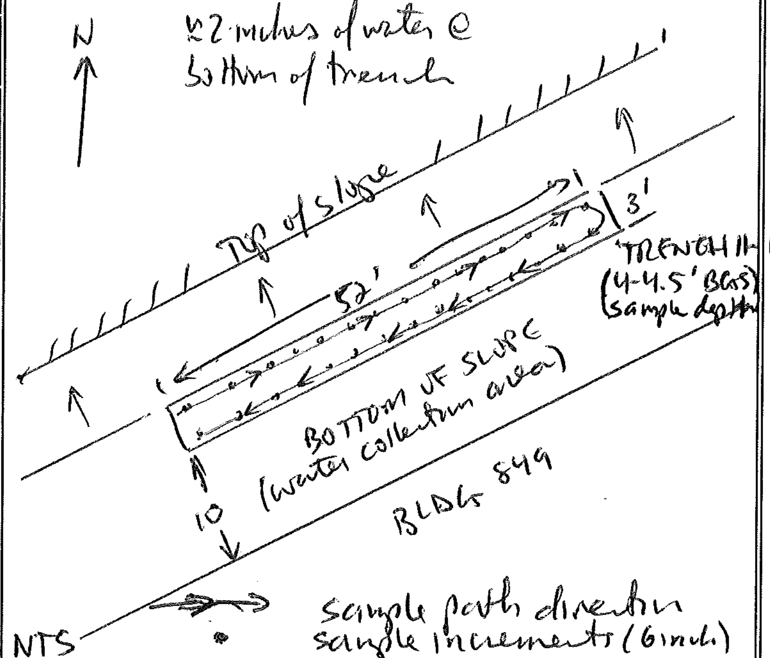
Time Sampled: 1320

Depth (ft bgs): 4-4.5

Physical description: very dense light brown, clayey silty soil

Analyses requested: MEC metals, geochem metals (Ca, Mn, Mg), explosives, PCBs, nitrocellulose, SVOCs, TOC, pH

Sample Location Sketch:



Photograph Log #:

PID: NA	Calibration Date: NA
O2/LEL: NA	Calibration Date: NA

Weather: overcast, light snow, winds to NE @ 5-10 mph

Temperature: 30°F

Sampling Equipment: stainless steel step probe

Equipment Decontamination Technique: DI, alconox/DI, alcohol, DI water

QC Samples: NONE

Analytical Laboratory: CT Laboratories, Baraboo, WI

Comments: IS collected from trench 11-1 where MD buried to ~4 feet
Sample collected @ 6-inch deep intervals for each increment

Field Technician: (Print) DAVID CRISPO

Date: 2/8/12

Shaw™ Shaw E & I

Soil / Sediment Field Logsheet

Site Name: GRAAP S MRS

Project #: 136147

Sample ID: GRSSS-008M-0001-SO

Sample Type*: Incremental Soil

*: ~~SED=Sediment~~; SUR=Surface soil; SUB=Subsurface Soil; OTH=Other. ~~grab=Grab, comp=Composite~~

Date Sampled: 2/8/12

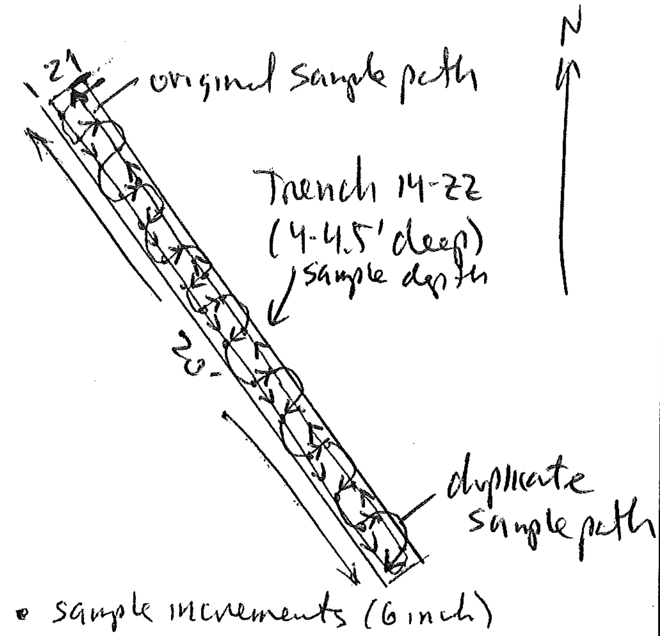
Time Sampled: 1345

Depth (ft bgs): 4-4.5

Physical description: very dense light brown, clayey, silty soil

Analyses requested: MEC metals, geochem metals (Ca, Mn, Mg), explosives, PCBs, nitrocellulose, SVOCs, TOC, pH

Sample Location Sketch:



NTS

Photograph Log #:

PID: NA

Calibration Date: NA

O2/LEL: NA

Calibration Date: NA

Weather: Overcast, light snow, winds to NE @ 5-10 mph

Temperature: 30° F

Sampling Equipment: Stainless steel step probe

Equipment Decontamination Technique: DI, alconox/DI, alcohol, DI water

QC Samples: GRSSS-009M-0001-SO (field duplicate)

Analytical Laboratory: CT Laboratories, Baraboo, WI

Comments: IS collected from trench T-14 22 where MD buried @ 4 ~~feet~~ inches DC 2/8/12
Sample collected at 6 inch intervals per increment

Field Technician: (Print) DAVID CRISPO

Date: 2/8/12

Field Sampling Audit

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FIELD SAMPLING AUDIT CHECKLIST

Shaw Audit No.:	136147-01	Audited Organization:	Shaw Sampling Crew (Crispo/Mallory/Harrison)
Shaw Project No.:	136147	Location:	Group 8 MRS, RVAAP
Date of Evaluation:	2/8/12	Name/Position of Evaluator:	Braden Livingstone, UXOQC/SSHO
Audited Activity:	Multi-increment surface soil sampling at the Group 8 MRS		

Item to be Evaluated	***Y***	***N***	***N/A***	***Comments***
Part 1: Sampling and Analysis Plan (SAP)				
1.1 General Information				
Is there a SAP?	X			
Are there procedures for transportation, handling, protection, storage, retention, and/or disposal of samples, including all provisions necessary to protect the integrity of the sample?	X			
Is there a documented system for uniquely identifying all samples and subsamples to ensure that there can be no confusion regarding the identity of such samples at any time?	X			
Does the sampling process address the factors to be controlled to ensure the validity of the environmental test and calibration results	X			No equipment requiring calibration
Is there a process for documenting corrective actions taken in the field?	X			
1.2 Standard Operating Procedures				
Are there SOPs for field activities available at the location where sampling is taking place and are they accessible to all sample collectors?		X		Not originally on site at beginning of sampling activities.
Have the SOPs been approved for the project?	X			
Part 2: Organization, Management and Personnel (not checked onsite)				
Are the sampling personnel's qualifications and/or training certifications adequate for the tasks performed?	X			
Are names of all sampling personnel recorded?	X			In daily JSA reports
Do sampling personnel meet minimum qualifications specified in the contract?	X			
Are staff training records maintained and up to date?	X			
Part 3: Equipment				
3.1 General Equipment Information				
Is the type of equipment sufficient for the sampling project?	X			Step probe samplers
Is the quantity of equipment sufficient for the sampling project?	X			

Item to be Evaluated	***Y***	***N***	***N/A***	***Comments***
Is the following information recorded for each piece of equipment that will be used for sampling project:			X	
Maintenance and repair procedures for equipment or instrument?			X	
Routine cleaning procedures?			X	
Filling solution replacement for probes?			X	
Parts replacement for instruments or probes?			X	
Calendar date for each procedure performed?			X	
Names of personnel performing maintenance and repair tasks?			X	
Description of malfunctions associated with any maintenance and repair?			X	
Vendor service records?			X	
Inclusive rental dates, types and unique descriptions of rental equipment?			X	
Is the equipment storage procedure acceptable?	X			Bldg 1036
Is there an existing QC check on sampling equipment?			X	
3.2 Field Calibration				
Is information about all calibration standards and reagents used for field testing linked to the calibration information associated with the field testing measurements for the project?			X	
Are field instruments properly calibrated and calibrations recorded in a bound field log book?			X	
For each instrument unit used for the sampling project, is the following information recorded for all calibrations:			X	
Unique identification (designation code) for the instrument?			X	
Date and time of each calibration and calibration verification?			X	
Instrument reading or result (display value) for all calibration verifications, with appropriate measurement units?			X	
Names of analyst performing each calibration of verification?			X	
Designation of each calibration standard used linked to the associated records for the calibration standard?			X	
The acceptance criteria for each calibration and verification standard used?			X	
The assay specifications or acceptance criteria for any QC standard or sample used to independently verify the calibration of the standard?			X	

Item to be Evaluated	***Y***	***N***	***N/A***	***Comments***
Are all corrective actions performed on the instrument prior to attempting reverification or recalibration of the instrument linked to the records required for preventive maintenance?			X	
Does the field instrumentation documentation include the standard concentrations used for calibration?			X	
Did all field-testing equipment and instrumentation brought to the field appear to function properly?			X	
Are manufacturer’s suggested maintenance activities and any repairs performed and documented for all applicable equipment and instruments?			X	
3.3 Containers				
Are sample containers well organized, properly prepared, protected from contamination, and ready for use?	X			Large zip-loc baggies used to collect MI samples
Are proper sample containers and sizes used for each type of sample?			X	
Are certificates of analysis for pre-cleaned bottles maintained on file?			X	
Are all containers and container caps free of cracks, chips, discolorations and other features that might affect the integrity of the collected samples?			X	
3.4 Sampling Equipment				
Is the appropriate equipment used for the sampling project? Check all relevant equipment used for sample collection, handling, storage and transport.	X			
Is equipment constructed of materials appropriate for the analytes of interest?	X			
Is equipment brought to the field precleaned?	X			
For equipment decontaminated on-site in the field, are the date and time of the cleaning procedure recorded in the field records or referenced in an internal SOP?	X			Step probes are cleaned after each sampling event and stored at Bldg 1036
Are cleaning steps in all procedures used for decontamination documented either by description or reference to an SOP?	X			
Are there current maintenance records for all field equipment?			X	
Part 4: Sampling Event Information				
For all samples, is the following information recorded and maintained in the project files?				
Site name and address?	X			
Date and time of sample collection?	X			
Name of sampler responsible for sample transmittal?	X			

Item to be Evaluated	***Y***	***N***	***N/A***	***Comments***
Unique field identification code for each sample container or group of containers?	X			
Total number of samples collected?	X			
Required analyses for each sample container or group of containers?			X	
Sample preservation used for each container or group of containers?			X	
Comments about samples, sample sources or other relevant field conditions?	X			
Identification of common carrier used to transport the samples, when applicable?			X	
Are shipping invoices and related records from common carriers archived with the field records, when applicable?	X			
Are sampling locations adequately documented in a bound field log book using indelible ink?	X			Documented in field logs and maintained in project files.
Are photos taken and is a photo log maintained?	X			
4.1 Field QC				
Are trip blanks and/or field blanks collected as specified in the approved sampling plan?	X			
Are field blanks collected after equipment is decontaminated in the field	X			Equipment is cleaned at Bldg 1036
Are field blanks collected if no equipment was cleaned?		X		Equipment is cleaned same day as sampling
Are additional samples for matrix spike/matrix spike duplicate analyses collected?	X			
Are all QC samples collected in the same manner as the routine field samples?	X			
Part 5: Sample Management				
5.1 Collection				
Are the samples taken from a representative point of the source?	X			
Are the samples being collected in accordance with the SAP?	X			
Are samples for different analyte groups collected in the appropriate order?			X	All of sample is in baggie
Are samples collected for all required analyses?	X			
Are samples to be tested for dissolved metals filtered prior to preservation?			X	
Is every effort made to prevent cross-contamination of samples?	X			Some non-conformance observed
Are gloves worn by all samplers handling purging equipment, sampling equipment, measurement equipment, and sample containers?	X			
Are new, clean unpowdered gloves used for each glove change?	X			

Item to be Evaluated	*Y*	*N*	*N/A*	*Comments*
Is care taken to avoid contact with sample and sample container interiors?	X			
Are VOC sample containers protected from any fuel sources and fuel-powered equipment?			X	No VOCs sampled
Do VOC sample containers remain capped until just prior to sample collection and do they remain capped after sample collection?			X	
Where applicable, are samples collected for measurement of dissolved components, filtered, preserved with acid, and placed on ice within 15 minutes of collection?			X	
5.2 Collection Devices				
Is sample collected using an intermediate collection device?			X	
Are intermediate collection devices rinsed with ample amounts of site water prior to collecting the sample?			X	
Is rinse water from intermediate devices discarded away from and downstream of the sampling location?			X	
Is the use of intermediate collection devices avoided when sampling for VOC's, oil and grease, or microbiologicals, where practical?			X	
Are any intermediate collection devices constructed of material appropriate for the analytes to be measured?			X	
Are sample containers submerged neck first, inverted into the oncoming direction of flow where applicable, slowly filled, and returned to the surface for preservation, if applicable?			X	
5.3 Sample Labeling				
Is each sample container or group of containers tagged or labeled with a unique field identification code that distinguishes the sample from all other samples?	X			
Are the unique identification codes for samples recorded in a manner that links the codes to all other field records associated with the samples?	X			
Is waterproof indelible ink used to label containers?	X			
5.4 Storage				
Are samples for different parameters segregated during storage?			X	
Are samples stored on ice?	X			
Is the cooler clearly labeled?	X			
Are samples properly preserved (if applicable)?	X			
5.5 Preservation				

Item to be Evaluated	***Y***	***N***	***N/A***	***Comments***
Do all sample preservation techniques conform to SOP or method requirements?	X			Placed on ice
Are all samples properly preserved within 15 minutes, as applicable?	X			
Are the preparation and dispensing of preservatives documented and traceable?			X	
Is preservation information and verification recorded for each sample, as applicable?			X	
Are samples placed on ice immediately after collection, if applicable?	X			
5.6 Delivery				
Are samples protected during delivery to prevent breakage?	X			
Are samples shipped in a timely manner?	X			
5.7 Disposal				
Are wastes generated as a result of the sampling project containerized and stored for proper disposal according to applicable local, state, and federal regulations?	X			Decontamination waste and PPE.
Are all sampling-derived waste containers properly labeled?	X			
Is all sampling-derived waste properly disposed of?			X	Not disposed yet. Stored at Bldg 1036
5.8 Documentation				
Is waterproof ink used for all paper documentation?	X			
Are the date and time of sample collection recorded for all samples?	X			
Are the ambient field conditions recorded for all samples?	X			
Is a specific description of each sampling location (source) recorded?	X			
Does the chain of custody/traffic report include the following: date, time, sample numbers, sampler names, shipping method, number of samples, matrix, and comments?	X			
Is preservation information recorded on the chain of custody/traffic report?	X			
Are copies of traffic reports or COC sent to the proper recipients?	X			
Are deviations, additions, or exclusions from the documented sampling procedure recorded in detail with the associated sampling information?	X			
Are these deviations included in all documents containing environmental test and/or calibration results?			X	
Are these deviations communicated to the appropriate personnel?	X			
Are all errors in documentation (if applicable) corrected and initiated without obliteration?	X			

Item to be Evaluated	*Y*	*N*	*N/A*	*Comments*
5.9 Field Reagents				
Are the concentration (or other assay value), the vendor catalog number and the description of the standard or reagent recorded for all preformulated solutions, neat liquids, powders, and blank water?			X	
Are certificates of assay, grade and other vendor specifications for all standards and reagents retained and recorded for the standards and reagents?			X	
Are the lot numbers and inclusive dates of use recorded for all reagents, detergents, solvents, and other chemicals used for decontamination and preservation of samples?			X	
Are the expiration dates for all calibration standards and reagents recorded?			X	
Are expired standards and reagents verified prior to use during sample collection?			X	
Are all steps used for preparation of standards or reagents in-house documented either by description or reference to an SOP?			X	
Part 6: Field Analyses				
6.1 General Field Test Information				
Are all field measurement tests and related data recorded and linked to the project, the date, and the sample source?			X	
Are all field measurements recorded with the appropriate units, the value of the test result, the parameter measured, the name of the analyst performing the test, the time of the measurement and the unique identification for the test instrument used?			X	
6.2 pH				
Are all samples requiring pH adjustment tested for proper pH preservation?			X	
Is at least one sample per analyte group requiring pH adjustment tested for proper preservation during repeat sampling?			X	
Is pH paper or a pH electrode inserted into sample containers?			X	
Do the pH meter and electrode system meet SOP specifications for accuracy, reproducibility and design?			X	
Are all measurements corrected for temperature (manual or automatic)?			X	
Is a pH 7 buffer used as the first calibration standard?			X	
For pH, do all calibration verifications meet the acceptance criteria?			X	

Item to be Evaluated	*Y*	*N*	*N/A*	*Comments*
If the calibration and/or calibration verifications did not meet the acceptance criteria, is the calibration or verification identified as a failure and was this documented in the calibration log?			X	
Are all sample measurements associated with acceptable calibration verifications?			X	
Is the pH meter system checked on a weekly basis to ensure >90% theoretical electrode slope?			X	
Are the field instrument probes rinsed with deionized or distilled water between standard solutions and between sample measurements?			X	
Are instrument pH readings allowed to stabilize before pH values are recorded?			X	
6.3 Filtration				
Are samples collected for analysis of dissolved components filtered within 15 minutes of collection and before addition of chemical preservatives where appropriate?			X	
Unless otherwise specified, are applicable samples filtered using a 0.45-um pore size?			X	
6.4 Temperature				
Do the temperature measurement devices meet SOP and/or sampling event specifications for design and measurement resolution?			X	
Are all sample measurements associated with calibration verifications of the temperature measurement device at a minimum of two temperatures using a NISTtraceable thermometer?			X	
If the calibration and/or calibration verifications did not meet the acceptance criteria, is the calibration or verification identified as a failure and was this documented in the calibration log?			X	
Are all temperature measurements chronologically associated with acceptable calibration verifications?			X	
Are the temperature device readings allowed to stabilize before measurement values were recorded?			X	
6.5 Conductivity				
Do the specific conductance meter and electrode system meet the SOP and/or sampling event specifications for accuracy and reproducibility?			X	
Do all calibration verifications meet the acceptance criterion?			X	

Item to be Evaluated	***Y***	***N***	***N/A***	***Comments***
If the calibration and/or calibration verifications did not meet the acceptance criteria, is the calibration or verification identified as a failure and was this documented in the calibration log			X	
Are all conductivity measurements chronologically associated with acceptable calibration verifications?			X	
Are all conductivity measurements corrected for temperature (manual or automatic)?			X	
Is the instrument allowed to stabilize before measurement values are recorded?			X	
6.6 Turbidity				
Does the turbidimeter meet the SOP and/or sampling event specifications for accuracy and reproducibility?			X	
Are all sample measurements associated with acceptable calibration verifications?			X	
If the calibration and/or calibration verifications did not meet the acceptance criteria, is the calibration or verification identified as a failure and was this documented in the calibration log?			X	
Are the sample cells (optical cuvettes) inspected for scratches and discarded or coated with a silicone oil mask, as necessary?			X	
Are the sample cells (optical cuvettes) optically matched for calibrations and sample measurements?			X	
Are the sample cells (optical cuvettes) cleaned with detergent and deionized or distilled water between standard solutions and between sample measurements, as applicable?			X	
Are the sample cells (optical cuvettes) rinsed with sample prior to filling with sample for measurement?			X	
Is the exterior of the sample cell (optical cuvette) kept free of fingerprints and dried with a lint-free wipe prior to insertion in the turbidimeter?			X	
6.7 Dissolved Oxygen				
Do the dissolved oxygen meter and electrode system meet the SOP and/or sampling event specifications for accuracy and reproducibility?			X	
Are all sample measurements associated with acceptable calibration verifications?			X	
If the calibration and/or calibration verifications did not meet the acceptance criteria, is the calibration or verification identified as a failure and was this documented in the calibration log?			X	

Item to be Evaluated	***Y***	***N***	***N/A***	***Comments***
Are all measurements corrected for temperature (manual or automatic)?			X	
Are all measurements corrected for salinity, where applicable (manual or automatic)?			X	
Is the salinity (conductivity) sensor calibration verified?			X	
Is the dissolved oxygen electrode stored in a water-saturated air environment when not in use?			X	
Are the dissolved oxygen readings allowed to stabilize before measurement values were recorded?			X	

Shaw a world of Solutions	Title: Quality Surveillance Audit Report	Form No: EIP-Q-006.01_2

Project: RVAAP MMRP **Date:** 2/8/12

Surveillance Title: Incremental Surface Soil Sampling **Location:** Group 8 MRS

Shaw Audit No.: 136147-1

Documents Applicable to Audit
• Final Work Plan Addendum for Military Munitions Response Program Remedial Investigation Environmental Services, Version 1.0 (December 2011), • Final SAP/QAPP Addendum (Appendix A of Work Plan Addendum), • Shaw SOPs (EI-FS-001, Field Logbook; EIF-FS-003, Chain of Custody; EI-FS-006, Sample Labeling; EI-FS-002, Shipping Packing Non-Hazardous, EI-FS-014, Equipment Decontamination; EI-FS-103, Soil Probe Core Sampling)

Non-Conformance Observed	Corrective Action	Opportunities for Improvement
Applicable Shaw SOPs were not onsite at the beginning of sampling activities.	The sampling crew retrieved the applicable Shaw SOPs from the field office prior to commencing sampling activities.	Having all applicable SOPs and work plan documents on site during sampling activities is useful in achieving project objectives.
Although sampling equipment is wrapped in tin foil to protect from contamination during travel to site, samplers should take greater effort to protect the equipment from sources that may contaminate it.	Sample crew will segregate the samplers from the rest of the equipment brought to the site (coolers, buckets, etc) to better protect the equipment from cross contamination.	Better care of samplers will be helpful to ensure no cross contamination occurs.
Periodic handling of decontaminated equipment with used gloves was observed.	Crew to ensure they use new gloves after each sample location and prior to handling clean sampling equipment.	Putting on new gloves after handling used equipment will be helpful to prevent cross contamination between samples.

Summary Of Audit Results
The purpose of this Audit Report is to determine the degree of conformance with project and external requirements for multi-increment surface soil sampling that are being performed at the Ravenna Army Ammunition Plant, Ravenna, Ohio under the Military Munitions Response Program. The sampling crew audited included Dave Crispo, Harry Harrison and Tom Mallory. In summary, the multi-increment soil sampling event followed the procedures established in the Work Plan Addendum, SAP and SOPs. Minor non-conformances were observed as noted above. These issues were discussed with the sampling crew and corrected in a timely manner. No follow up corrective actions are required. This report has been sent to Dave Cobb, Project Manager, to provide an overview of occurring field activities.

AUDIT COMPLETED BY: ____________ DATE: 2/8/12

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Appendix C
Data Validation Report

Data Evaluation Report
for the Military Munitions Response Program
Remedial Investigation Environmental Services at the
Ravenna Army Ammunition Plant

Ravenna, OH
February 2012 Sampling Events at the Group 8 MRS

Prepared for the
U.S. Army Corps of Engineers – Baltimore District
10 South Howard Street, Room 700
Baltimore, Maryland 21201
USACE contract MAMMS No. W912-0-D-0005, DO No.0002

and

Shaw Environmental & Infrastructure, Inc.
150 Royall Street
Canton, Massachusetts 02021

Shaw Project No. 136147

By
E-Lab Data Consultants
30710 S Holly Oaks Circle
Magnolia, TX 77355

E-LAB DATA CONSULTANTS

Data Evaluation Report for the Military Munitions Response Program Remedial Investigation Environmental Services at the Ravenna Army Ammunition Plant

Ravenna, OH

February 2012 Sampling Events at the Group 8 MRS

May 20, 2012

Approved by: ______________________ Date: 05/20/2012
Larry Duty, Project Chemist

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Acronyms and Abbreviations

%RSD	percent relative standard deviation
%D	percent difference
CCAL	continuing calibration
CCV	continuing calibration verification
COC	chain of custody
DER	Data Evaluation Report
DL	detection limit
DOD	Department of Defense
ELAP	Environmental Laboratory Accreditation Program
GC/MS	gas chromatograph/mass spectrometry
ICAL	initial calibration
ICS	interference check sample
ICV	initial calibration verification
LCG	Louisville Chemistry Guideline
LCS	laboratory control sample
LKM	Lloyd Kahn Method
LOD	limit of detection
LOQ	limit of quantitation
MEC	munitions and explosives of concern
MRS	munitions response site
MS	matrix spike
MSD	matrix spike duplicate
NELAC	National Environmental Laboratory Accreditation Conference
PDS	post digestion spike
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
SAP Addendum	Sampling and Analysis Plan and QAPP

SDG	Sample Delivery Group
SOP	standard operating procedure
TOC	total organic carbon
USACE	U.S. Army Corps of Engineers

1.0 LABORATORY NELAP CERTIFICATION STATEMENT

E-Lab Data Consultants has verified that at the time the laboratory data were generated for the project, CT Laboratories was National Environmental Laboratory Accreditation Conference (NELAC) and Department of Defense (DOD) Environmental Laboratory Accreditation Program (ELAP) accredited for the matrices, analytes, and parameters of analysis requested on the chain-of-custody form. The CT Laboratories current certifications are presented in the laboratory data package for the Group 8 MRS that are provided in Appendix D of the Remedial Investigation Report in electronic format.

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2.0 INTRODUCTION

This report contains the results of the data evaluation conducted for soil samples collected and analyzed from the Group 8 Munitions Response Site (MRS) as part of the Military Munitions Response Program, Remedial Investigation Environmental Services, at the Ravenna Army Ammunition Plant, Ravenna, Ohio. This sampling event was contracted to Shaw Environmental & Infrastructure, Inc. (Shaw) by the U.S. Army Corps of Engineers (USACE) Baltimore District, under the United States Army's firm fixed-price Performance-Based Acquisition contract W912DR-09-D-0005, Delivery Order No. 0002. This report was generated by E-Lab Data Consultants under contract from Shaw Environmental in compliance with the *Final Sampling and Analysis Plan and Quality Assurance Project Plan Addendum for Military Munitions Response Program Remedial Investigation Environmental Services Version 1.0* (Shaw, 2011); herein referenced as the SAP Addendum..

The purpose of the sampling event is to provide data for evaluating contaminant concentrations in soil at the Group 8 MRS area. These samples were analyzed by CT Laboratories (Baraboo, Wisconsin) in accordance with the approved *Department of Defense Quality Systems Manual for Environmental Laboratories, Version 4.2, DoD, 2010* (DoD QSM) and the analytical methods specified and requested on the chain of custody (COC) form. Table 2-1 provides a list of the samples collected, a laboratory sample number cross-reference, sample matrix, date collected, sample purpose, and analytical methods performed for each sample. This data evaluation report (DER) report includes data review/validation for the analyses requested in accordance with *Louisville Chemistry Guideline (LCG) Environmental Engineering Branch-Louisville District, June 2002.*

The data were evaluated against the acceptance limits published in the DoD QSM and/or laboratory-established statistical process control limits for the data quality parameters of sensitivity, accuracy, precision, and completeness. The data were also evaluated for fulfillment of the quality assurance (QA) parameters of representativeness and comparability as defined in the SAP Addendum (Shaw, 2011). The laboratory data reports are presented in electronic format (on CD) in Appendix D of the Remedial Investigation Report for the Group 8 MRS. The laboratory data reports include the laboratory sample delivery group case narratives and the reportable data as specified in the DoD QSM and the SAP Addendum (Shaw, 2011).

In accordance with Section V of the LCG, a review of the data was conducted independent of the laboratory. This review consisted of an evaluation of laboratory performance criteria from the case narrative, an evaluation of the sample-specific criteria included in the laboratory data packages, and data transcriptions in accordance with the DoD QSM.

Table 2-1
Field Sample and Laboratory ID Numbers

Field I.D.	Lab Sample Number	Matrix	Date Collected	Time Collected	Purpose	Analytical Methods –
GR8SS-001M-0001-SO	122187	soil	2/8/2012	1430	Field Sample	MEC and Geochem Metals-6010C/7471A/7196A Explosives-8330B Nitrocellulose-9056M PCBs-8082A SVOCs-8270C TOC-LKM pH-9045D
GR8SS-002M-0001-SO	122188	soil	2/8/2012	1240	Field Sample	MEC and Geochem Metals-6010C/7471A/7196A Explosives-8330B Nitrocellulose-9056M PCBs-8082A SVOCs-8270C TOC-LKM pH-9045D
GR8SS-003M-0001-SO	122189	soil	2/8/2012	1310	Field Sample	MEC and Geochem Metals-6010C/7471A/7196A Explosives-8330B Nitrocellulose-9056M PCBs-8082A SVOCs-8270C TOC-LKM pH-9045D
GR8SS-004M-0001-SO	122190	soil	2/8/2012	1400	Field Sample	MEC and Geochem Metals-6010C/7471A/7196A Explosives-8330B Nitrocellulose-9056M PCBs-8082A SVOCs-8270C TOC-LKM pH-9045D

Table 2-1 (continued)
Sample Field and Laboratory ID Numbers

Field I.D.	Lab Sample Number	Matrix	Date Collected	Time Collected	Purpose	Analytical Methods –
GR8SS-005M-0001-SO	122191	soil	2/8/2012	1430	Field replicate of GR8SS-004M-0001-SO	MEC and Geochem Metals-6010C/7471A/7196A Explosives-8330B Nitrocellulose-9056M PCBs-8082A SVOCs-8270C TOC-LKM pH-9045D
GR8SS-006M-0001-SO	122192	soil	2/8/2012	1300	Field Sample	MEC and Geochem Metals-6010C/7471A/7196A Explosives-8330B Nitrocellulose-9056M PCBs-8082A SVOCs-8270C TOC-LKM pH-9045D
GR8SS-007M-0001-SO	122193	soil	2/8/2012	1320	Field Sample	MEC and Geochem Metals-6010C/7471A/7196A Explosives-8330B Nitrocellulose-9056M PCBs-8082A SVOCs-8270C TOC-LKM pH-9045D
GR8SS-008M-0001-SO	122194	soil	2/8/2012	1345	Field Sample	MEC and Geochem Metals-6010C/7471A/7196A Explosives-8330B Nitrocellulose-9056M PCBs-8082A SVOCs-8270C TOC-LKM pH-9045D

Table 2-1 (continued)
Sample Field and Laboratory ID Numbers

Field I.D.	Lab Sample Number	Matrix	Date Collected	Time Collected	Purpose	Analytical Methods –
GR8SS-009M-0001-SO	122195	soil	2/8/2012	1405	Field replicate of GR8SS-008M-0001-SO	MEC and Geochem Metals-6010C/7471A/7196A Explosives-8330B Nitrocellulose-9056M PCBs-8082A SVOCs-8270C TOC-LKM pH-9045D
GR8-RB-01	122196	water	2/9/2012	0845	Equipment Rinsate Blank	MEC Metals-6010C/7470A Explosives-8330 Nitrocellulose-9056M PCBs-8082B SVOCs-8270C

These two types of review processes are discussed further in Sections 3.0 and 4.0 of this DER. The results of the independent data review are presented in Section 5.0. An overall assessment of the data relative to the quantitative and QA parameters is provided in Section 6.0. Section 7.0 presents an evaluation of the quality and usability of the data in regards to project decisions. Section 8.0 discusses other potential data uses and limitations. Section 9.0 documents corrective actions and work plan deviations. Section 10.0 documents rejected data and the resultant project consequences. Section 11.0 summarizes the technical conclusions.

Following the specifications in the LCG related to the data review process, the data were annotated with data review qualifiers and associated bias codes on the analytical data sheets. Table 2-2 provides definitions of the data qualifiers and bias definitions, and Table 2-3 lists and defines the data review qualifier codes.

Table 2-2
Data Review Qualifier Definitions

Qualifier	Definitions
U	The analyte was analyzed for but not detected. The value preceding the U is the detection limit (DL).
J	The identification of the analyte is acceptable, but the quality assurance criteria indicate that the quantitative values may be outside the normal expected range of precision (i.e. the quantitative value is considered estimated).
R	Data are considered to be rejected and shall not be used. This flag denotes the failure of quality control criteria such that it cannot be determined if the analyte is present or absent from the sample. Re-sampling and analysis are necessary to confirm or deny the presence of the analyte.
UJ	This flag is a combination of the U and J qualifiers which indicates that the analyte is not present. The reported value is considered to be an estimated DL.
P,C,D,A	NOT to be used unless prior authorization is given by the USACE Louisville Senior Chemist.

Table 2-3
Data Review Qualifier Codes

Qualifier Code	Data Quality Condition Resulting in assigned qualification
General Use	
FB	Field blank contamination
FD	Field duplicate evaluation criteria not met
HT	Holding time requirement was not met
PR	Preservation requirements not met
LCS	Laboratory control sample evaluation criteria not met
MB	Preparation blank or preparation blank contamination
RB	Rinsate blank contamination
DL-LOQ	The value detected is reported between the detection limit and limit of quantitation
TB	Trip blank contamination

Table 2-3 (continued)
Data Review Qualifier Codes

Qualifier Code	Data Quality Condition Resulting in assigned qualification
Inorganic Methods	
CCB	Continuing calibration blank contamination
CCV	Continuing calibration verification evaluation criteria not met
D	Laboratory duplicate precision evaluation criteria not met
DL	Serial dilution results did not met evaluation criteria
ICS	Interference check sample evaluation criteria not met
ICV	Initial calibration verification evaluation criteria not met
MS	Matrix spike recovery outside acceptance range
PDS	Post-digestion spike recovery outside acceptance range
MSA	Method of standard additions correlation coefficient < 0.995
PB	Preparation blank
Organic Methods	
CCAL	Continuing calibration evaluation criteria not met
ICAL	Initial calibration evaluation criteria not met
ID	Target compound identification criteria not met
IS	Internal standard evaluation criteria not met
MS/SD	Matrix spike/matrix spike duplicate accuracy and/or precision criteria not met
SUR	Surrogate recovery outside acceptance range
TUNE	Instrument performance (tuning) criteria not met
P	The detected concentration difference between the primary and secondary column is greater than 25%.

3.0 LABORATORY CASE NARRATIVE REVIEW CRITERIA

Data reviewed by the analytical laboratory included laboratory batch and sample-specific performance criteria. Results not meeting the QC acceptance criteria were documented by the laboratory in the case narratives. The laboratory performance criteria evaluated from the case narratives include: initial calibration procedures and results, continuing calibration procedures and results, and other items identified in the case narrative as potentially affecting the data. The sample-specific criteria reviewed from the case narrative include: internal standard recoveries and other items identified as potentially affecting the data. The subsections below discuss how each of the parameters was evaluated, as specified in the SAP Addendum (Shaw, 2011).

3.1 Initial Calibration

The DoD QSM contains the QC acceptance criteria for initial calibration for analytical methods required for the project. If the case narrative indicated that the initial calibration for any analyte did not met the acceptance criteria, then the data was evaluated and all results for that given analyte associated with the initial calibration were qualified estimated (“J/UJ”) with a qualifier code of “ICAL”.

3.2 Initial and/or Continuing Calibration Verification

The DoD QSM contains the QC acceptance criteria for initial and continuing calibration verification for each analytical method used in the project. If the case narrative indicates that the initial or continuing calibration verification for any analyte did not meet the acceptance criteria, then all associated sample results for that given analyte were qualified as estimated (“J/UJ”) with a qualifier code of “ICV” or “CCV” for inorganics and “ICAL” or “CCAL” for organics

3.3 Other Items Identified in the Case Narrative

Other items which the laboratory may note in the case narrative include: instrument tuning, system performance evaluation, internal standard area counts, retention times, Methods of Standard Additions, and/or standard operating procedure (SOP) deviations. If a case narrative describes a laboratory performance criterion not covered by the DoD QSM, the data should be evaluated and qualified using guidance from the method, or professional judgment should be used.

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4.0 FIELD AND LABORATORY DATA PACKAGE REVIEW

Sample-specific evaluation parameters include: sample temperature, holding times, blank sample contamination, laboratory control sample (LCS) analysis, matrix spike (MS) analysis, and field duplicate or replicate sample results. The subsections below discuss how each of these sample specific parameters was evaluated. No field analytical data were collected during this phase of the project; all analytical data were generated by an off-site or fixed laboratory. Therefore, no field data review criteria are specified in this data usability summary.

4.1 Holding Times

Holding times were evaluated according to the procedures outlined in the DoD QSM. Holding times were calculated by computing the difference between the sample collection date recorded on the COC and the sample analysis date recorded in the laboratory reports. Analyses performed past the holding time limits were qualified as estimates ("J/UJ") or rejected ("R") unusable with reason code "HT".

4.2 Blanks

Trip blank, preparation or method blanks, and calibration blanks analysis results were reviewed. The DoD QSM criteria were used to evaluate blank sample results for impacts to field sample data quality. Sample results associated with blank sample concentrations which may impact the sample results were qualified as estimates ("J").

4.3 Surrogate Recoveries

Surrogate spike recoveries were evaluated according to procedures in the DoD QSM. Samples with surrogate recoveries outside the acceptance limits were qualified as follows:

- If the surrogate recovery was greater than the upper control limit then positive results for the associated compounds were qualified as estimates ("J"). Non-detect results were acceptable and were not qualified.
- If the surrogate recovery was less than the lower control limit, the associated analytes were qualified as estimated ("J/UJ").

A qualifier code of "SUR" was assigned to all results qualified or rejected on the basis of surrogate spike recoveries.

4.4 Laboratory Control Sample Results

LCS recoveries were compared to acceptance limits in the DoD QSM and laboratory control limits listed in the test reports.

- Positive sample results associated with LCS recoveries greater than acceptance limits were qualified as estimated ("J"). Non-detect sample results associated high LCS recoveries were not affected and not qualified.
- Positive sample results associated with LCS recoveries less than acceptance limits but greater than 10% were qualified as estimated, "J." Non-detect sample results associated with LCS recoveries less than acceptance limits were qualified "UJ."
- Sample results associated with a LCS recovery less than10 percent were considered unusable and qualified "R" rejected.

A qualifier code of "LCS" was assigned to all results qualified or rejected on the basis of laboratory control sample evaluation.

4.5 Matrix Spike Sample Analysis

Matrix spike recoveries were evaluated following procedures in the DoD QSM. Matrix spike recoveries were compared to the DoD QSM and laboratory specific control limits. Sample results were not qualified on the basis of MS recoveries alone. Professional judgment and consideration of other associated QC measures was used to determine the need for qualifier assignment.

Parent sample results were qualified when MS recoveries exceeded acceptance limits and in consideration of other QC measurements as follows:

- Positive results associated with MS recoveries greater than acceptance limits were qualified as estimates ("J"). Non-detect sample results associated MS recoveries greater than acceptance limits were not qualified.
- Positive results associated with MS recoveries less than the acceptance limits, but greater than 10% were qualified "J." Non-detect sample results associated with MS recoveries less than the acceptance limits were qualified "UJ."
- Parent sample results with a MS recovery less than 10 percent were considered unusable and qualified "R", rejected.

4.6 Field Duplicate Results

Field duplicate analysis results and paired sample precision were compared to the concentration-dependent acceptance criteria given in the LCG Section IV, Chapter 4, Table 4-1.

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5.0 DATA REVIEW RESULTS

5.1.1 Laboratory Data Package Review

The field samples analyzed and their QC designations are listed in Table 5-1

Table 5-1
Field Sample and Associated QC Designations

Field I.D.	Lab Sample Number	Matrix	Purpose
GR8SS-001M-0001-SO	122187	soil	Field Sample
GR8SS-002M-0001-SO	122188	soil	Field Sample
GR8SS-003M-0001-SO	122189	soil	Field Sample
GR8SS-004M-0001-SO	122190	soil	Field Sample
GR8SS-005M-0001-SO	122191	soil	Field replicate of GR8SS-004M-0001-SO
GR8SS-006M-0001-SO	122192	soil	Field Sample
GR8SS-007M-0001-SO	122193	soil	Field Sample
GR8SS-008M-0001-SO	122194	soil	Field Sample
GR8SS-009M-0001-SO	122195	soil	Field replicate of GR8SS-008M-0001-SO
GR8-RB-01	122196	water	Equipment Rinsate Blank

5.1.2 Review of the Laboratory Case Narrative

Items identified in the case narrative as outside of control limits for laboratory performance criteria were evaluated for the Sample Delivery Groups (SDGs).

The analysis methods used were based upon the COC. All samples arrived at the laboratory intact, on time, and within acceptable temperature range. A copy of the COC and cooler receipt form are included with each data package. Following are sample shipment incidents for this event that are documented by the laboratory.

The case narrative indicated that initial calibrations (ICAL) and continuing calibrations (CCAL) were within laboratory QC limits for organics. The case narrative also indicated that the gas chromatograph/mass spectrometry (GC/MS) tunes, and internal standard retention times were within QC limits.

The case narrative indicates that some metals continuing calibration verifications (CCV) recoveries were outside control limits. The affected samples were reanalyzed with acceptable CCV recoveries.

The laboratory incorrectly identified sample GR8-RB-01 as a groundwater matrix. This sample was a field QC equipment rinsate blank and there is no adverse effect on the data.

5.1.3 Holding Times

Holding times were calculated by computing the difference between the sample collection date and time found on the COC and the extraction or sample analysis date and time found on the sample test reports. The case narrative indicates Sample 122196 (GR8-RB-01) was analyzed for hexavalent chromium outside holding time. The analysis result was non-detect for hexavalent chromium and is qualified "UJ-HT" by the data validator.

5.1.4 SVOC Review

5.1.4.1 Blanks

The field equipment rinsate blank reports detection of bis(2-ethylhexyl)phthalate (0.54µg/L) and naphthalene (0.21 µg/L).

The laboratory method blank reports detection of bis(2-ethylhexyl)phthalate (0.494 µg/L).

5.1.4.2 Tune and DDT Breakdown Checks

The decafluorotriphenylphosphine (DFTPP) tunes were verified to be in compliance within the SW846-8270 criteria. All dichlorodiphenyltrichloroethane (DDT) breakdown ratios were within the DoD QSM 4.2 20% acceptance limits.

5.1.4.3 Initial Calibration and Verifications

The initial calibration data was reviewed for compliance with the DoD QSM. The laboratory reported either a percent relative standard deviation (%RSD) or a correlation coefficient within the DoD QSM acceptance criteria. There are no qualifiers assigned to the associated data as a result.

The laboratory initial calibration verification (ICV) was analyzed from a second source and reports all compounds recovered within the DoD QSM acceptance criteria.

The laboratory CCV reported bis(2-chloroisopropyl)ether recovered with a 26.6% difference (%D). Section V, element 2.5 requires bis(2-chloroisopropyl)ether positive detected results be qualified "J'. None of the normal environmental samples report detection of bis(2-chloroisopropyl)ether, therefore, data qualifications were not required.

5.1.4.4 Laboratory Control Sample Recovery

Table 5-2 shows LCS SVOC compounds recovered outside the DoD QSM acceptance criteria.

Table 5-2
SVOC LCS Failed Compound Recoveries

Compound	% LCS Recovery	DOD QSM Acceptance Range	Associated Samples	Qualifier-Reason Code
2,4,5-Trichlorophenol	8%	36-135	122196	J/R-LCS
2,4,6-Trichlorophenol	5%	39-115		J/R-LCS
2,4-Dichlorophenol	14%	34-115		J/UJ-LCS
2,4-Dinitrophenol	0%	29-146		J/R-LCS
2-chlorophenol	17%	30-120		J/UJ-LCS
2-nitrophenol	14%	33-115		J/UJ-LCS
4,6-dinitro-2-methylphenol	6%	42-144		J/R-LCS

5.1.4.5 Matrix Spike/Matrix Spike Duplicate Recoveries

Laboratory established control limits and DoD QSM evaluation criteria were used for comparison to matrix spike recoveries. The Section V, element 2.9 of the LCG states that sample data should not be qualified based on MS/MSD recoveries alone. Rather professional judgment should be used to evaluate sample precision and accuracy in conjunction with other QC information. None of the data were qualified based on MS/MSD bias and precision measurement result.

5.1.4.6 Surrogate Recoveries

Guidance from the DoD QSM was followed to assess surrogate spike compound recoveries.

Element 2.10 of the LCG allows one surrogate from each SVOC fraction to be recovered outside the acceptance criteria (but not less than 10%) for data to be acceptable for use without qualification.

The following Table 5-3 describes SVOC surrogate recoveries reported outside the DoD QSM acceptance criteria.

Table 5-3
SVOC Failed Surrogate Recoveries

Sample ID	S1	S2	S3	S4	S5	S6	Qualifier
122187	38	50	51	47	51	47	None
122188	45	61	59	64	62	62	None
122189	38	56	55	54	57	54	None
122190	38	60	62	64	63	57	None
122191	44	61	64	66	63	62	None
122192	**33**	53	52	53	55	51	None
122193	**29**	58	55	59	57	60	None
122194	**23**	51	44	51	51	54	None
122195	**22**	54	49	54	55	55	None
122196	**22**	73	**12**	78	25	78	Acid extractable compound are qualified J/UJ-Sur Base/neutral extractable compound are not qualified

Bold indicates recovery outside acceptance criteria, acid extractable compounds are shaded cells
S1 = 2,4,6-Tribromophenol
S2 = 2-Fluorobiphenyl
S3 = 2-Fluorophenol
S4 = Nitrobenzene-d5
S5 = Phenol-d5
S6 = Tertphenyl-d14

5.1.5 PCB Review

5.1.5.1 Blanks

The field equipment rinse blank samples and laboratory method blanks did not contain detectable PCB Aroclors.

5.1.5.2 Initial Calibration and Verifications

The initial calibration data was reviewed for compliance with the DoD QSM. The laboratory reported either a least square regression (r≥ 0.995) or a correlation coefficient (≥ 0.99) within the DoD QSM acceptance criteria. There are no qualifiers assigned to the associated data.

The laboratory ICV was analyzed using a second source standard solution and all compounds recovered within the DoD QSM acceptance criteria.

The laboratory CCV was compliant for PCB Aroclors.

5.1.5.3 Laboratory Control Sample Recovery

All compounds were recovered within the specified acceptance ranges.

5.1.5.4 Matrix Spike/Matrix Spike Duplicate Recoveries

Laboratory established control limits and DoD QSM evaluation criteria were used for comparison to matrix spike recoveries. The Section V, element 3.7 of the LCG states that sample data should not be qualified based on MS/MSD recoveries alone. Rather professional judgment should be used to evaluate sample precision and accuracy in conjunction with other QC information. None of the data were qualified based on MS/MSD bias and precision measurement result.

5.1.5.5 Surrogate Recoveries

Guidance from the DoD QSM was followed to assess surrogate spike compound recoveries. None of the PCB data is qualified due to failed surrogate recoveries.

5.1.5.6 Sample Duplicate Agreement and Target Analyte Confirmation

Samples results showing detected PCB compounds were confirmed by second column confirmation with a ≤40% agreement. None of the data is qualified based on duplicate or conformation results.

5.1.6 Explosives Review

5.1.6.1 Blanks

The field equipment rinse blank reported detection of HMX (1.2µg/L). The compound was not detected in any of the investigatory soil samples therefore data qualifiers were not assigned. The associated laboratory method blanks did not report any explosive compounds, therefore data qualifiers were not assigned.

5.1.6.2 Initial Calibration and Verifications

The initial calibration data was reviewed for compliance with the DoD QSM. The laboratory reported either a percent relative standard deviation (%RSD) or a correlation coefficient within the DoD QSM acceptance criteria.

The laboratory ICV was analyzed using a second source standard solution and all compounds recovered within the DoD QSM (85-115%) acceptance criteria.

The laboratory CCV was compliant for all calibrated compounds.

5.1.6.3 Laboratory Control Sample Recovery

All compounds were recovered within the acceptance range specified in the DoD QSM.

5.1.6.4 Matrix Spike/Matrix Spike Duplicate Recoveries

Laboratory established control limits and DoD QSM evaluation criteria were used for comparison to matrix spike recoveries. The Section V, element 3.7 of the LCG states that sample data should not be qualified based on MS/MSD recoveries alone. Rather professional judgment should be used to evaluate sample precision and accuracy in conjunction with other QC information. None of the data were qualified based on MS/MSD bias and precision measurement result.

5.1.6.5 Surrogate Recoveries

Guidance from the DoD QSM was followed to assess surrogate spike compound recoveries. None of the explosive data is qualified due to failed surrogate recoveries.

5.1.6.6 Sample Duplicate Agreement and Target Analyte Confirmation

Samples results showing detectable explosive compounds were confirmed by second column confirmation with a ≤40% agreement. None of the data is qualified based on duplicate or conformation results.

5.1.7 CVAA Metals Review

5.1.7.1 Blanks

Mercury was not detected in the field equipment rinse blank or laboratory method blanks.

5.1.7.2 Initial Calibration and Verifications

The initial calibration data was reviewed for compliance with the DoD QSM. The laboratory reported either a percent relative standard deviation (%RSD) or a correlation coefficient within the DoD QSM acceptance criteria.

The laboratory ICV was analyzed using a second source standard solution and mercury recovered within the acceptance criteria.

The laboratory CCV was compliant for mercury.

5.1.7.3 Laboratory Control Sample Recovery

DoD QSM acceptance limits were used to evaluate the LCS recoveries in aqueous and soil matrices. LCS recoveries met DoD QSM acceptance range for mercury of 80-120%. Sample data were not qualified based on LCS recovery.

5.1.7.4 Matrix Spike/Matrix Duplicate Recoveries

Laboratory established control limits and DoD QSM evaluation criteria were used for comparison to matrix spike recoveries. When a parent sample concentration exceeds the matrix spike level by 4-times or greater the spike is invalid and the recovery results are not used. Matrix spike recoveries met criteria for all valid spike elements.

5.1.7.5 Post Digestion Spike Recoveries

Guidance from the DoD QSM is used for the post digestion spike (PDS) recovery assessment. The DoD QSM specifies a 75 – 125% acceptance criteria (but not < 30%) for data to be acceptable for use without qualification. Post digest spike recoveries met acceptance criteria.

5.1.7.6 Serial Dilution Recovery

None of the data is qualified based on serial dilution recovery.

5.1.8 ICP Metals Review

5.1.8.1 Blanks

Target metals were not detected in the laboratory method blanks. The laboratory initial and continuing calibration blanks met specifications. The field equipment rinse blank reports detection of total aluminum at12.0 µg/L. Aluminum concentrations in the field samples were greater than 10-times the rinse blank concentration. Field samples were not qualified based on the field equipment rinse blank results.

5.1.8.2 Initial Calibration and Verifications

The initial calibration data was reviewed for compliance with the DoD QSM. The laboratory reported either a percent relative standard deviation (%RSD) or a correlation coefficient within the DoD QSM acceptance criteria. There are no qualifiers assigned to the associated data as a result.

The laboratory ICV was analyzed using a second source standard solution and all target elements recovered within the DoD QSM acceptance criteria.

The laboratory CCV recoveries for all target elements recovered within the 90-110 acceptance criteria with the exception of copper (113%) and lead (111%), in an aqueous matrix. The associated sample does not report detection of copper or lead, therefore data qualification was not required.

5.1.8.3 ICP Interference Check Sample

The laboratory reported ICP Interference Check Samples (ICSA/AB) were reviewed for compliance with the DoD QSM. The reported ICSA and ICSAB results were compliant and do not indicate interelement effects on the data.

5.1.8.4 Laboratory Control Sample Recovery

All compounds were recovered within the acceptance range specified in the DoD QSM.

5.1.8.5 Matrix Spike/Matrix Duplicate Recoveries

Laboratory established control limits and DoD QSM evaluation criteria were used for comparison to matrix spike recoveries. When a parent sample concentration exceeds the matrix spike level by 4-times or greater the spike is invalid and the recovery results are not used.

Guidance from DoD QSM is used for the PDS recovery assessment. PDS analysis was not required for matrix effect determinations.

5.1.8.6 Serial Dilution Recovery

Guidance from the DoD QSM is used for serial dilution recovery assessment. None of the data are qualified based on serial dilution recovery.

5.1.9 Inorganic Review

5.1.9.1 Blanks

None of the target inorganic analytes were detected in the laboratory method and field equipment rinse blanks. The laboratory initial and continuing calibration blanks did not detect target analytes greater than ½ the LOQ.

5.1.9.2 Initial Calibration and Verifications

The initial calibration data was reviewed for compliance with the DoD QSM. The laboratory reported either a percent relative standard deviation (%RSD) or a correlation coefficient within the DoD QSM acceptance criteria.

The laboratory ICV was analyzed from second source standard solutions. ICV recoveries met DoD QSM acceptance criteria.

The laboratory CCV recoveries met acceptance criteria.

5.1.9.3 Laboratory Control Sample Recovery

The All analytes were recovered within the acceptance range specified in the DoD QSM.

5.1.9.4 Matrix Spike/Matrix Duplicate Recoveries

Laboratory established control limits and DoD QSM evaluation criteria were used for comparison to matrix spike recoveries. The Section V, element 3.7 of the LCG states that sample data should not be qualified based on MS/MSD recoveries alone. Rather professional judgment should be used to evaluate sample precision and accuracy in conjunction with other QC information. None of the data were qualified based on MS/MSD bias and precision measurement result.

5.2 Field Duplicate Result Agreement

Results for field duplicate sample analyses were compared to the concentration-dependent acceptance criteria listed in the LCG Section IV, Chapter 4, and Table 4-1:

The following field duplicates were submitted:

- Sample GR8SS-005M-0001-SO was the field replicate of GR8SS-004M-0001-SO
- Sample GR8SS-009M-0001-SO was the field replicate of GR8SS-008M-0001-SO

Table 5-4 shows the field duplicate comparison results for detected analytes. The remaining analytes are not detected or qualified not detected due to associated blank contamination.

Table 5-4
Field Duplicate Comparison

Analyte	GR8SS-004M-0001-SO Result	GR8SS-005M-0001-SO Result	Absolute Difference	Qualifier
Semivolatile Organic Compounds - µg/kg				
2-methylnaphthalene	280	260	20	<3X Difference than lowest detection, none
Acenaphthene	45	140	95	<3X Difference than lowest detection, none
Acenaphthalene	51	26	25	<3X Difference than lowest detection, none
Anthracene	100	270	170	<3X Difference than lowest detection, none
Benzo(a)anthracene	270	510	240	<3X Difference than lowest detection, none
Benzo(a)pyrene	210	280	70	<3X Difference than lowest detection, none
Benzo(b)fluoranthene	380	510	130	<3X Difference than lowest detection, none
Benzo(g,h,i)perylene	130	160	30	<3X Difference than lowest detection, none
Benzo(k)fluoranthene	160	260	100	<3X Difference than lowest detection, none
Bis(2-ethylhexyl) phthalate	2000	140	1860	>5X Difference than lowest detection, major (J-FD)
Carbazole	100	190	90	<3X Difference than lowest detection, none
Chrysene	290	420	130	<3X Difference than lowest detection, none
Dibenzo(a,h)anthracene	49	72	23	<3X Difference than lowest detection, none
Dibenzofuran	95	150	55	<3X Difference than lowest detection, none
di-n-butylphthalate	460	180	280	<3X Difference than lowest detection, none
Fluoranthene	780	1400	620	<3X Difference than lowest detection, none
Fluorene	44	150	106	<3X Difference than lowest detection, none

Table 5-4 (continued)
Field Duplicate Comparison

Analyte	GR8SS-004M-0001-SO Result	GR8SS-005M-0001-SO Result	Absolute Difference	Qualifier
Semivolatile Organic Compounds - µg/kg (continued)				
Indeno(1,2,3-cd)pyrene	120	170	50	<3X Difference than lowest detection, none
Naphthalene	280	250	30	<3X Difference than lowest detection, none
Phenanthrene	570	1100	530	<3X Difference than lowest detection, none
Pyrene	550	1000	450	<3X Difference than lowest detection, none
PCBs- µg/kg				
Aroclor-1254	580	2700	2120	>3X Difference than lowest detection, minor (J-FD)
Aroclor-1260	160	310	150	<3X Difference than lowest detection, none
Explosives- µg/kg				
Nitroguanidine	0.17	0.14	0.03	<3X Difference than lowest detection, none
CVAA Metals- µg/kg				
Mercury	0.63	0.90	0.27	<3X Difference than lowest detection, none
ICP Metals- µg/kg				
Barium	257	415	158	<3X Difference than lowest detection, none
Cadmium	396	14.9	381.1	>5X Difference than lowest detection, major (J-FD)
Calcium	39600	41800	2200	<3X Difference than lowest detection, none
Iron	50300	45700	4600	<3X Difference than lowest detection, none
Tri-chromium	27.9	24.5	3.4	<3X Difference than lowest detection, none
Strontium	119	113	6	<3X Difference than lowest detection, none
Aluminum	15200	17800	2600	<3X Difference than lowest detection, none
Antimony	22.8	12.0	10.8	<3X Difference than lowest detection, none
Chromium	27.9	28.5	0.6	<3X Difference than lowest detection, none
Copper	711	384	327	<3X Difference than lowest detection, none
Lead	887	1030	143	<3X Difference than lowest detection, none
Magnesium	6000	7090	1090	<3X Difference than lowest detection, none
Manganese	1280	1360	80	<3X Difference than lowest detection, none
Zinc	1020	1000	20	<3X Difference than lowest detection, none
Inorganics - µg/kg				
TOC	64000	62000	2000	<3X Difference than lowest detection, none
% Solids	98.4	98.4	0	<3X Difference than lowest detection, none
pH	8.24	8.11	NA	

Table 5-4 (continued)
Field Duplicate Comparison

Analyte	GR8SS-008M-0001-SO Result	GR8SS-009M-0001-SO Result	Absolute Difference	Qualifier
Hex-chromium	2.6	4.0	3.4	<3X Difference than lowest detection, none
Semivolatile Organic Compounds- µg/kg				
No Detections				
PCBs- µg/kg				
No Detections				
Explosives- µg/kg				
No Detections				
CVAA Metals- µg/kg				
Mercury	0.018	0.023	0.005	<3X Difference than lowest detection, none
ICP Metals- µg/kg				
Barium	80.0	83.1	3.1	<3X Difference than lowest detection, none
Cadmium	1.1	1.2	0.1	<3X Difference than lowest detection, none
Calcium	9450	9450	0	<3X Difference than lowest detection, none
Iron	36200	37500	1300	<3X Difference than lowest detection, none
Tri-chromium	16.1	17.3	1.2	<3X Difference than lowest detection, none
Strontium	27.6	27.4	0.2	<3X Difference than lowest detection, none
Aluminum	11800	12200	400	<3X Difference than lowest detection, none
Antimony	2.3	2.2	0.1	<3X Difference than lowest detection, none
Chromium	16.1	17.3	1.2	<3X Difference than lowest detection, none
Copper	50.9	54.2	3.3	<3X Difference than lowest detection, none
Lead	44.3	44.8	0.5	<3X Difference than lowest detection, none
Magnesium	5143	4230	913	<3X Difference than lowest detection, none
Manganese	448	476	28	<3X Difference than lowest detection, none
Zinc	106	119	13	<3X Difference than lowest detection, none
Inorganics - µg/kg				
TOC	3300	2900		<3X Difference than lowest detection, none
% Solids	98.7	98.7		<3X Difference than lowest detection, none
pH	7.64	7.7	NA	

Using professional judgment, only the field duplicate pairs were qualified.

5.3 Validation Qualifiers and Reason Codes

The following Table 5-5 describes applied data qualifiers and reason codes to the data reviewed in the DER.

Table 5-5
Validation Qualifiers and Reason Codes

Parameter	Sample Number	Result	Lab Qual	LOQ	DL	DVQ	Reason Code(s)
Bis(2-Ethylhexyl)phthalate	GR8SS-005M-0001-SO	140	J	410	89	J	FD
Di-n-Butyl Phthalate	GR8SS-005M-0001-SO	180	J	410	80	J	DL-LOQ
Acenaphthylene	GR8SS-005M-0001-SO	26	J	120	24	J	DL-LOQ
Bis(2-Ethylhexyl)phthalate	GR8SS-009M-0001-SO	95	J	400	88	J	DL-LOQ
Pyrene	GR8SS-007M-0001-SO	100	J	120	26	J	DL-LOQ
Indeno(1,2,3-cd)pyrene	GR8SS-007M-0001-SO	38	J	120	23	J	DL-LOQ
Benzo(ghi)perylene	GR8SS-007M-0001-SO	38	J	120	22	J	DL-LOQ
Dibenzofuran	GR8SS-007M-0001-SO	39	J	120	24	J	DL-LOQ
Benzo(a)pyrene	GR8SS-007M-0001-SO	40	J	120	23	J	DL-LOQ
Benzo(k)fluoranthene	GR8SS-007M-0001-SO	43	J	120	25	J	DL-LOQ
Dibenzo(a,h)anthracene	GR8SS-005M-0001-SO	72	J	120	22	J	DL-LOQ
Cadmium	GR8SS-005M-0001-SO	14.9		0.041	0.0061	J	FD
PCB-1254	GR8SS-005M-0001-SO	2700		500	120	J	FD
PCB-1260	GR8SS-005M-0001-SO	310	J	500	61	J	DL-LOQ
Hexavalent Chromium	GR8SS-005M-0001-SO	4	J	10	2.6	J	DL-LOQ
Fluorene	GR8SS-004M-0001-SO	44	J	120	25	J	DL-LOQ
Acenaphthene	GR8SS-004M-0001-SO	45	J	120	24	J	DL-LOQ
Dibenzo(a,h)anthracene	GR8SS-004M-0001-SO	49	J	120	22	J	DL-LOQ
Acenaphthylene	GR8SS-004M-0001-SO	51	J	120	24	J	DL-LOQ
Dibenzofuran	GR8SS-004M-0001-SO	95	J	120	24	J	DL-LOQ
Nitroguanidine	GR8SS-005M-0001-SO	0.14	J	0.25	0.06	J	DL-LOQ
Cadmium	GR8SS-004M-0001-SO	396	M	0.2	0.03	J	FD
PCB-1254	GR8SS-004M-0001-SO	580		100	23	J	FD
Dibenzo(a,h)anthracene	GR8SS-003M-0001-SO	64	J	120	22	J	DL-LOQ
Fluorene	GR8SS-003M-0001-SO	91	J	120	25	J	DL-LOQ
Nitroguanidine	GR8SS-004M-0001-SO	0.17	J	0.25	0.059	J	DL-LOQ

Table 5-5 (continued)
Validation Qualifiers and Reason Codes

Parameter	Sample Number	Result	Lab Qual	LOQ	DL	DVQ	Reason Code(s)
4-Chloro-3-Methylphenol	GR8-RB-01	0.87	U	5.4	0.87	UJ	SUR
2,4-Dimethylphenol	GR8-RB-01	0.89	U	5.4	0.89	UJ	SUR
o-Cresol	GR8-RB-01	0.93	U	5.4	0.93	UJ	SUR
2-Chlorophenol	GR8-RB-01	0.95	UQ	5.4	0.95	UJ	LCS,SUR
2-Nitrophenol	GR8-RB-01	0.98	UQ	5.4	0.98	UJ	LCS,SUR
2,4-Dichlorophenol	GR8-RB-01	1.1	UQ	5.4	1.1	UJ	LCS,SUR
2,4,6-Trichlorophenol	GR8-RB-01	1.1	UQ	5.4	1.1	R	LCS,SUR
4-Nitrophenol	GR8-RB-01	1.2	U	5.4	1.2	UJ	SUR
2,4,5-Trichlorophenol	GR8-RB-01	1.2	UQ	5.4	1.2	R	LCS,SUR
Cresols (Total)	GR8-RB-01	1.5	U	9.8	1.5	UJ	SUR
2,4-Dinitrophenol	GR8-RB-01	1.6	UQ	5.4	1.6	R	LCS,SUR
4,6-Dinitro-2-Methylphenol	GR8-RB-01	1.7	UQ	6.5	1.7	R	LCS,SUR
Benzoic Acid	GR8-RB-01	12	U	54	12	UJ	SUR
Naphthalene	GR8-RB-01	0.21	J	1.1	0.2	J	DL-LOQ
Bis(2-Ethylhexyl)phthalate	GR8-RB-01	0.54	JB	3.3	0.48	J	DL-LOQ
Benzyl Alcohol	GR8-RB-01	1.7	J	3.3	0.59	J	DL-LOQ
Hexavalent Chromium	GR8-RB-01	6	UH	24	6	J	HT
Di-n-Butyl Phthalate	GR8SS-002M-0001-SO	100	J	400	80	J	DL-LOQ
Naphthalene	GR8SS-002M-0001-SO	110	J	120	21	J	DL-LOQ
Dibenzo(a,h)anthracene	GR8SS-002M-0001-SO	26	J	120	22	J	DL-LOQ
Bis(2-Ethylhexyl)phthalate	GR8SS-002M-0001-SO	290	J	400	88	J	DL-LOQ
Carbazole	GR8SS-002M-0001-SO	32	J	120	28	J	DL-LOQ
Dibenzofuran	GR8SS-002M-0001-SO	37	J	120	24	J	DL-LOQ
Anthracene	GR8SS-002M-0001-SO	41	J	120	24	J	DL-LOQ
Benzo(k)fluoranthene	GR8SS-002M-0001-SO	47	J	120	25	J	DL-LOQ
Nitroguanidine	GR8SS-002M-0001-SO	0.12	J	0.25	0.06	J	DL-LOQ
Benzo(a)anthracene	GR8SS-007M-0001-SO	55	J	120	25	J	DL-LOQ
Chrysene	GR8SS-007M-0001-SO	72	J	120	25	J	DL-LOQ
Benzo(b)fluoranthene	GR8SS-007M-0001-SO	90	J	120	25	J	DL-LOQ

Table 5-5 (continued)
Validation Qualifiers and Reason Codes

Parameter	Sample Number	Result	Lab Qual	LOQ	DL	DVQ	Reason Code(s)
Anthracene	GR8SS-004M-0001-SO	100	J	120	24	J	DL-LOQ
Carbazole	GR8SS-004M-0001-SO	100	J	120	29	J	DL-LOQ
Bis(2-Ethylhexyl)phthalate	GR8SS-004M-0001-SO	2000		410	89	J	FD
Benzo(ghi)perylene	GR8SS-002M-0001-SO	65	J	120	22	J	DL-LOQ
Indeno(1,2,3-cd)pyrene	GR8SS-002M-0001-SO	70	J	120	23	J	DL-LOQ
Benzo(a)pyrene	GR8SS-002M-0001-SO	92	J	120	23	J	DL-LOQ
2,4,6-Trinitrotoluene	GR8SS-003M-0001-SO	0.3	J	0.4	0.09	J	DL-LOQ
Acenaphthene	GR8SS-003M-0001-SO	110	J	120	24	J	DL-LOQ
Di-n-Butyl Phthalate	GR8SS-003M-0001-SO	110	J	410	80	J	DL-LOQ
Aluminum	GR8-RB-01	12	J	36	6	J	DL-LOQ
Naphthalene	GR8SS-006M-0001-SO	23	J	120	21	J	DL-LOQ
Bis(2-Ethylhexyl)phthalate	GR8SS-006M-0001-SO	260	J	410	88	J	DL-LOQ

6.0 OVERALL ASSESSMENT

The data reported in the SDGs are considered acceptable for use (as qualified) in meeting project objectives. An overall assessment of each of the data QA objectives is provided below.

6.1 Accuracy

Accuracy is defined as the degree of agreement of a measurement to an accepted reference or true value. Accuracy was measured as the percent recovery (%R) of an analyte in a reference standard or spiked sample. The LCS, MS, MSD, and surrogate recoveries were within QC limits, except as noted in Section 5.0. None of the data was rejected and estimated data are considered acceptable. Therefore, the overall level of accuracy demonstrated by the analyses is considered acceptable.

6.2 Precision

Precision is defined as the agreement between a set of replicate measurements without assumption or knowledge of the true value. Precision of laboratory measurements was evaluated by the comparison of sample/sample duplicate results.

The LCS and sample duplicates were within QC limits established by the DoD QSM. As such, the overall level of precision demonstrated by the analyses is acceptable.

6.3 Completeness

All of the data are considered usable for reconciliation with project objectives. Analytical completeness is defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis. The completeness goal for the data packages is 100% which satisfies the site project goal of 95%.

6.4 Representativeness

Representativeness is the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness was evaluated by comparing the results obtained for the field duplicate sample pairs. Representativeness was maintained during the sampling event by conducting sampling in accordance with the project work plan and relevant SOPs. Results for all analytes in the field duplicate met the evaluation criteria; except as noted in Section 5.2.

6.5 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability can be related to accuracy and precision because these quantities are measures of data reliability. Data are comparable if collection techniques, measurement procedures, method and reporting are equivalent for the samples within a sample set. The samples in these SDGs were collected under the site work plan and were analyzed in accordance with the QA and QC measures prescribed in the DOD QSM. Acceptable levels of overall accuracy and precision were attained making these comparable under the guidelines.

6.6 Sensitivity

Sensitivity is evaluated in Section 7.1.

7.0 DATA USABILITY RELATIVE TO PROJECT OBJECTIVES

The usability of the sample data relative to the intended end uses is discussed in this section. To facilitate the discussion, the project objectives and associated decisions for which sampling data are to be used as a data source are discussed.

The purpose of the soil sampling event is to provide data to evaluate potential soil contamination concentrations in the Group 8 MRS area.

In order to evaluate the usability of the data for making project decisions, the data must be reconciled with the project objectives and decision criteria. Only data considered to be valid (i.e., the quality of the data is known) as determined through data validation, may be considered for reconciliation with the project objectives.

The reconciliation process begins with a comparison of the maximum sample detection limits obtained to the decision criteria. In general, for the data to be considered to be usable for making the project decisions, the sample detection limits obtained for each analyte must be less than or equal to the decision criteria. Non-detect results at sample detection limits which exceed decision criteria are not sufficient for making project decisions based on those criteria. Below in Section 7.1, the sample detection limits obtained are compared to the project decision criteria.

After evaluating the usability of the data with respect to limit of detection (LOD) obtained and project decision criteria, any potential biases and imprecision in results suggested by QC results must be assessed in order to evaluate the ultimate usability of the data for making decision. Potential biases and imprecision in analytical results and data usability are discussed in Section 7.2.

Since multiple samples and field duplicates were collected, these data can be used to evaluate the representativeness of the samples to the medium sampled. The results of this evaluation are discussed in Section 9.3.

7.1 Levels of Quantitation and Field Sampling Plan Decision Criteria Comparison

The limit of quantitation (LOQ) is the concentration of the lowest non-zero standard (adjusted for sample size and dilutions) in the laboratory's initial calibration curve. The LOD represents the detection limit for an analyte adjusted for sample size and dilutions.

The majority of the aqueous data are considered usable for meeting project objectives of sensitivity, as the limit of LOQ for each analyte is at or below the remediation goals.

When required, samples were analyzed at diluted concentrations due to constituent recoveries above the upper calibration range or matrix interferences. In instances where the analysis required dilutions, only the constituents that exceeded the upper calibration range are accepted, otherwise all constituents are reported at the lowest possible LOD. High screening results required the analysis be performed at diluted concentrations.

7.2 Effects of Potential Biases and Imprecision on Usability of the Data

After evaluating the usability of the data with respect to sample detection limits obtained and project decision criteria, any potential biases and imprecision in results suggested by QC results must be assessed in order to evaluate the ultimate usability of the data making decisions. Potential biases and imprecision in analytical results are inferred from the results obtained for various types of QC sample analyses. Potential bias and imprecision can result from the analytical system or the specific matrix analyzed.

Quality control analyses that provide an indication of the potential bias and imprecision in the analytical system relative to the specific sample matrix include MS analyses, post digestion spiked analyses, laboratory duplicate analyses of field duplicate samples, and field duplicate analyses. Matrix spike samples are site-specific samples into which target analytes are spiked. As such, the percent recoveries obtained from the MS analyses provide an indication of the potential biases of the analytical method on site-specific samples. Additionally, laboratory duplicate results provide an indication of the precision of the analyses on site-specific samples.

None of the data was qualified with directional bias applied. The indeterminate bias qualified data has little or no effect on the project decision making process.

7.3 Representativeness

Representativeness is the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Sampling and analyses were conducted in compliance with the DoD QSM and relevant SOPs in order to maintain representativeness. Field duplicate samples were outside QC limits for only a few analytes and only the field duplicate pair was qualified. The sample results were close to the LOD and results were much less than the project action concentrations. This would have little or no impact on project objectives. This is another indication that representativeness was achieved during this sampling event.

8.0 POTENTIAL ADDITIONAL DATA USES AND LIMITATIONS

In addition to being used in making the decisions specified in the project work plan, the supplemental sample data generated may potentially have other end uses including risk assessment. The analytical data quality is generally considered sufficient for this additional potential end use, however, the magnitude of potential biases and imprecision discussed above must be considered. Prior to use in risk assessment, end users of the data should perform a data quality assessment relative to their specific risk assessment objectives and should perform an evaluation of whether the analytical data are sufficiently representative of the medium under evaluation.

All data were reviewed in accordance with the provisions of the DoD QSM using guidance from the LCG. The data review is considered to meet the minimum requirements specified in the DoD QSM, version 4.2. Data qualifiers were added as listed in Tables 2-2 and 2-3.

Data qualified as “U” (non-detectable) or “J” (estimated) should be used for risk assessment purposes. Section 7.2 above provides a detailed description of the magnitude and direction of potential bias associated with J-qualified data and should be useful in evaluating the uncertainty associated with qualified results.

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9.0 CORRECTIVE ACTIONS AND WORKPLAN DEVIATIONS

No field corrective actions were required during the course of the field investigation. No SAP Addendum (Shaw, 2011) modifications were implemented.

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10.0 REJECTED DATA AND PROJECT CONSEQUENCES

None of the data were rejected for the normal environmental samples during data review with the exception of results for the field equipment rinsate blank SVOC compounds that were reported outside the LCS acceptance criteria. As a result, the normal environmental sample data were considered to be usable for reconciliation with project objectives.

As discussed in Sections 5.0 and 7.0, some results were qualified estimated based on a variety of minor QC problems. Section 7.2 discussed the direction and magnitude of the bias associated with the qualified results.

After reconciliation of the data with project objective (by means of evaluating the data set relative to sample detection limits, the magnitude and direction of any potential biases, and representativeness), all results for the samples are considered to be suitable for making decision of whether individual analyte concentrations exceed the decision criteria specified in the work plan.

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11.0 CONCLUSIONS

With the exception of limitations noted in Section 5.0, the data are considered to be usable for making project decisions. As described in Section 7.0, these data are also considered to be of sufficient analytical quality for a variety of other end uses including baseline risk assessment. For end users of the data other than those for which decision criteria are specified in Section 8.0, the end user of the data should perform a data quality assessment relative to their specific end use objectives. This assessment should include an evaluation of whether the analytical data are sufficiently representative of the medium under evaluation for their specific data use.

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12.0 REFERENCES

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United States Army Corps of Engineers (USACE), 2002, *Louisville Chemistry Guideline*, Louisville District, Environmental Engineering Branch, Revision 5, June.

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Appendix D
Laboratory Data Reports

Note: Data submitted on compact disc.

Data Summary Tables

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Table D-1
Summary of Surface Soil Sample Results
Group 8 MRS
Ravenna Army Ammunition Plant

Parameter	Units	Screening Criteria HQ=0.1	Screening Criteria CR=10^{-6}	Surface Soil BSV	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result (µg/L)	VQ
				Location Code:	GR8SS-001M		GR8SS-002M		GR8SS-003M		GR8SS-004M		GR8SS-004M		NA	
				Sample Number:	GR8SS-001M-0001-SO		GR8SS-002M-0001-SO		GR8SS-003M-0001-SO		GR8SS-004M-0001-SO		GR8SS-005M-0001-SO		GR8-RB-01	
				Sample Date:	2/8/2012		2/8/2012		2/8/2012		2/8/2012		2/8/2012		2/8/2012	
				Sample Purpose:	REG		REG		REG		REG		FD		RB	
				Depth (feet bgs):	0 - 0.5		0 - 0.5		0 - 0.5		0 - 0.5		0 - 0.5		NA	
Explosives																
1,3,5-Trinitrobenzene	mg/kg	225	TBC	---	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.23	U
1,3-Dinitrobenzene	mg/kg	0.765	TBC	---	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.2	U
2,4,6-Trinitrotoluene	mg/kg	3.65	28.4	---	<0.2	U	<0.2	U	0.3	J	<0.2	U	<0.2	U	<0.22	U
2,4-Dinitrotoluene	mg/kg	12.8	1.1	---	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.3	U
2,6-Dinitrotoluene	mg/kg	6.42	1.1	---	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.3	U
2-Amino-4,6-Dinitrotoluene	mg/kg	1.54	TBC	---	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.24	U
3,5-Dinitroaniline	mg/kg	TBC	TBC	---	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.23	U
4-Amino-2,6-Dinitrotoluene	mg/kg	1.54	TBC	---	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.28	U
HMX	mg/kg	359	TBC	---	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<1.2	U
m-Nitrotoluene	mg/kg	76.5	3.88	---	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.23	U
Nitrobenzene	mg/kg	13*	4.8*	---	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.22	U
Nitroglycerin	mg/kg	0.61*	52.5	---	<1	U	<1	U	<1	U	<1	U	<1	U	<2.2	U
Nitroguanidine	mg/kg	610*	TBC	---	<0.125	U	0.12	J	<0.125	U	0.17	J	0.14	J	<32	U
o-Nitrotoluene	mg/kg	0.61*	TBC	---	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.4	U
Petn	mg/kg	TBC	TBC	---	<1	U	<1	U	<1	U	<1	U	<1	U	<3	U
p-Nitrotoluene	mg/kg	76.5	52.5	---	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.22	U
RDX	mg/kg	22.7	8.03	---	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.18	U
Tetryl	mg/kg	24.4*	TBC	---	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.21	U
Metals																
Aluminum	mg/kg	3,496	TBC	17,700	11,300		16,300		11,200		15,200		**17,800**		12	J
Antimony	mg/kg	2.82	TBC	0.96	**5**		**6.6**		**11.7**		**22.8**		**12**		<2	U
Barium	mg/kg	351	TBC	88.4	127		152		247		257		**415**		<0.29	U
Cadmium	mg/kg	6.41	10.9	0	**6.6**		**23.3**		**21.3**		**396**	**J**	**14.9**	**J**	<0.3	U
Chromium (as Cr^{+3})	mg/kg	8,147	TBC	17.4	23		22.8		39		27.9		28.5		<6	U
Copper	mg/kg	311	TBC	17.7	**470**		225		**585**		**711**		**384**		<1.2	U
Iron	mg/kg	2,313	TBC	23,100	**34,300**		**37,200**		**54,400**		**50,300**		**45,700**		<16	U
Lead	mg/kg	400**	TBC	26.1	**493**		300		**977**		**887**		**1,030**		<1.4	U
Mercury	mg/kg	2.27	TBC	0.036	0.26		0.21		0.89		0.63		0.9		<0.03	U
Strontium	mg/kg	4,700*	TBC	0	48.6		103		75.2		119		113		<0.3	U
Zinc	mg/kg	2,321	23,209	61.8	470		346		1,060		1,020		1,000		<1.6	U
Geochemical Parameters																
Calcium	mg/kg	NE	NE	15,800	14,200		42,600		19,700		39,600		41,800		NA	
Magnesium	mg/kg	NE	NE	3,030	3,860		6,760		4,230		6,000		7,090		NA	
Manganese	mg/kg	NE	NE	1,450	816		1,380		1,090		1,280		1,360		NA	
Semivolatile Organic Compounds																
1,2,4-Trichlorobenzene	mg/kg	6.2*	22*	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.18	U
1,2-Dichlorobenzene	mg/kg	190*	TBC	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.2	U
1,3-Dichlorobenzene	mg/kg	TBC	TBC	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.22	U
1,4-Dichlorobenzene	mg/kg	350*	2.4*	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.21	U
2,4,5-Trichlorophenol	mg/kg	620*	TBC	---	<0.305	U	<0.3	U	<0.305	U	<0.305	U	<0.305	U	<1.2	R
2,4,6-Trichlorophenol	mg/kg	6.1*	44*	---	<0.305	U	<0.3	U	<0.305	U	<0.305	U	<0.305	U	<1.1	R
2,4-Dichlorophenol	mg/kg	18*	TBC	---	<0.305	U	<0.3	U	<0.305	U	<0.305	U	<0.305	U	<1.1	UJ
2,4-Dimethylphenol	mg/kg	120*	TBC	---	<0.305	U	<0.3	U	<0.305	U	<0.305	U	<0.305	U	<0.89	U
2,4-Dinitrophenol	mg/kg	12*	TBC	---	<1	U	<1	U	<1	U	<1	U	<1	U	<1.6	R
2-Chloronaphthalene	mg/kg	630*	TBC	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.2	U
2-Chlorophenol	mg/kg	39*	TBC	---	<1	U	<1	U	<1	U	<1	U	<1	U	<0.95	UJ
2-Methylnaphthalene	mg/kg	30.6	TBC	---	0.092	J	0.12		0.4		0.28		0.26		<0.18	U

Table D-1
Summary of Surface Soil Sample Results
Group 8 MRS
Ravenna Army Ammunition Plant

				Location Code:	GR8SS-001M		GR8SS-002M		GR8SS-003M		GR8SS-004M		GR8SS-004M		NA	
				Sample Number:	GR8SS-001M-0001-SO		GR8SS-002M-0001-SO		GR8SS-003M-0001-SO		GR8SS-004M-0001-SO		GR8SS-005M-0001-SO		GR8-RB-01	
				Sample Date:	2/8/2012		2/8/2012		2/8/2012		2/8/2012		2/8/2012		2/8/2012	
				Sample Purpose:	REG		REG		REG		REG		FD		RB	
				Depth (feet bgs):	0 - 0.5		0 - 0.5		0 - 0.5		0 - 0.5		0 - 0.5		NA	
		Screening Criteria		Surface Soil												
Parameter	Units	HQ=0.1	CR=10^{-6}	BSV	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result (µg/L)	VQ
2-Nitroaniline	mg/kg	61*	TBC	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.24	U
2-Nitrophenol	mg/kg	TBC	TBC	---	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.98	UJ
3,3'-Dichlorobenzidine	mg/kg	TBC	1.1*	---	<0.255	UJ	<0.255	U	<0.255	U	<0.255	U	<0.255	U	<0.72	U
3-Nitroaniline	mg/kg	TBC	TBC	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.28	U
4,6-Dinitro-2-Methylphenol	mg/kg	0.49*	TBC	---	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<1.7	R
4-Bromophenyl Phenyl Ether	mg/kg	TBC	TBC	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.22	U
4-Chloro-3-Methylphenol	mg/kg	610*	TBC	---	<1	U	<1	U	<1	U	<1	U	<1	U	<0.87	UJ
4-Chloroaniline	mg/kg	24*	2.4*	---	<0.1	UJ	<0.1	U	<0.1	U	<0.1	U	<0.1	U	<0.13	U
4-Chlorophenyl Phenyl Ether	mg/kg	TBC	TBC	---	<0.1	UJ	<0.1	U	<0.1	U	<0.1	U	<0.1	U	<0.2	U
4-Nitrobenzenamine	mg/kg	NE	NE	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.16	U
4-Nitrophenol	mg/kg	61.2	TBC	---	<1	U	<1	U	<1	U	<1	U	<1	U	<1.2	UJ
Acenaphthene	mg/kg	340*	TBC	---	<0.06	UJ	<0.06	U	0.11	J	0.045	J	0.14		<0.2	U
Acenaphthylene	mg/kg	122	TBC	---	0.038	J	<0.06	U	<0.06	U	0.051	J	0.026	J	<0.18	U
Anthracene	mg/kg	1,700*	TBC	---	0.048	J	0.041	J	0.19		0.1	J	0.27		<0.12	U
Benzo(a)anthracene	mg/kg	TBC	0.221	---	0.11	J	0.13		**0.41**		**0.27**		**0.51**		<0.13	U
Benzo(a)pyrene	mg/kg	TBC	0.022	---	**0.069**	**J**	**0.092**	**J**	**0.27**		**0.21**		**0.28**		<0.15	U
Benzo(b)fluoranthene	mg/kg	TBC	0.221	---	0.15	J	0.19		**0.46**		**0.38**		**0.51**		<0.18	U
Benzo(ghi)perylene	mg/kg	122	TBC	---	0.06	J	0.065	J	0.15		0.13		0.16		<0.23	U
Benzo(k)fluoranthene	mg/kg	TBC	2.21	---	0.042	J	0.047	J	0.23		0.16		0.26		<0.22	U
Benzoic Acid	mg/kg	24,000*	TBC	---	<1.5	U	<1.5	U	<1.5	U	<1.5	U	<1.5	U	<12	UJ
Benzyl Alcohol	mg/kg	TBC	TBC	---	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U	<0.205	U	1.7	J
Bis(2-Chloroethoxy)methane	mg/kg	23	TBC	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.21	U
Bis(2-Chloroethyl)ether	mg/kg	TBC	0.21*	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.23	U
Bis(2-Chloroisopropyl)ether	mg/kg	310*	4.6*	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.24	U
Bis(2-Ethylhexyl)phthalate	mg/kg	35*	120*	---	0.79	J	0.29	J	<0.205	U	2	J	0.14	J	0.54	J
Butyl Benzyl Phthalate	mg/kg	260*	1,200*	---	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U	<0.205	U	<0.51	U
Carbazole	mg/kg	44.6	TBC	---	0.045	J	0.032	J	0.15		0.1	J	0.19		<0.13	U
Chrysene	mg/kg	22.1	TBC	---	0.11	J	0.13		0.43		0.29		0.42		<0.17	U
Cresols (Total)	mg/kg	NE	NE	---	<1.85	U	<1.8	U	<1.8	U	<1.85	U	<1.85	U	<1.5	UJ
Dibenzo(a,h)anthracene	mg/kg	TBC	0.022	---	<0.06	UJ	**0.026**	**J**	**0.064**	**J**	**0.049**	**J**	**0.072**	**J**	<0.18	U
Dibenzofuran	mg/kg	15.3	TBC	---	0.036	J	0.037	J	0.16		0.095	J	0.15		<0.21	U
Diethyl Phthalate	mg/kg	4,900	TBC	---	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U	<0.205	U	<0.49	U
Dimethyl Phthalate	mg/kg	TBC	TBC	---	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U	<0.205	U	<0.59	U
Di-n-Butyl Phthalate	mg/kg	610*	TBC	---	0.14	J	0.1	J	0.11	J	0.46		0.18	J	<0.73	U
Di-n-Octyl Phthalate	mg/kg	TBC	TBC	---	<0.1	UJ	<0.1	U	<0.1	U	<0.1	U	<0.1	U	<0.53	U
Fluoranthene	mg/kg	163	TBC	---	0.28	J	0.29		1.2		0.78		1.4		<0.14	U
Fluorene	mg/kg	243	TBC	---	<0.06	UJ	<0.06	U	0.091	J	0.044	J	0.15		<0.21	U
Hexachlorobenzene	mg/kg	4.9*	0.3*	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.29	U
Hexachlorobutadiene	mg/kg	6.1*	6.2*	---	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U	<0.205	U	<0.2	U
Hexachlorocyclopentadiene	mg/kg	37*	TBC	---	<0.1	UJ	<0.1	U	<0.1	U	<0.1	U	<0.1	U	<0.28	U
Hexachloroethane	mg/kg	6.1*	35*	---	<0.06	UJ	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.24	U
Indeno(1,2,3-cd)pyrene	mg/kg	TBC	0.221	---	0.048	J	0.07	J	0.16		0.12		0.17		<0.2	U
Isophorone	mg/kg	1,200*	510*	---	<0.1	UJ	<0.1	U	<0.1	U	<0.1	U	<0.1	U	<0.2	U
Naphthalene	mg/kg	122	TBC	---	0.081	J	0.11	J	0.36		0.28		0.25		0.21	J
N-Nitroso-di-n-Propylamine	mg/kg	NE	NE	---	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U	<0.205	U	<0.2	U
N-Nitrosodiphenylamine	mg/kg	TBC	0.12	---	<0.205	UJ	<0.2	U	<0.205	U	<0.205	U	<0.205	U	<0.39	U
o-Cresol	mg/kg	TBC	99*	---	<1	U	<1	U	<1	U	<1	U	<1	U	<0.93	U
Phenanthrene	mg/kg	122	TBC	---	0.23	J	0.19		0.99		0.57		1.1		<0.33	U
Pyrene	mg/kg	122	TBC	---	0.2	J	0.23		0.87		0.55		1		<0.14	U

Table D-1
Summary of Surface Soil Sample Results
Group 8 MRS
Ravenna Army Ammunition Plant

				Location Code:	**GR8SS-001M**		**GR8SS-002M**		**GR8SS-003M**		**GR8SS-004M**		**GR8SS-004M**		**NA**	
				Sample Number:	**GR8SS-001M-0001-SO**		**GR8SS-002M-0001-SO**		**GR8SS-003M-0001-SO**		**GR8SS-004M-0001-SO**		**GR8SS-005M-0001-SO**		**GR8-RB-01**	
				Sample Date:	**2/8/2012**		**2/8/2012**		**2/8/2012**		**2/8/2012**		**2/8/2012**		**2/8/2012**	
				Sample Purpose:	**REG**		**REG**		**REG**		**REG**		**FD**		**RB**	
				Depth (feet bgs):	**0 - 0.5**		**0 - 0.5**		**0 - 0.5**		**0 - 0.5**		**0 - 0.5**		**NA**	
		Screening Criteria		**Surface Soil**												
Parameter	**Units**	**HQ=0.1**	**CR=10^{-6}**	**BSV**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result (µg/L)**	**VQ**
Polychlorinated Biphenyls																
Aroclor-1016	mg/kg	0.419	0.203	---	<0.05	U	<0.05	U	<0.1	U	<0.05	U	<0.25	U	<0.00011	U
Aroclor-1221	mg/kg	TBC	0.14*	---	<0.05	U	<0.05	U	<0.1	U	<0.05	U	<0.25	U	<0.000091	U
Aroclor-1232	mg/kg	TBC	0.14*	---	<0.05	U	<0.05	U	<0.1	U	<0.05	U	<0.25	U	<0.00016	U
Aroclor-1242	mg/kg	TBC	0.22*	---	<0.05	U	<0.05	U	<0.1	U	<0.05	U	<0.25	U	<0.0001	U
Aroclor-1248	mg/kg	TBC	0.203	---	<0.05	U	<0.05	U	<0.1	U	<0.05	U	<0.25	U	<0.000095	U
Aroclor-1254	mg/kg	0.12	0.203	---	**0.51**		**0.3**		**0.74**		**0.58**	J	**2.7**	J	<0.0001	U
Aroclor-1260	mg/kg	TBC	0.203	---	**0.41**		0.15		**0.23**		0.16		**0.31**	J	<0.00011	U
General Chemistry																
Nitrocellulose	mg/kg	1.8E+07*	TBC	---	<100	U	<100	U	<100	U	<100	U	<100	U	<1.1	U
Hexavalent Chromium	mg/kg	5.61	1.64	0	<4.95	U	<5	U	<5	U	<5	U	**4**	J	6	J
pH	pH Units	---	---	---	7.19		7.92		7.68		8.24		8.11		NA	
Total Organic Carbon	mg/kg	---	---	---	47,000		41,000		89,000		64,000		62,000		NA	
Total Solids	%	---	---	---	98.5		98.7		98.7		98.7		NA		NA	

[a] *Screening values are the lowest of the facility-wide cleanup goals for the National Guard Trainee and the Residential Farmer (Adult and Child) as presented in the* Facility Wide Human Health Remediation Goals at the Ravenna Army Ammunition Plant, Ravenna, Ohio (*March 2010).*
[b] *Shaded cells indicate that the detected concentration exceeds the established background screening value (inorganics only) or are detected values for organics.*
[c] *Bold values indicate the detected concentration exceeds the screening criteria for analytes considered as munitions constituents only.*
** No facility-wide cleanup goal is available and the value is based on the EPA Regional Screening Level Resident Supporting Table (2012).*
*** The residential screening level of 400 mg/kg for lead was not adjusted for an HQ of 0.1 since it was not derived using the hazard index approach.*
The facility-wide cleanup goal HQ=0.1 for pyrene was used for acenapthylene, benzo(ghi)pyrelene, naphthalene, and phenanthrene.
--- denotes a cleanup goal and/or BSV is not available.
< denotes less than.
bgs denotes below ground surface.
BSV denotes background screening value as presented in the Final Facility-Wide Human Health Cleanup Goals for the RVAAP *(SAIC, 2010).*
CR denotes cancer risk at 1 x10^{-6}.
Cr^{+3} denotes trivalent chromium.
FD denotes field duplicate sample.
HQ denotes hazard quotient of 0.1.
µg/L denotes micrograms per liter.
mg/kg denotes milligrams per kilogram.
NA denotes not analyzed.
NE denotes analyte is not considered as a munitions constituent.
RB denotes rinsate blank.
TBC denotes to be calculated.
VQ denotes validation qualifier.

Validation Qualifiers:
J denotes estimated: The analyte was positively identified; the quantitation is estimation.
R denotes the data is considered rejected and shall not be used.
U denotes not detected or the concentration was below the detection limit.
UJ denotes not detected. The detection limits and quantitation limits are approximate.

Table D-2
Summary of Subsurface Soil Sample Results
Group 8 MRS
Ravenna Army Ammunition Plant

				Location Code:	GR8SS-006M		GR8SS-007M		GR8SS-008M		GR8SS-008M		NA	
				Sample Number:	GR8SS-006M-0001-SO		GR8SS-007M-0001-SO		GR8SS-008M-0001-SO		GR8SS-009M-0001-SO		GR8-RB-01	
				Sample Date:	2/8/2012		2/8/2012		2/8/2012		2/8/2012		2/8/2012	
				Sample Purpose:	REG		REG		REG		FD		RB	
				Depth (feet bgs):	4 - 4.5		4 - 4.5		4 - 4.5		4 - 4.5		NA	
		Screening Criteria		Subsurface Soil										
Parameter	Units	HQ=0.1	CR=10^{-6}	BSV	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result (µg/L)	VQ
Explosives														
1,3,5-Trinitrobenzene	mg/kg	225	TBC	--	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.23	U
1,3-Dinitrobenzene	mg/kg	0.765	TBC	--	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.2	U
2,4,6-Trinitrotoluene	mg/kg	3.65	28.4	--	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.22	U
2,4-Dinitrotoluene	mg/kg	12.8	1.1	--	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.3	U
2,6-Dinitrotoluene	mg/kg	6.42	1.1	--	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.3	U
2-Amino-4,6-Dinitrotoluene	mg/kg	1.54	TBC	--	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.24	U
3,5-Dinitroaniline	mg/kg	TBC	TBC	--	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.23	U
4-Amino-2,6-Dinitrotoluene	mg/kg	1.54	TBC	--	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.28	U
HMX	mg/kg	359	TBC	--	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<1.2	U
m-Nitrotoluene	mg/kg	76.5	3.88	--	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.23	U
Nitrobenzene	mg/kg	13*	4.8*	--	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.22	U
Nitroglycerin	mg/kg	0.61*	52.5	--	<1	U	<1	U	<1	U	<1	U	<2.2	U
Nitroguanidine	mg/kg	610*	TBC	--	<0.125	U	<0.125	U	<0.125	U	<0.125	U	<32	U
o-Nitrotoluene	mg/kg	0.61*	TBC	--	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.4	U
PETN	mg/kg	TBC	TBC	--	<1	U	<1	U	<1	U	<1	U	<3	U
p-Nitrotoluene	mg/kg	76.5	52.5	--	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.22	U
RDX	mg/kg	22.7	8.03	--	<0.25	U	<0.25	U	<0.25	U	<0.25	U	<0.18	U
Tetryl	mg/kg	24.4*	TBC	--	<0.2	U	<0.2	U	<0.2	U	<0.2	U	<0.21	U
Metals														
Aluminum	mg/kg	3,496	TBC	19,500	14,500		10,900		11,800		12,200		12	J
Antimony	mg/kg	2.82	TBC	0.96	**3.4**		**5.9**		2.3		2.2		<2	U
Barium	mg/kg	351	TBC	124	86.3		113		80		83.1		<0.29	U
Cadmium	mg/kg	6.41	10.9	0	3.4		6.3		1.1		1.2		<0.3	U
Chromium (as Cr^{+3})	mg/kg	8,147	TBC	27.2	20.1		22.7		16.1		17.3		<6	U
Copper	mg/kg	311	TBC	32.3	32.7		112		50.9		54.2		<1.2	U
Iron	mg/kg	2,313	TBC	35,200	31,600		**39,500**		**36,200**		**37,500**		<16	U
Lead	mg/kg	400**	TBC	19.1	125		202		44.3		44.8		<1.4	U
Mercury	mg/kg	2.27	TBC	0.044	0.041		0.24		0.018		0.023		<0.03	U
Strontium	mg/kg	4,700*	TBC	--	43.1		38.8		27.6		27.4		<0.3	U
Zinc	mg/kg	2,321	23,209	93.3	144		299		106		119		<1.6	U
Geochemical Parameters														
Calcium	mg/kg	NE	NE	35,500	11,300		10,800		9,450		9,450		NA	
Magnesium	mg/kg	NE	NE	8,790	3,830		3,370		4,130		4,230		NA	
Manganese	mg/kg	NE	NE	3,030	604		846		448		476		NA	
Semivolatile Organic Compounds														
1,2,4-Trichlorobenzene	mg/kg	6.2*	22*	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.18	U
1,2-Dichlorobenzene	mg/kg	190*	TBC	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.2	U
1,3-Dichlorobenzene	mg/kg	TBC	TBC	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.22	U
1,4-Dichlorobenzene	mg/kg	350*	2.4*	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.21	U
2,4,5-Trichlorophenol	mg/kg	620*	TBC	--	<0.305	U	<0.305	U	<0.305	UJ	<0.305	UJ	<1.2	R
2,4,6-Trichlorophenol	mg/kg	6.1*	44*	--	<0.305	U	<0.305	U	<0.305	UJ	<0.305	UJ	<1.1	R
2,4-Dichlorophenol	mg/kg	18*	TBC	--	<0.305	U	<0.305	U	<0.305	UJ	<0.305	UJ	<1.1	UJ
2,4-Dimethylphenol	mg/kg	120*	TBC	--	<0.305	U	<0.305	U	<0.305	UJ	<0.305	UJ	<0.89	U
2,4-Dinitrophenol	mg/kg	12*	TBC	--	<1	U	<1	U	<1	UJ	<1	UJ	<1.6	R

Table D-2
Summary of Subsurface Soil Sample Results
Group 8 MRS
Ravenna Army Ammunition Plant

				Location Code:	GR8SS-006M		GR8SS-007M		GR8SS-008M		GR8SS-008M		NA	
				Sample Number:	GR8SS-006M-0001-SO		GR8SS-007M-0001-SO		GR8SS-008M-0001-SO		GR8SS-009M-0001-SO		GR8-RB-01	
				Sample Date:	2/8/2012		2/8/2012		2/8/2012		2/8/2012		2/8/2012	
				Sample Purpose:	REG		REG		REG		FD		RB	
				Depth (feet bgs):	4 - 4.5		4 - 4.5		4 - 4.5		4 - 4.5		NA	
		Screening Criteria		Subsurface Soil										
Parameter	**Units**	**HQ=0.1**	**CR=10^{-6}**	**BSV**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result (µg/L)**	**VQ**
2-Chloronaphthalene	mg/kg	630*	TBC	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.2	U
2-Chlorophenol	mg/kg	39*	TBC	--	<1	U	<1	U	<1	UJ	<1	UJ	<0.95	UJ
2-Methylnaphthalene	mg/kg	30.6	TBC	--	<0.06	U	0.13		<0.06	U	<0.06	U	<0.18	U
2-Nitroaniline	mg/kg	61*	TBC	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.24	U
2-Nitrophenol	mg/kg	TBC	TBC	--	<0.5	U	<0.5	U	<0.5	UJ	<0.5	UJ	<0.98	UJ
3,3'-Dichlorobenzidine	mg/kg	TBC	1.1*	--	<0.255	U	<0.255	U	<0.255	U	<0.255	U	<0.72	U
3-Nitroaniline	mg/kg	TBC	TBC	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.28	U
4,6-Dinitro-2-Methylphenol	mg/kg	0.49*	TBC	--	<0.5	U	<0.5	U	<0.5	UJ	<0.5	UJ	<1.7	R
4-Bromophenyl Phenyl Ether	mg/kg	TBC	TBC	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.22	U
4-Chloro-3-Methylphenol	mg/kg	610*	TBC	--	<1	U	<1	U	<1	UJ	<1	UJ	<0.87	UJ
4-Chloroaniline	mg/kg	24*	2.4*	--	<0.1	U	<0.1	U	<0.1	U	<0.1	U	<0.13	U
4-Chlorophenyl Phenyl Ether	mg/kg	TBC	TBC	--	<0.1	U	<0.1	U	<0.1	U	<0.1	U	<0.2	U
4-Nitrobenzenamine	mg/kg	NE	NE	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.16	U
4-Nitrophenol	mg/kg	61.2	TBC	--	<1	U	<1	U	<1	UJ	<1	UJ	<1.2	UJ
Acenaphthene	mg/kg	340*	TBC	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.2	U
Acenaphthylene	mg/kg	122	TBC	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.18	U
Anthracene	mg/kg	1,700*	TBC	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.12	U
Benzo(a)anthracene	mg/kg	TBC	0.221	--	<0.06	U	0.055	J	<0.06	U	<0.06	U	<0.13	U
Benzo(a)pyrene	mg/kg	TBC	0.022	--	<0.06	U	**0.04**	**J**	<0.06	U	<0.06	U	<0.15	U
Benzo(b)fluoranthene	mg/kg	TBC	0.221	--	<0.06	U	0.09	J	<0.06	U	<0.06	U	<0.18	U
Benzo(ghi)perylene	mg/kg	122	TBC	--	<0.06	U	0.038	J	<0.06	U	<0.06	U	<0.23	U
Benzo(k)fluoranthene	mg/kg	TBC	2.21	--	<0.06	U	0.043	J	<0.06	U	<0.06	U	<0.22	U
Benzoic Acid	mg/kg	24,000*	TBC	--	<1.5	U	<1.5	U	<1.5	UJ	<1.5	UJ	<12	UJ
Benzyl Alcohol	mg/kg	TBC	TBC	--	<0.205	U	<0.2	U	<0.205	U	<0.2	U	1.7	J
Bis(2-Chloroethoxy)methane	mg/kg	23	TBC	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.21	U
Bis(2-Chloroethyl)ether	mg/kg	TBC	0.21*	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.23	U
Bis(2-Chloroisopropyl)ether	mg/kg	310*	4.6*	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.24	U
Bis(2-Ethylhexyl)phthalate	mg/kg	35*	120*	--	0.26	J	<0.2	U	<0.205	U	0.095	J	0.54	J
Butyl Benzyl Phthalate	mg/kg	260*	1,200*	--	<0.205	U	<0.2	U	<0.205	U	<0.2	U	<0.51	U
Carbazole	mg/kg	44.6	TBC	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.13	U
Chrysene	mg/kg	22.1	TBC	--	<0.06	U	0.072	J	<0.06	U	0.06	U	<0.17	U
Cresols (Total)	mg/kg	NE	NE	--	<1.85	U	<1.8	U	<1.85	U	<1.8	U	<1.5	UJ
Dibenzo(a,h)anthracene	mg/kg	TBC	0.022	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.18	U
Dibenzofuran	mg/kg	15.3	TBC	--	<0.06	U	0.039	J	<0.06	U	<0.06	U	<0.21	U
Diethyl Phthalate	mg/kg	4,900	TBC	--	<0.205	U	<0.2	U	<0.205	U	<0.2	U	<0.49	U
Dimethyl Phthalate	mg/kg	TBC	TBC	--	<0.205	U	<0.2	U	<0.205	U	<0.2	U	<0.59	U
Di-n-Butyl Phthalate	mg/kg	610*	TBC	--	<0.205	U	<0.2	U	<0.205	U	<0.2	U	<0.73	U
Di-n-Octyl Phthalate	mg/kg	TBC	TBC	--	<0.1	U	<0.1	U	<0.1	U	<0.1	U	<0.53	U
Fluoranthene	mg/kg	163	TBC	--	<0.06	U	0.12		<0.06	U	0.06	U	<0.14	U
Fluorene	mg/kg	243	TBC	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.21	U
Hexachlorobenzene	mg/kg	4.9*	0.3*	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.29	U
Hexachlorobutadiene	mg/kg	6.1*	6.2*	--	<0.205	U	<0.2	U	<0.205	U	<0.2	U	<0.2	U
Hexachlorocyclopentadiene	mg/kg	37*	TBC	--	<0.1	U	<0.1	U	<0.1	U	<0.1	U	<0.28	U
Hexachloroethane	mg/kg	6.1*	35*	--	<0.06	U	<0.06	U	<0.06	U	<0.06	U	<0.24	U
Indeno(1,2,3-cd)pyrene	mg/kg	TBC	0.221	--	<0.06	U	0.038	J	<0.06	U	<0.06	U	<0.2	U

Table D-2
Summary of Subsurface Soil Sample Results
Group 8 MRS
Ravenna Army Ammunition Plant

				Location Code:	GR8SS-006M		GR8SS-007M		GR8SS-008M		GR8SS-008M		NA	
				Sample Number:	GR8SS-006M-0001-SO		GR8SS-007M-0001-SO		GR8SS-008M-0001-SO		GR8SS-009M-0001-SO		GR8-RB-01	
				Sample Date:	2/8/2012		2/8/2012		2/8/2012		2/8/2012		2/8/2012	
				Sample Purpose:	REG		REG		REG		FD		RB	
				Depth (feet bgs):	4 - 4.5		4 - 4.5		4 - 4.5		4 - 4.5		NA	
		Screening Criteria		Subsurface Soil										
Parameter	**Units**	**HQ=0.1**	**CR=10^{-6}**	**BSV**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result (µg/L)**	**VQ**
Isophorone	mg/kg	1,200*	510*	--	<0.1	U	<0.1	U	<0.1	U	<0.1	U	<0.2	U
Naphthalene	mg/kg	122	TBC	--	0.023	J	0.13		<0.06	U	0.06	U	0.21	J
N-Nitroso-di-n-Propylamine	mg/kg	NE	NE	--	<0.205	U	<0.2	U	<0.205	U	<0.2	U	<0.2	U
N-Nitrosodiphenylamine	mg/kg	TBC	0.12	--	<0.205	U	<0.2	U	<0.205	U	<0.2	U	<0.39	U
o-Cresol	mg/kg	TBC	99*	--	<1	U	<1	U	<1	U	<1	U	<0.93	U
Phenanthrene	mg/kg	122	TBC	--	<0.06	U	0.12		<0.06	U	<0.06	U	<0.33	U
Pyrene	mg/kg	122	TBC	--	<0.06	U	0.1	J	<0.06	U	<0.06	U	<0.14	U
Polychlorinated Biphenyls														
Aroclor-1016	mg/kg	0.419	0.203	--	<0.05	U	<0.05	U	<0.05	U	<0.05	U	<0.00011	U
Aroclor-1221	mg/kg	TBC	0.14*	--	<0.05	U	<0.05	U	<0.05	U	<0.05	U	<0.000091	U
Aroclor-1232	mg/kg	TBC	0.14*	--	<0.05	U	<0.05	U	<0.05	U	<0.05	U	<0.00016	U
Aroclor-1242	mg/kg	TBC	0.22*	--	<0.05	U	<0.05	U	<0.05	U	<0.05	U	<0.0001	U
Aroclor-1248	mg/kg	TBC	0.203	--	<0.05	U	<0.05	U	<0.05	U	<0.05	U	<0.000095	U
Aroclor-1254	mg/kg	0.12	0.203	--	<0.05	U	0.33		<0.05	U	<0.05	U	<0.0001	U
Aroclor-1260	mg/kg	TBC	0.203	--	<0.05	U	0.12		<0.05	U	<0.05	U	<0.00011	U
General Chemistry														
Nitrocellulose	mg/kg	1.8E+07*	TBC	---	<100	U	<100	U	<100	U	<100	U	<1.1	U
Hexavalent Chromium	mg/kg	5.61	1.64	0	<5	U	<5	U	<5	U	<5	U	6	J
pH	pH Units	---	---	---	7.09		7.9		7.64		7.7		NA	
Total Organic Carbon	mg/kg	---	---	---	9,200		23,000		3,300		2,900		NA	
Total Solids	%	---	---	---	98.4		98.4		98.8		98.4		NA	

[a] *Screening values are the lowest of the facility-wide cleanup goals for the National Guard Trainee and the Residential Farmer (Adult and Child) as presented in the* Facility Wide Human Health Remediation Goals at the Ravenna Army Ammunition Plant, Ravenna, Ohio (*March 2010).*
[b] *Shaded cells indicate that the detected concentration exceeds the established background screening value (inorganics only) or are detected values for organics.*
[c] *Bold values indicate the detected concentration exceeds the screening criteria for analytes considered as munitions constituents only.*
** No facility-wide cleanup goal is available and the value is based on the EPA Regional Screening Level Resident Supporting Table (2012).*
*** The residential screening level of 400 mg/kg for lead was not adjusted for an HQ of 0.1 since it was not derived using the hazard index approach.*
The facility-wide cleanup goal HQ=0.1 for pyrene was used for acenapthylene, benzo(ghi)pyrelene, naphthalene, and phenanthrene.
--- denotes a cleanup goal and/or BSV is not available.
< denotes less than.
bgs denotes below ground surface.
BSV denotes background screening value as presented in the Final Facility-Wide Human Health Cleanup Goals for the RVAAP *(SAIC, 2010).*
CR denotes cancer risk at 1 x10^{-6}.
Cr^{+3} denotes trivalent chromium.
FD denotes field duplicate sample.
HQ denotes hazard quotient of 0.1.
µg/L denotes micrograms per liter.
mg/kg denotes milligrams per kilogram.
NA denotes not analyzed.
NE denotes analyte is not considered as a munitions constituent.
RB denotes rinsate blank.
TBC denotes to be calculated.
VQ denotes validation qualifier.

Validation Qualifiers:
J denotes estimated: The analyte was positively identified; the quantitation is estimation.
R denotes the data is considered rejected and shall not be used.
U denotes not detected or the concentration was below the detection limit.
UJ denotes not detected. The detection limits and quantitation limits are approximate.

Chains of Custody

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Rev. 9/2009

CHAIN OF CUSTODY

Page 1 of 1

Company: Shaw E&I
Project Contact: David Crispo
Telephone: 617-589-8146
Project Name: RVAAP MMRP
Project #: 136147
Location: Ravenna, OH
Sampled By: D Crispo

CT LABORATORIES

1230 Lange Court, Baraboo, WI 53913
608-356-2760 Fax 608-356-2766
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Folder #: 89284
Company: SHAW E&I INC
Project: RVAAP GROUP 8 MRS
Logged By: ETK PM: ET

ogram:
M RCRA SDWA NPDES
lid Waste Other MMRP
) #

Report To: david.crispo@shawgrp.com
EMAIL:
Company: Shaw E&I
Address: Stoughton MA

Invoice To:*
EMAIL:
Company:
Address:

**Party listed is responsible for payment of invoice as per CT Laboratories' terms and conditions*

Client Special Instructions
MEC metals include: Al, Sb, Ba, Cd, Cr (III & VI), Cu Fe, Pb, Zn, Sr and Hg
Geochem metals include: Ca, Mg, Mn

Matrix:
GW - groundwater SW - surface water WW - wastewater DW - drinking water
S - soil/sediment SL - sludge A - air M - misc/waste

ANALYSES REQUESTED

Turnaround Time
Normal RUSH*
Date Needed:

Rush analysis requires prior CT Laboratories' approval
Surcharges:
24 hr 200%
2-3 days 100%
4-9 days 50%

Fill in Spaces with Bottles per Test

Collection Date	Collection Time	Matrix	Grab/Comp	Sample ID Description	Filtered? Y/N	MEC METALS	GEOCHEM METALS	EXPLOSIVES	NITROCELLULOSE	PCBs	SVOCs	TOC	pH	Total # Containers	Designated MS/MSD	CT Lab ID # (Lab use only)
2/8/12	1430	S	IS	GR8SS-001M-0001-SO		X	X	X	X	X	X	X	X	1		122187
2/8/12	1240			GR8SS-002M-0001-SO										1		188
2/8/12	1310			GR8SS-003M-0001-SO										1		189
2/8/12	1400			GR8SS-004M-0001-SO										1	X	190
2/8/12	1430			GR8SS-005M-0001-SO										1		191
2/8/12	1300			GR8SS-006M-0001-SO										1		192
2/8/12	1320			GR8SS-007M-0001-SO										1		193
2/8/12	1345			GR8SS-008M-0001-SO										1		194
2/8/12	1405			GR8SS-009M-0001-SO										1		195
2/9/12	0845	W	G	GR8-RB-01	N									7		196

Relinquished By:	Date/Time	Received By:	Date/Time	Lab Use Only
D Crispo	2/9/12 @1200	UPS	2/9/12 @1200	Ice Present Yes No
Received by:	Date/Time	Received for Laboratory By:	Date/Time	Temperature 2.4, 4.6
		[signature]	~~2-9~~ 2-10-12	Cooler # 5080, 3846

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Appendix E
Investigation-Derived Waste Management

Investigation-Derived Waste Management Report

Ravenna Army Ammunition Plant
Ravenna, Ohio

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

Prepared for:

U.S. Army Corps of Engineers
Baltimore District
10 S. Howard Street, Room 7000
Baltimore, Maryland 21201

Prepared by:

Shaw Environmental & Infrastructure, Inc.
150 Royall Street
Canton, Massachusetts 02021

December 14, 2012

Table of Contents

List of Tables

List of Attachments

Acronyms and Abbreviations

CFR	Code of Federal Regulations
DOT	Department of Transportation
FSAP	Facility-Wide Sampling and Analysis Plan
IDW	Investigation-Derived Waste
mg/L	milligrams per liter
PCB	polychlorinated biphenyls
PPE	personal protective equipment
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RVAAP	Ravenna Army Ammunition Plant
SAP	sampling and analysis plan
SAIC	Science Applications International Corporation
Shaw	Shaw Environmental & Infrastructure, Inc.
SVOC	semivolatile organic compound
TCLP	Toxicity Characteristic Leaching Procedure
USEPA	U.S. Environmental Protection Agency
VISTA	Vista Environmental Sciences Corporation
VOC	volatile organic compound
VQ	validation qualifier

1.0 Investigation-Derived Waste Management

Investigation-Derived Waste (IDW) generated during the remedial investigation (RI) activities conducted at the Ravenna Army Ammunition Plant (RVAAP), Ohio, under the Military Munitions Response Program included the following:

- Solid Waste (expendable waste debris) consisting of personal protective equipment (PPE).

- Solid Waste (used absorbent pads) derived from collection of residual liquids from decontamination of sampling equipment.

All IDW generated during the RI activities was managed in accordance with sampling requirements of *Munitions Constituents Sampling and Analysis Plan/Quality Assurance Project Plan* (Shaw, 201a); hereafter referred to as the SAP and Section 7.0 of the *Facility-Wide Sampling and Analysis Plan* (FSAP; SAIC, 2001).

1.1 IDW Collection and Containerization

Characterization and classification of the different types of IDW were based on the specific protocols described below.

- **Expendable Waste Debris and Spent Absorbent Pads:** Expendable waste debris and spent absorbent pads considered to be potentially contaminated based on visual inspection and use of the waste material was placed in segregated trash bags and stored in a 55-gallon drum sealed with gasketed ring-topped lid.

A summary of IDW generated is presented in **Table 1**.

Table 1
Summary of Investigation-Derived Waste

Drum ID Number	Container Size and Type	Contents and Volume	Generation Dates
Solid Waste			
Shaw-2012-01	55-gallon open top	PPE and spent absorbent pads (half-full)	8/12/2011-5/9/2012

1.2 Waste Container Labeling

All containerized waste was labeled as specified in Section 7.2 of the *FSAP*. Label information on each container was written in indelible ink and included at a minimum; container number, contents, source of the waste, source location, project name and site identification, physical characteristics of the waste, and generation dates. The label was placed on the side of the container at a location that was protected from damage or degradation.

1.3 IDW Field Staging

The drum containing IDW was staged at Building 1036. The drum was placed on a wooden pallet at Building 1036 and was labeled as "On Hold Pending Analysis" until analytical results were received.

1.4 Weekly Inspection Inventories

Shaw contracted Vista Environmental Services (VISTA) to conduct weekly inspection inventories of the containerized IDW in accordance with Section 40, Part 262 of the Code of Federal Regulations (40 CFR 262). The weekly inspections were performed by VISTA for the duration of the waste storage at the facility. Once analytical results were received by Shaw, VISTA placed the appropriate waste characterization label on the drum.

1.5 IDW Sampling

The IDW sample was analyzed by the following United States Environmental Protection Agency (U.S. EPA) methods:

Table 2
Investigation-Derived Waste Analysis Methods

Sample Name	Analysis	Methods
IDW-WC-0001	TCLP Metals TCLP SVOCs TCLP VOCs PCBs Explosives RCRA Characteristics[1]	6010C, 7470A 8270C 8260C 8082A 8330B 9045D, 1010, ASTM D5049, and ASTM D4978

Notes:
[1]RCRA Characteristics include analysis for reactive cyanide and sulfide, flashpoint and pH.
RCRA = Resource Conservation and Recovery Act
PCBs = polychlorinated biphenyls
SVOCs = semivolatile organic compounds
TCLP = Toxicity Characteristic Leaching Procedure
VOCs = volatile organic compounds

The detected analytical results for each of the IDW samples are presented in **Table 3**. The IDW laboratory data report is presented in **Attachment 1**.

1.6 Listed Waste Screening

Review of available historical documents and generator knowledge, does not support that wastes generated meet the listed description as defined in 40 CFR 261, Subpart D. Therefore, the IDW generated was not considered listed.

1.7 Characteristic Waste Screening

The solid waste was evaluated to determine if it exhibited characteristics of a hazardous waste. RCRA characterization was performed on the waste to determine if was reactive, ignitable, or corrosive. To check for the characteristic of toxicity, the analytical results from were compared to the RCRA Toxicity Characteristic Leaching Procedure (TCLP) regulatory levels. All detected analytes were below the toxicity limits and did not exhibit characteristics of a hazardous waste. (**Table 3**).

1.8 IDW Transport and Disposal

Based on the analytical data and the screening criteria discussed above, the drum containing expendable waste debris and used absorbent pads did not exhibit characteristics of a hazardous solid waste. All waste disposal documents were reviewed by the RVAAP Facility Manager prior to off-site disposal in accordance with the RVAAP Waste Management Guidelines. All generated waste was transported off-site for disposal at Vexor Technology, Inc. in Medina, Ohio. The drum was disposed as Non-DOT regulated, Non Hazardous Material. The approved-waste profile and non-hazardous waste manifest are provided in **Attachment 2** and **Attachment 3**, respectively.

Table 3
Detected Analytes in Investigation-Derived Waste Samples

Sample ID	Sample Date	Test Group	Method	Analyte	Result	VQ	Units	Characteristic Waste Evaluation	
								EPA Hazardous Waste Code	RCRA TCLP Level (mg/L)[1]
IDW-WC-0001	02-Oct-12	Metals	6010C	TCLP Barium	0.034		mg/L	D005	100
		Metals	6010C	TCLP Chromium	0.0006	J	mg/L	D007	5
		Metals	6010C	TCLP Lead	0.0065		mg/kg	D008	5
		Metals	6010C	TCLP Selenium	0.004	B	mg/kg	D010	1

Notes:
[1]Toxicity Characteristic Leaching Procedure (TCLP), 40 CFR 261.24
mg/L = milligrams per liter
VQ = validation qualifier

Validation Qualifiers
J = The reported result is an estimated value
B = Analyte detected in associated method blank.

ATTACHMENT 1
IDW LABORATORY DATA REPORT

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ANALYTICAL REPORT

SHAW E&I INC
DAVID CRISPO
100 TECHNOLOGY CENTER DRIVE
STOUGHTON, MA 02072

Copy: Maqsud.Rahman@shawgrp.com

Project Name: RVAAP MMRP
Project Phase:
Contract #: 2385
Project #: 136147
Folder #: 93596
Purchase Order #: 734474

Arrival Temperature: 2.0
Report Date: 10/22/2012
Date Received: 10/3/2012
Reprint Date: 10/22/2012

CT LAB#: 223573 Sample Description: IDW-WC-0001 Client Sample #: Sampled: 10/2/2012 1200

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Metals Results												
TCLP Arsenic	<0.0040	mg/L	0.0040	0.012	0.024	0.024	1.00	U	10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Barium	0.034	mg/L	0.00029	0.00090	0.0018	0.0018	1.00		10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Cadmium	<0.00030	mg/L	0.00030	0.0010	0.0020	0.0020	1.00	U	10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Chromium	0.0039	mg/L	0.00060	0.0020	0.0040	0.0040	1.00	J	10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Lead	0.0065	mg/L	0.0014	0.0020	0.0040	0.0040	1.00		10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Selenium	0.0040	mg/L	0.0022	0.0065	0.013	0.013	1.00	J B	10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Silver	<0.00070	mg/L	0.00070	0.0020	0.0040	0.0040	1.00	U	10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Mercury	<0.000030	mg/L	0.000030	0.000060	0.00012	0.00012	1.00	U	10/9/2012 08:00	10/11/12 12:02	LJF	EPA 7470A
Organic Results												
TCLP 1,1-Dichloroethene	<0.024	mg/L	0.024	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP 1,2-Dichloroethane	<0.030	mg/L	0.030	0.050	0.10	0.10	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP 2-Butanone	<0.24	mg/L	0.24	0.25	0.50	0.50	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP Benzene	<0.019	mg/L	0.019	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP Carbon tetrachloride	<0.023	mg/L	0.023	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP Chlorobenzene	<0.024	mg/L	0.024	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP Chloroform	<0.015	mg/L	0.015	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^

Solid sample results reported on a Dry Weight Basis

CT LABORATORIES
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SHAW E&I INC
Project Name: RVAAP MMRP
Project Phase:
Project #: 136147

Contract #: 2385
Folder #: 93596

CT LAB#: 223573 Sample Description: IDW-WC-0001 Client Sample #: Sampled: 10/2/2012 1200

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
TCLP Tetrachloroethene	<0.030	mg/L	0.030	0.050	0.10	0.10	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP Trichloroethene	<0.021	mg/L	0.021	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP Vinyl chloride	<0.018	mg/L	0.018	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP 1,2 Dichloroethane-d4	112	% Recovery	70			120	1.00		10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C
TCLP Bromofluorobenzene	107	% Recovery	75			120	1.00		10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C
TCLP d8-Toluene	106	% Recovery	85			120	1.00		10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C
TCLP Dibromofluoromethane	113	% Recovery	85			115	1.00		10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C
TCLP 1,4-Dichlorobenzene	<0.0019	mg/L	0.0019	0.0040	0.010	0.010	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP 2,4,5-Trichlorophenol	<0.011	mg/L	0.011	0.020	0.050	0.050	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP 2,4,6-Trichlorophenol	<0.010	mg/L	0.010	0.020	0.050	0.050	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP 2,4-Dinitrotoluene	<0.0021	mg/L	0.0021	0.0040	0.010	0.010	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP 2-Methylphenol	<0.0086	mg/L	0.0086	0.020	0.050	0.050	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP 3 & 4-Methylphenol	<0.014	mg/L	0.014	0.36	0.90	0.90	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Hexachlorobenzene	<0.0027	mg/L	0.0027	0.0040	0.010	0.010	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Hexachlorobutadiene	<0.0018	mg/L	0.0018	0.0040	0.010	0.010	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Hexachloroethane	<0.0022	mg/L	0.0022	0.0040	0.010	0.010	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Nitrobenzene	<0.0016	mg/L	0.0016	0.0040	0.010	0.010	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Pentachlorophenol	<0.011	mg/L	0.011	0.020	0.050	0.050	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Pyridine	<0.0062	mg/L	0.0062	0.010	0.030	0.030	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Surr: 2,4,6-Tribromophenol	87	% Recovery	40			125	1.00		10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C
TCLP Surr: 2-Fluorobiphenyl	82	% Recovery	50			110	1.00		10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C
TCLP Surr: 2-Fluorophenol	52	% Recovery	20			110	1.00		10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C
TCLP Surr: Nitrobenzene-d5	83	% Recovery	40			110	1.00		10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C
TCLP Surr: Phenol-d5	36	% Recovery	10			115	1.00		10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C
TCLP Surr: Terphenyl-d14	84	% Recovery	50			135	1.00		10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C

Solid sample results reported on a Dry Weight Basis

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SHAW E&I INC
Project Name: RVAAP MMRP
Project Phase:
Project #: 136147

Contract #: 2385
Folder #: 93596

CT LAB#: 223575 Sample Description: IDW-WC-0001 Client Sample #: Sampled: 10/2/2012 1200

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	90.9	%					1.00			10/5/12 13:15	BMS	EPA 8000C
pH	9.05	S.U.					1.00			10/9/12 14:00	CER	EPA 9045D ^
Flashpoint	>140	Deg. F					1.00			10/10/12 15:30	EJC	EPA 1010 ^
Cyanide, Reactive	<22	mg/kg	22			22	1.00	U		10/12/12 09:00	EJC	ASTM D5049 ^
Sulfide Reactive	<110	mg/kg	110			110	1.00	U		10/8/12 16:00	EJC	ASTM D4978 ^
Organic Results												
Aroclor-1016	<11	ug/kg	11	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Aroclor-1221	<22	ug/kg	22	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Aroclor-1232	<30	ug/kg	30	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Aroclor-1242	<32	ug/kg	32	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Aroclor-1248	<32	ug/kg	32	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Aroclor-1254	<25	ug/kg	25	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Aroclor-1260	<13	ug/kg	13	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Surr: DCBP	26	% Recovery	60			125	1.00	S	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A
1,3,5-Trinitrobenzene	<0.25	mg/kg	0.25	0.59	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
1,3-Dinitrobenzene	<0.16	mg/kg	0.16	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
2,4,6-Trinitrotoluene	<0.18	mg/kg	0.18	0.39	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
2,4-Dinitrotoluene	<0.16	mg/kg	0.16	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
2,6-Dinitrotoluene	<0.14	mg/kg	0.14	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
2-Amino-4,6-dinitrotoluene	<0.18	mg/kg	0.18	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
2-Nitrotoluene	<0.18	mg/kg	0.18	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
3,5-Dinitroaniline	<0.18	mg/kg	0.18	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
3-Nitrotoluene	<0.22	mg/kg	0.22	0.59	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
4-Amino-2,6-dinitrotoluene	<0.16	mg/kg	0.16	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
4-Nitrotoluene	<0.20	mg/kg	0.20	0.39	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B

Solid sample results reported on a Dry Weight Basis

CT LABORATORIES
delivering more than data from your environmental analyses

SHAW E&I INC
Project Name: RVAAP MMRP
Project Phase:
Project #: 136147

Contract #: 2385
Folder #: 93596

CT LAB#: 223575 Sample Description: IDW-WC-0001 Client Sample #: Sampled: 10/2/2012 1200

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
HMX	<0.24	mg/kg	0.24	0.59	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
Nitrobenzene	<0.20	mg/kg	0.20	0.39	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
Nitroglycerin	<0.98	mg/kg	0.98	2.4	3.9	3.9	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
PETN	<1.2	mg/kg	1.2	2.4	3.9	3.9	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
RDX	<0.27	mg/kg	0.27	0.59	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
Tetryl	<0.18	mg/kg	0.18	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
1,2-Dinitrobenzene	99	% Recovery	74			128	1.00		10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B

Solid sample results reported on a Dry Weight Basis

Notes:

^ Indicates the laboratory is NELAP accredited for this analyte by the indicated matrix and method. DL (detection limit), LOD (limit of detection), loq (limit of quantitation) as defined by most recent DOD QSM version.

All samples were received intact and properly preserved unless otherwise noted. The results reported relate only to the samples tested. This report shall not be reproduced, except in full, without written approval of this laboratory. The Chain of Custody is attached.

This report has been specifically prepared to satisfy project or program requirements. These results are in compliance with NELAC requirements for the parameters where accreditation is required or available, unless noted in the case narrative.

Submitted by: Eric T. Korthals
Project Manager
608-356-2760

QC Qualifiers

Code	Description
B	Analyte detected in the associated Method Blank.
C	Toxicity present in BOD sample.
D	Diluted Out.
E	Safe, No Total Coliform detected.
F	Unsafe, Total Coliform detected, no E. Coli detected.
G	Unsafe, Total Coliform detected and E. Coli detected.
H	Holding time exceeded.
J	Estimated value.
L	Significant peaks were detected outside the chromatographic window.
M	Matrix spike and/or Matrix Spike Duplicate recovery outside acceptance limits.
N	Insufficient BOD oxygen depletion.
O	Complete BOD oxygen depletion.
P	Concentration of analyte differs more than 40% between primary and confirmation analysis.
Q	Laboratory Control Sample outside acceptance limits.
R	See Narrative at end of report.
S	Surrogate standard recovery outside acceptance limits due to apparent matrix effects.
T	Sample received with improper preservation or temperature.
U	Analyte concentration was below detection limit.
V	Raised Quantitation or Reporting Limit due to limited sample amount or dilution for matrix background interference.
W	Sample amount received was below program minimum.
X	Analyte exceeded calibration range.
Y	Replicate/Duplicate precision outside acceptance limits.
Z	Specified calibration criteria was not met.

Current CT Laboratories Certifications

Illinois NELAP ID# 002413
Kansas NELAP ID# E-10368
Kentucky ID# 0023
Pennsylvania NELAP ID# 68-04201
New Jersey NELAP ID# WI001
North Carolina ID# 674
Wisconsin (WDNR) Chemistry ID# 157066030
Wisconsin (DATCP) Bacteriology ID# 105-289
DoD-ELAP A2LA Cert # 3317.013
Alaska ID # UST-099
Louisiana ID # 115843
Virginia ID# 460203
ISO/IEC 17025-2005 A2LA Cert # 3317.01
GA EPD Stipulation ID 115843, Exp 6-30-13

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QC SUMMARY REPORT

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Soil

Analytical Run #:	88561	Analysis Date:	10/08/2012	Prep Batch #:		Matrix:	SOLID
CTLab #:	226712	Analysis Time:	16:00	Prep Date/Time:		Method:	
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Sulfide Reactive	100	mg/kg			100	100	70 --- 130		

SHAW E&I INC **Project Name:** **RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Water

Analytical Run #:	88561	Analysis Date:	10/08/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #:	226713	Analysis Time:	16:00	Prep Date/Time:		Method:	
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Sulfide Reactive	2.00	mg/L			2.00	100	70 --- 130		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Water

Analytical Run #:	88561	Analysis Date:	10/08/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #:	226716	Analysis Time:	16:00	Prep Date/Time:		Method:	
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Sulfide Reactive	2	mg/L		U	0		2		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Soil

Analytical Run #:	88690	Analysis Date:	10/12/2012	Prep Batch #:	Matrix: SOLID
CTLab #:	229180	Analysis Time:	09:00	Prep Date/Time:	Method:
Parent Sample #:		Analyst:	EJC	Prep Analyst:	

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Cyanide, Reactive	20.0	mg/kg			20.0	100	70 --- 130		

SHAW E&I INC **Project Name:** **RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Water

Analytical Run #:	88690	Analysis Date:	10/12/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #:	229181	Analysis Time:	09:00	Prep Date/Time:		Method:	
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Cyanide, Reactive	10.0				10.0	100	70 --- 130		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Soil

Analytical Run #:	88690	Analysis Date:	10/12/2012	Prep Batch #:		Matrix:	SOLID
CTLab #:	229182	Analysis Time:	09:00	Prep Date/Time:		Method:	
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Cyanide, Reactive	20	mg/kg		U	0.00		8		

SHAW E&I INC | **Project Name:** **RVAAP MMRP**

SDG #: **0** | **Folder #:** **93596** | **Project Number:** **136147**

Method Blank Water

Analytical Run #:	88690	Analysis Date:	10/12/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #:	229183	Analysis Time:	09:00	Prep Date/Time:		Method:	
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Cyanide, Reactive	10			U	0		4		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Soil

Analytical Run #:	88649	Analysis Date:	10/10/2012	Prep Batch #:		Matrix:	SOLID
CTLab #:	226783	Analysis Time:	15:30	Prep Date/Time:		Method:	SW1010
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Flashpoint	78.7	Deg. F			79.8	99	90 --- 110		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Water

Analytical Run #: 88649	Analysis Date: 10/10/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #: 226784	Analysis Time: 15:30	Prep Date/Time:		Method:	SW1010
Parent Sample #:	Analyst: EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Flashpoint	78.7	Deg. F			79.8	99	90 --- 110		

SHAW E&I INC

Project Name: **RVAAP MMRP**

SDG #: **0** **Folder #:** **93596** **Project Number:** **136147**

Duplicate

Analytical Run #:	88634	Analysis Date:	10/11/2012	Prep Batch #:	42371	Matrix:	TCLP
CTLab #:	225708	Analysis Time:	12:06	Prep Date/Time:	10/10/2012 09:30	Method:	SW7470
Parent Sample #:	223573	Analyst:	LJF	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Mercury	0.0000300	mg/L	BDL	U			0.12	0	20

SHAW E&I INC | **Project Name:** **RVAAP MMRP**

SDG #: **0** | **Folder #:** **93596** | **Project Number:** **136147**

Lab Control Spike Water

Analytical Run #:	88634	Analysis Date:	10/11/2012	Prep Batch #:	42371	Matrix:	LIQUID
CTLab #:	225707	Analysis Time:	13:36	Prep Date/Time:	10/10/2012 09:30	Method:	SW7470
Parent Sample #:		Analyst:	LJF	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Mercury	0.00287	mg/L			0.00300	96	80 --- 120		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Water

Analytical Run #:	88634	Analysis Date:	10/11/2012	Prep Batch #:	42371	Matrix:	LIQUID
CTLab #:	225706	Analysis Time:	12:00	Prep Date/Time:	10/10/2012 09:30	Method:	SW7470
Parent Sample #:		Analyst:	LJF	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Mercury	0.00003	mg/L		U	0		00006		

SHAW E&I INC **Project Name:** **RVAAP MMRP**

SDG #: **0** **Folder #:** **93596** **Project Number:** **136147**

Matrix Spike Duplicate Water

Analytical Run #:	88634	Analysis Date:	10/11/2012	Prep Batch #:	42371	Matrix:	TCLP
CTLab #:	225710	Analysis Time:	12:10	Prep Date/Time:	10/10/2012 09:30	Method:	SW7470
Parent Sample #:	225709	Analyst:	LJF	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Mercury	0.00164	mg/L	BDL		0.00200	82	80 --- 120	6	20

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Matrix Spike Water

Analytical Run #:	88634	Analysis Date:	10/11/2012	Prep Batch #:	42371	Matrix:	TCLP
CTLab #:	225709	Analysis Time:	12:08	Prep Date/Time:	10/10/2012 09:30	Method:	SW7470
Parent Sample #:	223573	Analyst:	LJF	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Mercury	0.00155	mg/L	BDL		0.00200	78	80 --- 120		

SHAW E&I INC **Project Name:** **RVAAP MMRP**

SDG #: **0** **Folder #:** **93596** **Project Number:** **136147**

Duplicate

Analytical Run #:	88688	Analysis Date:	10/12/2012	Prep Batch #:	42396	Matrix:	TCLP
CTLab #:	226815	Analysis Time:	15:32	Prep Date/Time:	10/11/2012	Method:	SW6010
Parent Sample #:	223573	Analyst:	NAH	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Arsenic	0.00400	mg/L	BDL	U			24	0	20
Barium	0.0360	mg/L	34.4				1.80	5	20
Cadmium	0.000300	mg/L	BDL	U			2.0	0	20
Chromium	0.00368	mg/L	3.86				4.0	5	20
Lead	0.00667	mg/L	6.53				4.0	2	20
Selenium	0.00220	mg/L	3.96	U			13.0	200	20
Silver	0.000700	mg/L	BDL	U			4.0	0	20

SHAW E&I INC

Project Name: **RVAAP MMRP**

SDG #: **0** **Folder #:** **93596** **Project Number:** **136147**

Lab Control Spike Water

Analytical Run #:	88688	Analysis Date:	10/12/2012	Prep Batch #:	42396
CTLab #:	226813	Analysis Time:	15:18	Prep Date/Time:	10/11/2012
Parent Sample #:		Analyst:	NAH	Prep Analyst:	LJF

Matrix:	LIQUID
Method:	SW6010

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Arsenic	0.808	mg/L			0.800	101	80 --- 120		
Barium	0.862	mg/L			0.800	108	80 --- 120		
Cadmium	0.0211	mg/L			0.0200	106	80 --- 120		
Chromium	0.0793	mg/L			0.0800	99	80 --- 120		
Lead	0.199	mg/L			0.200	100	80 --- 120		
Selenium	0.805	mg/L			0.800	101	80 --- 120		
Silver	0.0209	mg/L			0.0200	104	80 --- 120		

SHAW E&I INC | **Project Name: RVAAP MMRP**

SDG #: 0 | **Folder #: 93596** | **Project Number: 136147**

Method Blank Water

Analytical Run #:	88688	Analysis Date:	10/12/2012	Prep Batch #:	42396	Matrix:	LIQUID
CTLab #:	226812	Analysis Time:	15:21	Prep Date/Time:	10/11/2012	Method:	SW6010
Parent Sample #:		Analyst:	NAH	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Arsenic	0.004	mg/L		U	0		0.012		
Barium	0.00029	mg/L		U	0		00090		
Cadmium	0.0003	mg/L		U	0		.0010		
Chromium	0.0006	mg/L		U	0		.0020		
Lead	0.0014	mg/L		U	0		.0020		
Selenium	0.00404	mg/L			0		.0065		
Silver	0.000967	mg/L			0		.0020		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Matrix Spike Duplicate Water

Analytical Run #:	88688	Analysis Date:	10/12/2012	Prep Batch #:	42396	Matrix:	TCLP
CTLab #:	226817	Analysis Time:	15:38	Prep Date/Time:	10/11/2012	Method:	SW6010
Parent Sample #:	226816	Analyst:	NAH	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Arsenic	0.783	mg/L	BDL		0.800	98	80 --- 120	2	20
Barium	0.883	mg/L	0.034		0.800	106	80 --- 120	2	20
Cadmium	0.0173	mg/L	BDL		0.0200	86	80 --- 120	2	20
Chromium	0.0716	mg/L	0.0039		0.0800	85	80 --- 120	2	20
Lead	0.180	mg/L	0.0065		0.200	87	80 --- 120	1	20
Selenium	0.797	mg/L	0.0040		0.800	99	80 --- 120	1	20
Silver	0.0183	mg/L	BDL		0.0200	92	80 --- 120	5	20

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Matrix Spike Water

Analytical Run #:	88688	Analysis Date:	10/12/2012	Prep Batch #:	42396	Matrix:	TCLP
CTLab #:	226816	Analysis Time:	15:35	Prep Date/Time:	10/11/2012	Method:	SW6010
Parent Sample #:	223573	Analyst:	NAH	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Arsenic	0.797	mg/L	BDL		0.800	100	80 --- 120		
Barium	0.905	mg/L	0.034		0.800	109	80 --- 120		
Cadmium	0.0176	mg/L	BDL		0.0200	88	80 --- 120		
Chromium	0.0731	mg/L	0.0039		0.0800	86	80 --- 120		
Lead	0.182	mg/L	0.0065		0.200	88	80 --- 120		
Selenium	0.804	mg/L	0.0040		0.800	100	80 --- 120		
Silver	0.0193	mg/L	BDL		0.0200	96	80 --- 120		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Water

Analytical Run #:	88668	Analysis Date:	10/12/2012	Prep Batch #:	42382	Matrix:	LIQUID
CTLab #:	226133	Analysis Time:	15:32	Prep Date/Time:	10/10/2012 08:30	Method:	SW8270
Parent Sample #:		Analyst:	RPN	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
1,4-Dichlorobenzene	0.0143	mg/L			0.0200	72	30 --- 100		30
2,4,5-Trichlorophenol	0.0175	mg/L			0.0200	88	50 --- 110		30
2,4,6-Trichlorophenol	0.0162	mg/L			0.0200	81	50 --- 115		30
2,4-Dinitrotoluene	0.0158	mg/L			0.0200	79	50 --- 120		30
2-Methylphenol	0.0146	mg/L			0.0200	73	40 --- 110		30
3 & 4-Methylphenol	0.0271	mg/L			0.0400	68	30 --- 110		30
Hexachlorobenzene	0.0101	mg/L			0.0200	50	50 --- 110		30
Hexachlorobutadiene	0.0134	mg/L			0.0200	67	25 --- 105		30
Hexachloroethane	0.0129	mg/L			0.0200	64	30 --- 95		30
Nitrobenzene	0.0165	mg/L			0.0200	82	45 --- 110		30
Pentachlorophenol	0.0178	mg/L			0.0200	89	40 --- 115		30
Pyridine	0.00109	mg/L			0.0200	5	1 --- 78		30

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Water

Analytical Run #:	88668	Analysis Date:	10/18/2012	Prep Batch #:	42382	Matrix:	LIQUID
CTLab #:	226132	Analysis Time:	10:35	Prep Date/Time:	10/10/2012 08:30	Method:	SW8270
Parent Sample #:		Analyst:	RPN	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
1,4-Dichlorobenzene	0.00019	mg/L		U	0		.0005		
2,4,5-Trichlorophenol	0.0011	mg/L		U	0		.0025		
2,4,6-Trichlorophenol	0.0010	mg/L		U	0		.0025		
2,4-Dinitrotoluene	0.00021	mg/L		U	0		.0005		
2-Methylphenol	0.00086	mg/L		U	0		.0025		
3 & 4-Methylphenol	0.0014	mg/L		U	0		.0045		
Hexachlorobenzene	0.00027	mg/L		U	0		.0005		
Hexachlorobutadiene	0.00018	mg/L		U	0		.0005		
Hexachloroethane	0.00022	mg/L		U	0		.0005		
Nitrobenzene	0.00016	mg/L		U	0		.0005		
Pentachlorophenol	0.0011	mg/L		U	0		.0025		
Pyridine	0.00062	mg/L		U	0		.0015		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Soil

Analytical Run #:	88694	Analysis Date:	10/12/2012	Prep Batch #:	42357	Matrix:	SOLID
CTLab #:	225361	Analysis Time:	17:58	Prep Date/Time:	10/11/2012 15:00	Method:	SW8330B
Parent Sample #:		Analyst:	RED	Prep Analyst:	RED		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
1,3,5-Trinitrobenzene	1.91	mg/kg			2.00	96	70 --- 126		
1,3-Dinitrobenzene	1.92	mg/kg			2.00	96	74 --- 120		
2,4,6-Trinitrotoluene	1.90	mg/kg			2.00	95	63 --- 128		
2,4-Dinitrotoluene	1.99	mg/kg			2.00	100	69 --- 128		
2,6-Dinitrotoluene	1.98	mg/kg			2.00	99	68 --- 125		
2-Amino-4,6-dinitrotoluene	2.02	mg/kg			2.00	101	73 --- 123		
2-Nitrotoluene	1.94	mg/kg			2.00	97	75 --- 119		
3,5-Dinitroaniline	2.20	mg/kg			2.00	110	54 --- 124		
3-Nitrotoluene	2.09	mg/kg			2.00	104	77 --- 121		
4-Amino-2,6-dinitrotoluene	1.98	mg/kg			2.00	99	66 --- 127		
4-Nitrotoluene	2.02	mg/kg			2.00	101	74 --- 122		
HMX	1.96	mg/kg			2.00	98	66 --- 129		
Nitrobenzene	1.81	mg/kg			2.00	90	72 --- 126		
Nitroglycerin	7.75	mg/kg			8.00	97	66 --- 130		
PETN	7.28	mg/kg			8.00	91	65 --- 134		
RDX	1.93	mg/kg			2.00	96	72 --- 123		
Tetryl	1.92	mg/kg			2.00	96	2 --- 130		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Soil

Analytical Run #:	88694	Analysis Date:	10/12/2012	Prep Batch #:	42357	Matrix:	SOLID
CTLab #:	225360	Analysis Time:	17:39	Prep Date/Time:	10/11/2012 15:00	Method:	SW8330B
Parent Sample #:		Analyst:	RED	Prep Analyst:	RED		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
1,3,5-Trinitrobenzene	0.13	mg/kg		U			0.25		
1,3-Dinitrobenzene	0.08	mg/kg		U			0.15		
2,4,6-Trinitrotoluene	0.09	mg/kg		U			0.25		
2,4-Dinitrotoluene	0.08	mg/kg		U			0.15		
2,6-Dinitrotoluene	0.07	mg/kg		U			0.15		
2-Amino-4,6-dinitrotoluene	0.09	mg/kg		U			0.15		
2-Nitrotoluene	0.09	mg/kg		U			0.15		
3,5-Dinitroaniline	0.09	mg/kg		U			0.15		
3-Nitrotoluene	0.11	mg/kg		U			0.25		
4-Amino-2,6-dinitrotoluene	0.08	mg/kg		U			0.15		
4-Nitrotoluene	0.10	mg/kg		U			0.25		
HMX	0.12	mg/kg		U			0.25		
Nitrobenzene	0.10	mg/kg		U			0.25		
Nitroglycerin	0.5	mg/kg		U			1.0		
PETN	0.6	mg/kg		U			1.0		
RDX	0.14	mg/kg		U			0.25		
Tetryl	0.09	mg/kg		U			0.15		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Soil

Analytical Run #:	88712	Analysis Date:	10/12/2012	Prep Batch #:	42358	Matrix:	SOLID
CTLab #:	225365	Analysis Time:	15:52	Prep Date/Time:	10/11/2012 15:00	Method:	SW8082
Parent Sample #:		Analyst:	JJY	Prep Analyst:	RED		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Aroclor-1016	474	ug/kg			500	95	40 --- 140		30
Aroclor-1260	517	ug/kg			500	103	60 --- 130		30

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Soil

Analytical Run #:	88712	Analysis Date:	10/12/2012	Prep Batch #:	42358	Matrix:	SOLID
CTLab #:	225364	Analysis Time:	15:33	Prep Date/Time:	10/11/2012 15:00	Method:	SW8082
Parent Sample #:		Analyst:	JJY	Prep Analyst:	RED		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Aroclor-1016	10	ug/kg		U	0		50		
Aroclor-1221	20	ug/kg		U	0		50		
Aroclor-1232	27	ug/kg		U	0		50		
Aroclor-1242	29	ug/kg		U	0		50		
Aroclor-1248	29	ug/kg		U	0		50		
Aroclor-1254	23	ug/kg		U	0		50		
Aroclor-1260	12	ug/kg		U	0		50		

SHAW E&I INC **Project Name:** **RVAAP MMRP**

SDG #: **0** **Folder #:** **93596** **Project Number:** **136147**

Lab Control Spike Water

Analytical Run #:	88733	Analysis Date:	10/15/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #:	229719	Analysis Time:	21:38	Prep Date/Time:		Method:	SW8260C
Parent Sample #:		Analyst:	RLD	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
1,1-Dichloroethene	1.09	mg/L			1.00	109	70 --- 130		
1,2-Dichloroethane	1.12	mg/L			1.00	112	70 --- 130		
2-Butanone	10.1	mg/L			10.0	101	30 --- 150		
Benzene	1.07	mg/L			1.00	107	80 --- 120		
Carbon tetrachloride	1.11	mg/L			1.00	111	65 --- 140		
Chlorobenzene	1.07	mg/L			1.00	107	80 --- 120		
Chloroform	1.14	mg/L			1.00	114	65 --- 135		
Tetrachloroethene	0.955	mg/L			1.00	96	45 --- 150		
Trichloroethene	1.09	mg/L			1.00	109	70 --- 125		
Vinyl chloride	1.32	mg/L			1.00	132	50 --- 145		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Water

Analytical Run #:	88733	Analysis Date:	10/15/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #:	229721	Analysis Time:	22:07	Prep Date/Time:		Method:	SW8260C
Parent Sample #:		Analyst:	RLD	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
1,1-Dichloroethene	0.00024	mg/L		U	0		00025		
1,2-Dichloroethane	0.0003	mg/L		U	0		.0005		
2-Butanone	0.0024	mg/L		U	0		.0025		
Benzene	0.00019	mg/L		U	0		00025		
Carbon tetrachloride	0.00023	mg/L		U	0		00025		
Chlorobenzene	0.00024	mg/L		U	0		00025		
Chloroform	0.00015	mg/L		U	0		00025		
Tetrachloroethene	0.0003	mg/L		U	0		.0005		
Trichloroethene	0.00021	mg/L		U	0		00025		
Vinyl chloride	0.00018	mg/L		U	0		00025		

CT LABORATORIES
delivering more than data from your environmental analyses

Sample Condition Report

Folder #: 93596
Client: SHAW E&I INC

Print Date / Time: 10/03/2012 15:35
Received Date / Time / By: 10/03/2012 1259 JLS

Project Name: RVAAP MMRP
Project Phase: IDW

Log-In Date / Time / By: 10/03/2012 1259 JLS
Project #: 136147 PM: ETK

Coolers: 3637
Custody Seals Present : **Y**

Temperature: 2.0 C On Ice: **Y**
COC Present:? **Y** Complete? **Y**

Seal Intact? **Y**
Ship Method: UPS
Adequate Packaging: **Y**

Numbers: SIGNED-DATED
Tracking Number: 1Z6028W22210000350
Temp Blank Enclosed?

Notes: samples received intact and in good condition

Sample ID / Description	Container Type	Cond. Code	pH OK?/Filtered?	Tests
223573 IDW-WC-0001				
	AMBER GL	1	/	8270

Total # of Containers of Type (*AMBER GL*) = 1

Sample ID / Description	Container Type	Cond. Code	pH OK?/Filtered?	Tests
223575 IDW-WC-0001				
	UNPRES GL	1	/	EXPL,PCB

Total # of Containers of Type (*UNPRES GL*) = 1

Condition Code	*Condition Description*
1	Sample Received OK

Rev. 9/2009

CHAIN OF CUSTODY

Page 1 of 1

Company: Shaw E&I
Project Contact: David Crispo
Telephone: 617 589-8146
Project Name: RVAAP MMRP
Project #: 136147
Location: BLDG 1036
Sampled By: D. CRISPO

CT LABORATORIES

Folder #: 93596
Company: SHAW E&I INC
Project: RVAAP MMRP
Logged By: JLS PM: ET

1230 Lange Court, Baraboo, WI 53913
608-356-2760 Fax 608-356-2766
www.ctlaboratories.com

Program:
QSM RCRA SDWA NPDES
Solid Waste Other MMRP

PO #

Report To: David Crispo
EMAIL: david.crispo@shawgrp.com
Company: Shaw E&I
Address: 150 Royall Street Canton, MA 02021

Invoice To:*
EMAIL:
Company:
Address:

*Party listed is responsible for payment of invoice as per CT Laboratories' terms and conditions

Client Special Instructions
Explosives analysis includes full list

Matrix:
GW - groundwater SW - surface water WW - wastewater DW - drinking water
S - soil/sediment SL - sludge A - air M - misc/waste

ANALYSES REQUESTED

Collection Date	Collection Time	Matrix	Grab/Comp	Sample ID Description	Filtered? Y/N	TCLP METALS	TCLP SVOCs	EXPLOSIVES*	PCBs	RCRA Characteristics	VOCs ~~TCLP~~ 10-3-12	Total # Containers	Designated MS/MSD	CT Lab ID # Lab use only
10/2/12	1200	M	C	IDW-WC-0001	—	X	X	X	X	X	X	2	—	~~223573~~ 223573/575

Fill in Spaces with Bottles per Test

Turnaround Time
Normal RUSH*
Date Needed:

Rush analysis requires prior CT Laboratories' approval
Surcharges:
24 hr 200%
2-3 days 100%
4-9 days 50%

Relinquished By:	Date/Time	Received By:	Date/Time
[signature]	10/2/12 / 1500	UPS	10/2/12 / 1500
Received by:	Date/Time	Received for Laboratory by: [signature]	Date/Time 10/3/12 1257

Lab Use Only
Ice Present Yes No
Temperature 2.0
Cooler # 3637

UPS Next Day Air®
UPS Worldwide Express®
Shipping Document

WEIGHT | LTR | PAK | WEIGHT 17 | DIMENSIONAL WEIGHT If Applicable | LARGE PACKAGE

SATURD/

SHIPMENT FROM
UPS ACCOUNT NO. 6028W2

REFERENCE NUMBER
136147.20013400

DAVID CRISPO
TELEPHONE 617-589-5048
THE SHAW GROUP
150 ROYALL ST
CANTON MA 02021-1031

DELIVERY TO
SAMPLE CUSTODIAN TELEPHONE 608-356-2760
CT LABORATORIES
1230 LANGE COURT
BARABOO, WI 53913

1Z 602 8W2 22 1000 0350

SHIPMENT NUMBER 6028 W279 XFX

DATE OF SHIPMENT 10/2/12

0101911202609 1/10 S

United Parcel Service, Louisville, KY

CUSTODY SEAL
DATE 10/2/12
SIGNATURE DPC

QEC Quality Environmental Container
800-255-3950 • 304-255-3900

CUSTODY SEAL
DATE 10/2/12
SIGNATURE DPC

QEC Quality Environmental Container
800-255-3950 • 304-255-3900

93596 - Page 35 of 35

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ATTACHMENT 2
IDW WASTE PROFILE

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VEXOR Technology, Inc.
955 West Smith Road
Medina, Ohio 44256
Phone: 330-721-9773
FAX: 330-721-9438
EPA ID# OHD 077772895

MATERIAL CHARACTERIZATION

www.vexortechnology.com

Approval # ______
Sample # ______
Sales Rep ______
Date Submitted ______

Generator RAVENNA ARMY AMMO PLT.
Site Address 8451 S.R. 5
City RAVENNA State OH ZIP 44266
Phone 330 358 3005 Fax
EPA ID# OH5210020736 SIC Code
Technical Contact DAVID CRISPO
Title CONSULT e-mail david.crispo@shawgrp.com

Bill To Name EMERALD ENVIRONMENTAL
Site Address 1621 ST. CLAIR AVE
City KENT State OH ZIP 44240
Phone 330 677 0785 Fax 330 677 1567
Business Contact CHRIS ARCHACKI
Title ______ e-mail
carchacki@emerald-environmental.com

MATERIAL DESCRIPTION

Name and Description of Material: PPE, SPENT ABSORBENT PADS

Process Generating Material: SAMPLING ACTIVITIES U.S. EPA Hazardous Waste: ____Yes X No

Proper DOT shipping name: NON DOT REGULATED MATERIAL

Method of Shipment: ☐ Bulk ☒ Drum ☐ Tote ☐ Cubic Yd Box ☐ Other/Explain: ______

Estimated Annual Volume: 1 Cubic Yards ____ Tons ____ Gallons ____ Drums X Container material (metal, plastic, etc.)

Frequency: ☒ One Time Only ☐ Daily ☐ Weekly ☐ Monthly ☐ Yearly ☐ Other- explain ______ Approx drum weight

Special Handling Instructions: NONE

Preferred Disposal Method: ☒ Landfill ☐ Waste to Energy ☐ Recycling ☐ VEF ☐ Other ______

MATERIAL PROPERTIES AT 78°F

a) Physical State: ☒ Solid ☐ Semi-solid ☐ Powder ☐ Liquid ☐ Phases

b) Reactivity: ☐ Water reactive ☐ Acid Reactive ☐ Alkaline Reactive ☐ Oxidizer ☐ Autosetting ☒ none

c) Flash Point, °F: ☐ ≤72 ☐ >72-100 ☐ >100-140 ☐ >140-200 ☐ >200 ☒ NA

d) S. G./Density______ e) pH: ☐ ≤ 2 ☐ >2 – 6 ☐ >6 – 9 ☐ >9 – <12.5 ☐ ≥12.5 ☒ NA

f) Odor: ☒ None ☐ Mild ☐ Strong : Describe:______ g) Color ______

h) Total Organic Halogen (TOX) ☒ 0 ppm ☐ >1000 ppm* If this material is considered a "USED OIL" and is to be managed as a USED OIL, please complete the "USED OIL" ADDENDUM and attach to this profile.

i) PCB Content: ☒ 0 ppm ☐ 1-49 ppm* ☐ equal to or > 50 ppm *Supporting analysis and documentation required.

MATERIAL COMPOSITION: List all components, add up to 100%.

Constituent	Range % (wt-vol)	
	Min	Max
PPE; TYVEKS, GLOVES ETC.	25	75
ABSORBENT PADS	25	75
A combined total should equal 100%		

Above is based on: Generator Knowledge ☒ Analytical Data ☒ MSDS ☐
Please attach analysis, TCLP information and appropriate MSDS sheets.
SAMPLE SUBMITTED WITH THIS PROFILE: Yes____ No X

CHEMICAL COMPOSITION: NA

Constituent	Range %	
	Min	Max
Sulfur		
Chlorine		
Bromine		
Fluorine		
Nitrogen		
Oxygen		
Carbon		
Ash		
Btu's		
Biomass		

Metals (other than RCRA)

Metal	ppm	Metal	ppm	Metal	ppm	Metal	ppm
Thallium	0	Antimony	0	Beryllium	0	Cobalt	0
Copper		Nickel		Vanadium		Tin	
Zinc		Iron		Manganese		Magnesium	
Molybdenum		Palladium					

MATERIAL CHARACTERIZATION

Approval # ________

*SAMPLED LIQUID ABSORBED IN PADS

RCRA CONTAMINANTS: ☒ TCLP ☐ TOTAL ☐ NONE IN THIS SECTION

EPA #	NAME		REGULATORY LEVEL	ACTUAL	EPA#	NAME		REGULATORY LEVEL	ACTUAL
D004	Arsenic	☐	>5.0		D024	m-Cresol	☐	>200.0	
D005	Barium	☐	>100.0	.034 mg/L	D025	p-Cresol	☐	>200.0	
D006	Cadmium	☐	>1.0		D026	Cresol (total)	☐	>200.0	
D007	Chromium	☐	>5.0	.0039 mg/L	D027	1,4-Dichlorobenzene	☐	>7.5	
D008	Lead	☐	>5.0	.0065 mg/L	D028	1,2-Dichlorethane	☐	>0.5	
D009	Mercury	☐	>0.2		D029	1,2-Dichlorethylene	☐	>.13	
D010	Selenium	☐	>1.0	.0040 mg/L	D030	2,4-Dinitrotoluene	☐	>0.008	
D011	Silver	☐	>5.0		D031	Heptachlor	☐	>0.13	
D012	Endrin	☐	>0.02		D032	Hexachlorobenzene	☐	>0.5	
D013	Lindane	☐	>0.4		D033	Hexachloro-1,3-butadiene	☐	>0.5	
D014	Methoxychlor	☐	>10.0		D034	Hexachloroethane	☐	>3.0	
D015	Toxaphene	☐	>0.05		D035	Methyl Ethyl Ketone	☐	>200.0	
D016	2,4-D	☐	>10.0		D036	Nitrobenzene	☐	>2.0	
D017	2,4,5-TP (Silvex)	☐	>1.0		D037	Petachlorophenol	☐	>100.0	
D018	Benzene	☐	>0.5		D038	Pyridine	☐	>100.0	
D019	Carbon Tetrchloride	☐	>0.5		D039	Tetrchloroethylene	☐	>0.7	
D020	Chlordane	☐	>0.03		D040	Trichloroethylene	☐	>0.5	
D021	Chlorobenzene	☐	>100.0		D041	2,4,5-Trichlorophenol	☐	>400.0	
D022	Chloroform	☐	>6.0		D042	2,4,6-Trichlorophenol	☐	>2.0	
D023	o-Cresol	☐	>200.0		D043	Vinyl Chloride	☐	>0.2	

GENERATOR CERTIFICATION

I hereby certify that to the best of my knowledge and belief, the information contained herein is a true and accurate description of the material being offered for disposal.

Samples of this material submitted to VEXOR are representative of the material described in this profile. I further certify that by utilizing this profile, neither I nor any other employee of the company will deliver for treatment, processing or recycling or attempt to deliver for same any material that is classified as a hazardous waste, medical or infectious waste or any other material that this facility is prohibited from accepting by law.

Authorized Representative Name (Printed) Mark Patterson Company Ravenna AAP

Authorized Representative Signature: Mark Patterson

Title: Facility Manager Date: 11/8/12

For VEXOR Use Only

Reviewed by: ________ Date: ________ Second review: ________ Date:

Approved for treatment (please check and initial) ________ Special Handling (if yes, make process directions in notes): ________

Treatment	Solidification/Landfill	Waste to Energy	VEF	Water	Used oil	Recycling	Other (please note processing)
Check all that apply							

Rejected – reason: ________

Price: ________ per unit: ________ CS initial ________ Price approved by: ________ Date: ________

Notes: ________

ATTACHMENT 3
IDW WASTE MANIFEST

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NON-HAZARDOUS WASTE MANIFEST	1. Generator ID Number OH5 210 020 736	2. Page 1 of 1	3. Emergency Response Phone 330-677-0785	4. Waste Tracking Number 112812-01

GENERATOR

5. Generator's Name and Mailing Address
Ravenna Army Ammunition Plant
8451 State Route 5
Ravenna, Ohio 44266
Generator's Phone: 330-358-2920

Generator's Site Address (if different than mailing address)
Same

6. Transporter 1 Company Name: Emerald Environmental Services, Inc — U.S. EPA ID Number: OHR 000 102 053

7. Transporter 2 Company Name: — U.S. EPA ID Number:

8. Designated Facility Name and Site Address
Vexor Technology
955 West Smith Road
Medina, Ohio 44256
Facility's Phone: 330-721-9773
U.S. EPA ID Number: OHD 077 772 895

9. Waste Shipping Name and Description	10. Containers No.	Type	11. Total Quantity	12. Unit Wt./Vol.
1. Non DOT Regulated, Non Hazardous Material (PPE & Absorbents)	01	DM	20	P
2.				
3.				
4.				

13. Special Handling Instructions and Additional Information
9.1.) Approval # VEX24393
Job Number 12-12018 for Shaw Environmental

14. **GENERATOR'S CERTIFICATION:** I certify the materials described above on this manifest are not subject to federal regulations for reporting proper disposal of Hazardous Waste.

Generator's/Offeror's Printed/Typed Name: Mark C. Patterson — Signature: Mark C. Patt — Month 11 Day 28 Year 12

INT'L

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

TRANSPORTER

16. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Paul Herman — Signature: Paul Herman — Month 11 Day 28 Year 12
Transporter 2 Printed/Typed Name: — Signature: — Month Day Year

DESIGNATED FACILITY

17. Discrepancy
17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
17b. Alternate Facility (or Generator) — U.S. EPA ID Number
Facility's Phone:
17c. Signature of Alternate Facility (or Generator) — Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a
Printed/Typed Name: Daniel Kindall — Signature: — Month 11 Day 28 Year 12

169-BLC-O 5 11977 (Rev. 8/06)

TRANSPORTER #1

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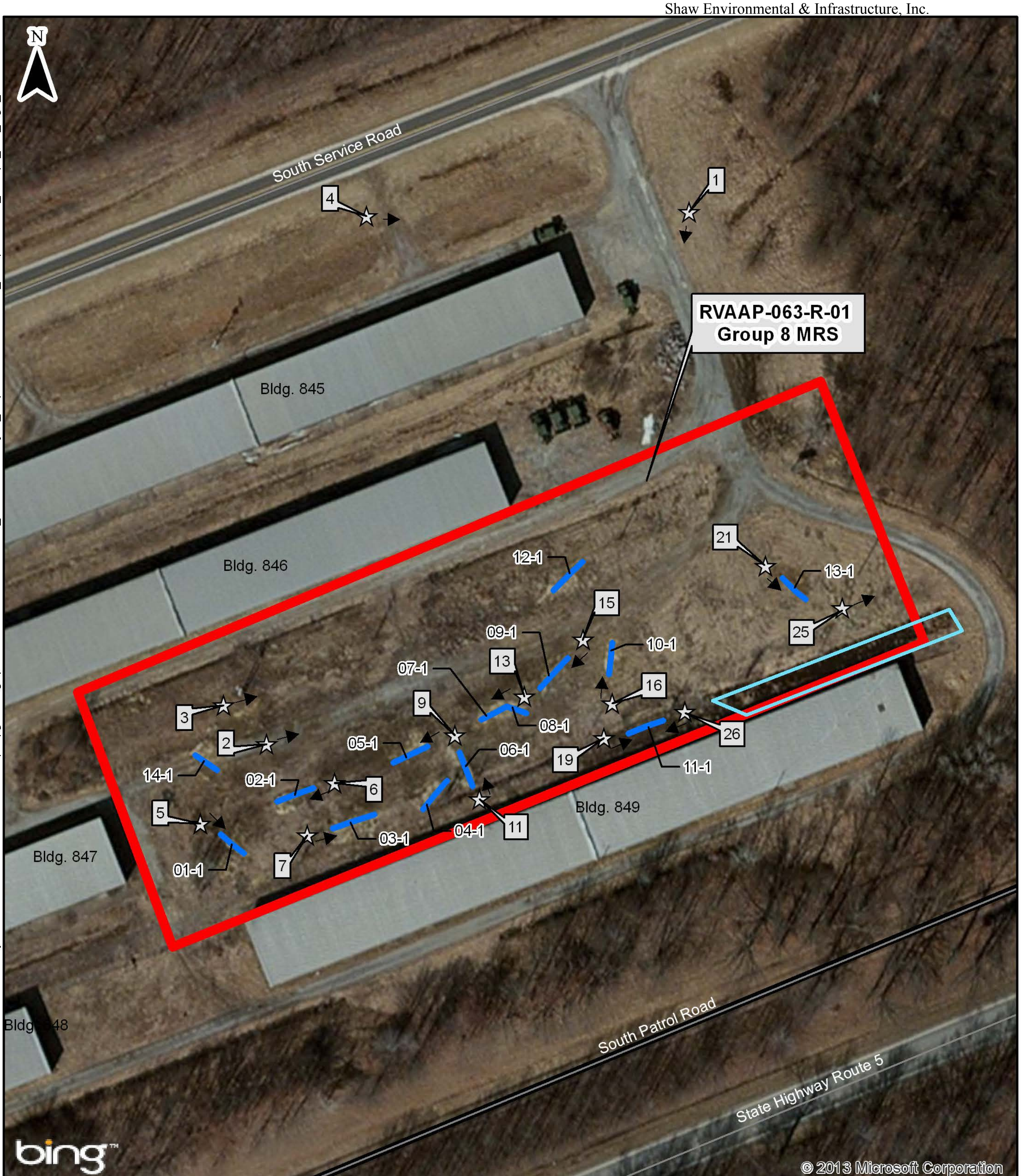
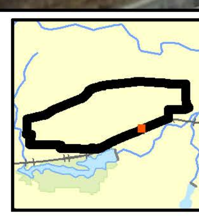
Appendix F
Photograph Documentation Log

Generated By: MM Date: 04/02/13 File Path:\\crpbtrpgi01\arcgisprod3\MAMMS\Ravenna\GIS_Documents\Project_Maps\MMRP\RIFS\RIFS_Group8\RVAAP_Group8_027_FigX_PhotoLocs.mxd



Facility Boundary
Group 8 MRS Boundary
Standing Water Area
Trench Location
Photograph Location
General Direction of Photograph



0 100 200 Feet

Projection : NAD_1983_UTM_Zone_17N

U.S. ARMY
CORPS OF ENGINEERS
BALTIMORE DISTRICT

MILITARY MUNITIONS RESPONSE PROGRAM

GROUP 8 MRS
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Project Number: 136147

PHOTOGRAPH LOCATIONS

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Photograph 1: Photograph of the Group 8 MRS entrance and debris removed from the surface of the MRS prior to investigation activities. Photo was taken facing south.

Photograph 2: Photograph of the access road and typical vegetation at the Group 8 MRS. Photo was taken facing east.

Photograph 3: Photograph of the access road and typical vegetation at the Group 8 MRS. Photo was taken facing northeast.

Photograph 4: Photograph of the Group 8 MRS instrument verification strip for start-up phase of geophysical mapping activities. Photo taken facing northeast.

Photograph 5: Photograph of Trench 1-1 excavation at the Group 8 MRS. Maximum depth of 48 inches attained. No MEC/MD identified.

Photograph 6: Photograph of Trench 2-1 at the Group 8 MRS. Maximum depth of 48 inches attained. No MEC/MD identified.

Photograph 7: Photograph of Trench 3-1 at the Group 8 MRS. Maximum depth of 48 inches attained. MD (24 unidentified projectile base plates) identified.

Photograph 8: Photograph of MD items (24 unidentified projectile base plates) removed from Trench 3-1 to 12 inches bgs.

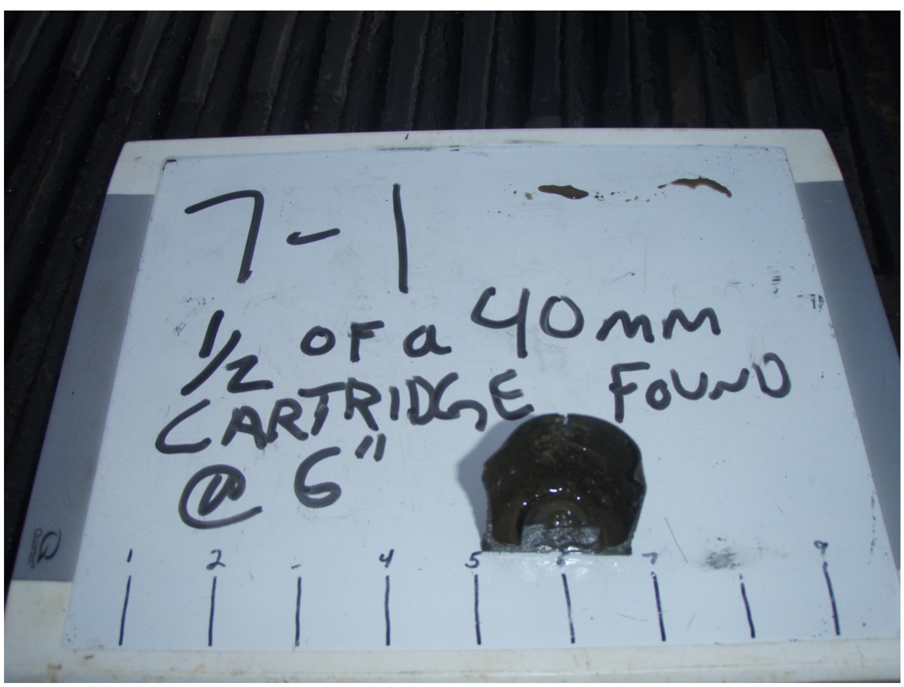
Photograph 9: Photograph of Trench 5-1 at the Group 8 MRS. Maximum depth of 48 inches attained. No MEC or MD identified.

Photograph 10: Photograph of Other Debris (OD) items removed from Trench 5-1 to 12 inches bgs.

Photograph 11: Photograph of Trench 6-1 at the Group 8 MRS. Maximum depth of 48 inches attained. MD items (tracer elements and lifting eyes/shipping plugs for projectiles) 12 inches bgs.

Photograph 12: Photograph of MD items (tracer elements) removed from Trench 6-1.

Photograph 13: Photograph of Trench 7-1 at the Group 8 MRS. Maximum depth of 48 inches attained. MD (40 mm cartridge fragment) found to 6 inches bgs.

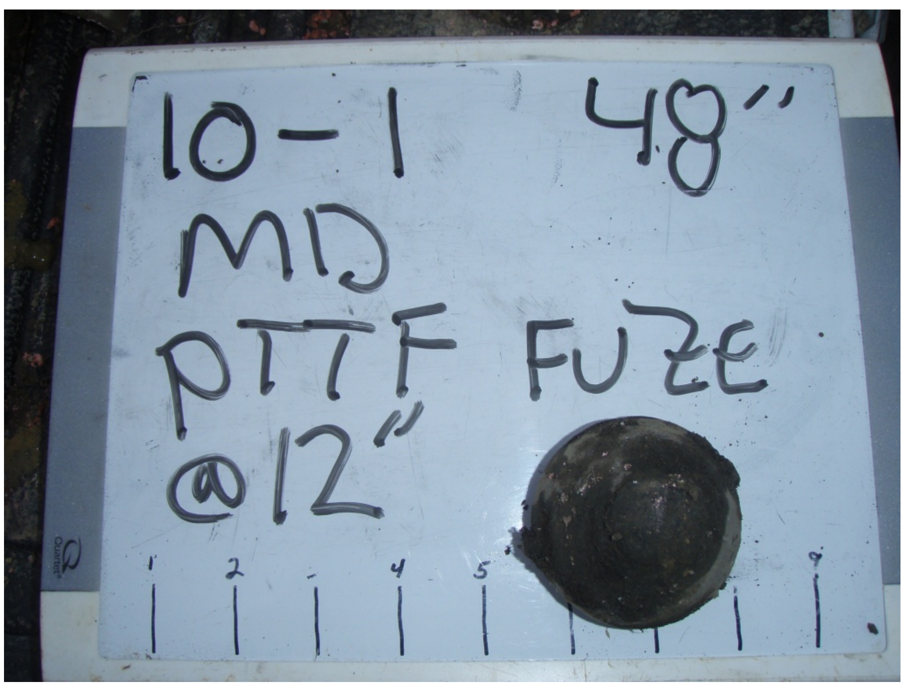


Photograph 14: Photograph of MD item (piece of a 40 mm cartridge) removed from Trench 7-1.

Photograph 15: Photograph of Trench 9-1 at the Group 8 MRS. Maximum depth of 48 inches attained. MD found (flash tubes, fuzes, and projectiles) found to 12 inches bgs.

Photograph 16: Photograph of MD items removed from Trench 9-1.

Photograph 17: Photograph of Trench 10-1 at the Group 8 MRS. Maximum depth of 48 inches attained. One MD item (fuze) found to 12 inches bgs.

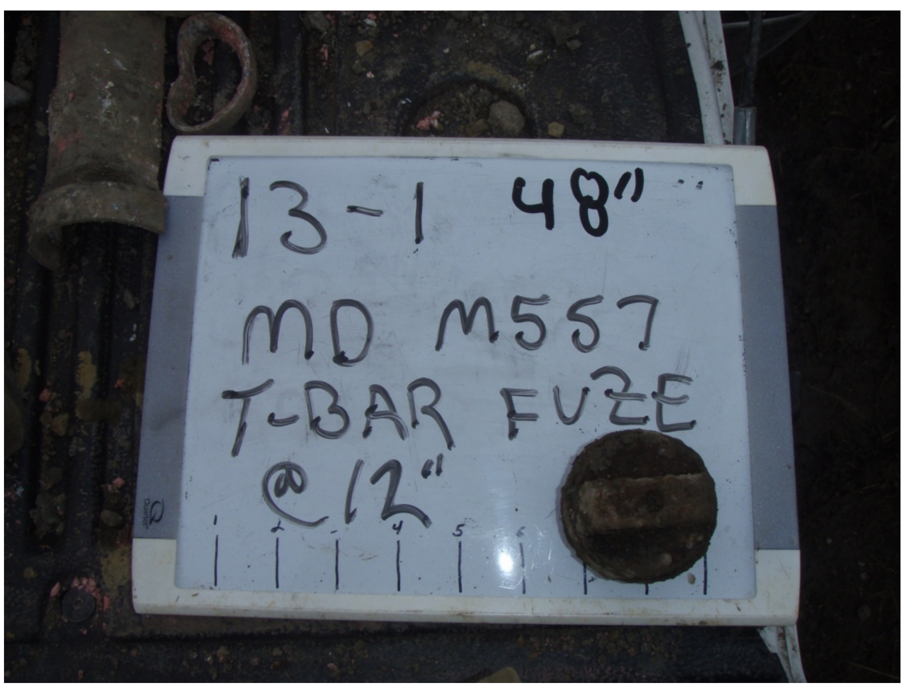


Photograph 18: Photograph of MD item (fuze) removed from Trench 10-1.

Photograph 19: Photograph of Trench 11-1 at the Group 8 MRS. Maximum depth of 48 inches attained. MD (fuzes and projectiles) found to 18 inches bgs.

Photograph 20: Photograph of MD items removed from Trench 11-1.

Photograph 21: Photograph of Trench 13-1 the Group 8 MRS. Maximum depth of 48 inches attained. MD (fuze) found at 12 inches bgs.



Photograph 22: Photograph of MD items removed from Trench 13-1.

Photograph 23: Photograph of Trench 14-1 the Group 8 MRS. Maximum depth of 48 inches attained. MD (shipping clips and washers) found to 4 inches bgs.

Photograph 24: Photograph of MD items removed from Trench 14-1.

Photograph 25: Photograph of surface soil ISM sample collection at the Group 8 MRS. Pin flags denote increment sample grids. Photograph taken facing east.

Photograph 26: Photograph of 6-inch sample increment collected for ISM sample GR8ss-007-0001-SS at Trench 11-1.

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Appendix G
Intrusive Investigation Results

Table G-1
Anomaly Reacquisition and Intrusive Investigation Results for Individual Target Anomalies
Group 8 MRS
Ravenna Army Ammunition Plant

Summary	Quantity	Estimated Weight
Munitions Debris:	**82 ea**	**238.5 lbs**
MPPEH:	**0 ea**	**NA**
Other Debris:	**1810 ea**	**3020 lbs**

Number of Anomalies Investigated: 272

Location	Work Unit	Anomaly ID	Anomaly Easting	Anomaly Northing	Item Northing	Item Easting	Initial Peak (Ch 2, mV)	Peak Reac Date	Reac Peak (Ch 2, mV)	Reac Offset East (m)	Reac Offset North (m)	Reac Successful	Surface Item	Reac Comments
Group 8 MRS	GRP8	12	496604.1	4559093.4	496604.5101	4559093.072	342.8724669	12/2/2011	433.7	0.381	-0.3048	Y	N	
Group 8 MRS	GRP8	14	496604.8	4559071.9	496604.3079	4559071.08	10.50117492	12/2/2011	24.7	-0.4572	-0.762	Y	N	
Group 8 MRS	GRP8	15	496605.4	4559075.6	496605.564	4559075.846	16.39385985	12/2/2011	24.6	0.1524	0.2286	Y	N	
Group 8 MRS	GRP8	24	496607.6	4559070.6	496607.436	4559070.928	16.7776947	12/2/2011	17.7	-0.1524	0.3048	Y	N	
Group 8 MRS	GRP8	32	496609.1	4559091.6	496609.1	4559092.584	446.5692136	12/2/2011	410.7	0	0.9144	Y	N	
Group 8 MRS	GRP8	39	496610.7	4559063.1	496610.7	4559063.1	21.83518982	12/2/2011	25.7	0	0	Y	N	
Group 8 MRS	GRP8	44	496611.15	4559074.95			10.44468308	12/2/2011	0	0	0	N	N	No peak cultural interference from fence post
Group 8 MRS	GRP8	54	496612.8	4559051.8	496612.718	4559051.882	149.9207001	12/2/2011	158.8	-0.0762	0.0762	Y	N	
Group 8 MRS	GRP8	55	496612.9	4559068.2	496612.9	4559069.02	1059.235717	12/2/2011	2148.5	0	0.762	Y	N	
Group 8 MRS	GRP8	66	496614	4559058.1	496614.7382	4559058.428	146.0917206	12/2/2011	197	0.6858	0.3048	Y	N	
Group 8 MRS	GRP8	84	496615.5	4559061.6	496615.418	4559061.846	792.3666381	12/2/2011	1213.6	-0.0762	0.2286	Y	N	
Group 8 MRS	GRP8	86	496615.7	4559073.6	496615.9461	4559073.846	283.9680786	12/2/2011	386.9	0.2286	0.2286	Y	N	
Group 8 MRS	GRP8	89	496616	4559103.3			13.73823547	12/2/2011	0	0	0	N	N	No peak cultural interference
Group 8 MRS	GRP8	110	496617.2	4559069.5	496617.2	4559069.5	86.05187222	12/2/2011	164.5	0	0	Y	N	
Group 8 MRS	GRP8	110	496617.2	4559069.5	496617.2	4559069.5	86.05187222	12/2/2011	164.5	0	0	Y	N	
Group 8 MRS	GRP8	115	496617.5	4559071.5	496617.5	4559071.5	49.5192947	12/2/2011	97.9	0	0	Y	N	
Group 8 MRS	GRP8	121	496618.2	4559088.1	496617.9539	4559088.428	131.8578339	12/2/2011	226.5	-0.2286	0.3048	Y	N	
Group 8 MRS	GRP8	130	496619.1	4559062.8	496619.1	4559062.8	75.99641418	12/2/2011	172.5	0	0	Y	N	
Group 8 MRS	GRP8	136	496619.7	4559072.4	496619.7	4559072.646	140.315094	12/2/2011	251.1	0	0.2286	Y	N	
Group 8 MRS	GRP8	155	496621.2	4559075.6	496621.4067	4559075.6	51.76716614	12/2/2011	49.9	0.192024	0	Y	N	
Group 8 MRS	GRP8	156	496621.3	4559104.5	496621.3	4559104.5	39.75144194	12/2/2011	38.9	0	0	Y	N	
Group 8 MRS	GRP8	160	496621.9	4559067.6	496622.2281	4559067.682	17.69546507	12/2/2011	25.1	0.3048	0.0762	Y	N	
Group 8 MRS	GRP8	172	496623.3	4559085.2	496623.6281	4559085.528	155.9586792	12/2/2011	796.7	0.3048	0.3048	Y	N	
Group 8 MRS	GRP8	186	496625.1	4559050	496624.8539	4559050.082	8.257492053	12/2/2011	28.2	-0.2286	0.0762	Y	N	
Group 8 MRS	GRP8	190	496625.3	4559074.7	496625.8184	4559074.562	45.95468901	12/2/2011	181.2	0.481584	-0.128016	Y	N	
Group 8 MRS	GRP8	200	496626.3	4559054.9	496626.464	4559054.693	44.8255539	12/2/2011	102.2	0.1524	-0.192024	Y	N	
Group 8 MRS	GRP8	201	496626.5	4559070.8	496626.5	4559070.8	1814.759155	12/2/2011	2289.5	0	0	Y	N	
Group 8 MRS	GRP8	201	496626.5	4559070.8	496626.5	4559070.8	1814.759155	12/2/2011	2289.5	0	0	Y	N	
Group 8 MRS	GRP8	203	496626.7	4559056.2	496626.7	4559056.062	58.98802184	12/2/2011	102.5	0	-0.128016	Y	N	
Group 8 MRS	GRP8	214	496627.9	4559049.6	496627.5719	4559049.682	21.85359193	12/2/2011	228.1	-0.3048	0.0762	Y	N	
Group 8 MRS	GRP8	238	496631.2	4559053.3	496631.2	4559053.3	522.7097778	12/2/2011	631.1	0	0	Y	N	
Group 8 MRS	GRP8	238	496631.2	4559053.3	496631.2	4559053.3	522.7097778	12/2/2011	631.1	0	0	Y	N	
Group 8 MRS	GRP8	238	496631.2	4559053.3	496631.2	4559053.3	522.7097778	12/2/2011	631.1	0	0	Y	N	
Group 8 MRS	GRP8	243	496632.2	4559051.9	496631.7899	4559051.982	83.4032058	12/2/2011	172.6	-0.381	0.0762	Y	N	
Group 8 MRS	GRP8	246	496632.4	4559103.1	496632.8921	4559102.772	357.8280028	12/2/2011	639.9	0.4572	-0.3048	Y	N	
Group 8 MRS	GRP8	252	496633.5	4559088.2	496633.5	4559087.872	593.2912596	12/2/2011	1066.7	0	-0.3048	Y	N	
Group 8 MRS	GRP8	257	496633.7	4559105.3	496633.7	4559105.3	8.705627441	12/2/2011	9.5	0	0	Y	N	
Group 8 MRS	GRP8	264	496634.8	4559111.95			9.79733276	12/2/2011	0	0	0	N	N	No peak cultural interference from building
Group 8 MRS	GRP8	280	496636.4	4559054	496636.0719	4559054.138	104.5154648	12/2/2011	380.3	-0.3048	0.128016	Y	N	
Group 8 MRS	GRP8	280	496636.4	4559054	496636.0719	4559054.138	104.5154648	12/2/2011	380.3	-0.3048	0.128016	Y	N	
Group 8 MRS	GRP8	280	496636.4	4559054	496636.0719	4559054.138	104.5154648	12/2/2011	380.3	-0.3048	0.128016	Y	N	
Group 8 MRS	GRP8	286	496637.1	4559056.3	496636.936	4559056.218	1225.936768	12/2/2011	1809.9	-0.1524	-0.0762	Y	N	
Group 8 MRS	GRP8	304	496638.8	4559105.6	496639.1281	4559105.272	470.8976745	12/2/2011	587.7	0.3048	-0.3048	Y	N	
Group 8 MRS	GRP8	317	496640.1	4559055	496640.1	4559055	57.17540734	12/2/2011	78.5	0	0	Y	N	
Group 8 MRS	GRP8	331	496641	4559102.7	496640.7539	4559102.7	118.5154343	12/2/2011	251.9	-0.2286	0	Y	N	
Group 8 MRS	GRP8	340	496642	4559055	496642	4559055	146.8368835	12/2/2011	242.5	0	0	Y	N	
Group 8 MRS	GRP8	359	496643.7	4559099.9	496643.864	4559099.9	29.6372757	12/2/2011	47.7	0.1524	0	Y	N	
Group 8 MRS	GRP8	367	496644.8	4559086.1	496644.8	4559086.1	273.9433899	12/2/2011	437	0	0	Y	N	
Group 8 MRS	GRP8	367	496644.8	4559086.1	496644.8	4559086.1	273.9433899	12/2/2011	437	0	0	Y	N	
Group 8 MRS	GRP8	369	496644.9	4559092.7	496644.5719	4559092.7	14.92062377	12/2/2011	23.7	-0.3048	0	Y	N	Interference from surrounding anomalies
Group 8 MRS	GRP8	370	496644.9	4559103.6	496644.9	4559103.6	84.05356595	12/2/2011	140.4	0	0	Y	N	
Group 8 MRS	GRP8	382	496646.6	4559110.9	496646.6	4559110.9	25.10432435	12/2/2011	41.1	0	0	Y	N	
Group 8 MRS	GRP8	393	496647.8	4559098.3	496647.8	4559098.3	2441.225098	12/2/2011	2283.7	0	0	Y	N	
Group 8 MRS	GRP8	397	496648	4559088.8	496648.3281	4559089.128	58.39403534	12/2/2011	89.1	0.3048	0.3048	Y	N	
Group 8 MRS	GRP8	412	496649.2	4559059.8	496649.2	4559059.8	308.7419739	12/2/2011	567.5	0	0	Y	N	
Group 8 MRS	GRP8	413	496649.3	4559080.1	496649.3	4559080.1	99.09835054	12/2/2011	299.5	0	0	Y	N	
Group 8 MRS	GRP8	416	496649.9	4559062.55	496649.9	4559062.166	24.73792271	12/2/2011	150.6	0	-0.356616	Y	N	
Group 8 MRS	GRP8	419	496650.2	4559101.8	496650.4461	4559102.456	121.078331	12/2/2011	166.1	0.2286	0.6096	Y	N	
Group 8 MRS	GRP8	419	496650.2	4559101.8	496650.4461	4559102.456	121.078331	12/2/2011	166.1	0.2286	0.6096	Y	N	
Group 8 MRS	GRP8	422	496650.4	4559112.9	496650.5378	4559113.064	13.59909057	12/2/2011	23.7	0.128016	0.1524	Y	N	
Group 8 MRS	GRP8	426	496650.7	4559063.1	496650.7	4559063.1	123.5698547	12/2/2011	146.8	0	0	Y	N	
Group 8 MRS	GRP8	429	496650.8	4559057.7	496650.718	4559057.618	89.92514036	12/2/2011	160.2	-0.0762	-0.0762	Y	N	
Group 8 MRS	GRP8	431	496650.9	4559107.1	496650.9	4559107.1	43.89754485	12/2/2011	62.1	0	0	Y	N	

Table G-1
Anomaly Reacquisition and Intrusive Investigation Results for Individual Target Anomalies
Group 8 MRS
Ravenna Army Ammunition Plant

Location	Work Unit	Anomaly ID	Anomaly Easting	Anomaly Northing	Item Northing	Item Easting	Initial Peak (Ch 2, mV)	Peak Reac Date	Reac Peak (Ch 2, mV)	Reac Offset East (m)	Reac Offset North (m)	Reac Successful	Surface Item	Reac Comments
Group 8 MRS	GRP8	439	496651.5	4559107.9	496651.7461	4559107.654	56.67335508	12/2/2011	68.7	0.2286	-0.2286	Y	N	
Group 8 MRS	GRP8	446	496652.4	4559098.8	496652.4	4559098.8	201.6880341	12/2/2011	222.5	0	0	Y	N	
Group 8 MRS	GRP8	449	496652.4	4559105.2	496652.4	4559105.2	314.9837954	12/2/2011	0	0	0	Y	N	Possible removed surface item (double checked position)
Group 8 MRS	GRP8	453	496652.7	4559084.5	496652.864	4559084.664	78.64328002	12/2/2011	203.1	0.1524	0.1524	Y	N	
Group 8 MRS	GRP8	463	496653.9	4559087.3	496654.4741	4559087.628	175.2964783	12/2/2011	256.6	0.5334	0.3048	Y	N	
Group 8 MRS	GRP8	464	496653.95	4559119.45			27.73841667	12/2/2011	0	0	0	N	N	No peak cultural interference from building
Group 8 MRS	GRP8	483	496655.4	4559060.7	496655.4	4559060.838	58.47420498	12/2/2011	116	0	0.128016	Y	N	
Group 8 MRS	GRP8	489	496655.8	4559087.6	496656.1281	4559087.6	23.40586852	12/2/2011	102.3	0.3048	0	Y	N	
Group 8 MRS	GRP8	493	496656.1	4559095	496656.1	4559095	124.8802642	12/2/2011	167.2	0	0	Y	N	
Group 8 MRS	GRP8	498	496656.5	4559065.5	496656.5	4559065.5	358.0241696	12/2/2011	399.9	0	0	Y	N	
Group 8 MRS	GRP8	498	496656.5	4559065.5	496656.5	4559065.5	358.0241696	12/2/2011	399.9	0	0	Y	N	
Group 8 MRS	GRP8	501	496656.8	4559100.9	496656.8	4559100.9	1475.477661	12/2/2011	1894.2	0	0	Y	N	
Group 8 MRS	GRP8	503	496657.1	4559109.5	496656.936	4559109.5	88.01578519	12/2/2011	117.7	-0.1524	0	Y	N	
Group 8 MRS	GRP8	510	496657.45	4559073.6	496657.45	4559073.6	40.50341036	12/2/2011	238.2	0	0	Y	N	
Group 8 MRS	GRP8	516	496658	4559084	496658.3281	4559084	105.8638305	12/2/2011	191.1	0.3048	0	Y	N	
Group 8 MRS	GRP8	541	496660.1	4559086.8	496660.018	4559086.882	150.6176605	12/2/2011	212.6	-0.0762	0.0762	Y	N	
Group 8 MRS	GRP8	547	496660.4	4559064.7	496660.7281	4559064.7	324.9064635	12/2/2011	772	0.3048	0	Y	N	
Group 8 MRS	GRP8	547	496660.4	4559064.7	496660.7281	4559064.7	324.9064635	12/2/2011	772	0.3048	0	Y	N	
Group 8 MRS	GRP8	547	496660.4	4559064.7	496660.7281	4559064.7	324.9064635	12/2/2011	772	0.3048	0	Y	N	
Group 8 MRS	GRP8	549	496660.6	4559108.7	496660.6	4559108.536	10.79174804	12/2/2011	19.7	0	-0.1524	Y	N	
Group 8 MRS	GRP8	555	496661.1	4559072.5	496661.264	4559072.992	69.75477597	12/2/2011	93.7	0.1524	0.4572	Y	N	
Group 8 MRS	GRP8	560	496661.3	4559111.5	496661.3	4559111.5	21.8125	12/2/2011	34	0	0	Y	N	
Group 8 MRS	GRP8	561	496661.4	4559074.9	496661.4	4559074.9	228.5894164	12/2/2011	344.5	0	0	Y	N	
Group 8 MRS	GRP8	564	496661.9	4559090.5	496661.9	4559090.5	70.4978561	12/2/2011	128.2	0	0	Y	N	
Group 8 MRS	GRP8	572	496662.7	4559099.3	496662.3719	4559098.972	64.16812897	12/2/2011	113.2	-0.3048	-0.3048	Y	N	
Group 8 MRS	GRP8	576	496662.9	4559097.7	496662.5719	4559097.372	19.76518249	12/2/2011	45.6	-0.3048	-0.3048	Y	N	
Group 8 MRS	GRP8	587	496664	4559090	496663.836	4559090	77.68850708	12/2/2011	247.5	-0.1524	0	Y	N	
Group 8 MRS	GRP8	598	496664.9	4559092.1	496664.9	4559092.1	121.4365157	12/2/2011	215.2	0	0	Y	N	
Group 8 MRS	GRP8	609	496665.6	4559123.55			16.1300125	12/2/2011	0	0	0	N	N	No peak cultural interference from building
Group 8 MRS	GRP8	616	496666.1	4559104.8	496665.7719	4559104.636	32.15856171	12/2/2011	62.2	-0.3048	-0.1524	Y	N	
Group 8 MRS	GRP8	621	496667.1	4559109.5	496667.1	4559109.91	37.49185942	12/2/2011	125.7	0	0.381	Y	N	
Group 8 MRS	GRP8	626	496667.6	4559106.4	496667.682	4559106.4	84.88795471	12/2/2011	248.2	0.0762	0	Y	N	
Group 8 MRS	GRP8	627	496667.6	4559093.6	496667.8461	4559093.6	78.46360015	12/2/2011	174	0.2286	0	Y	N	
Group 8 MRS	GRP8	628	496667.8	4559088.5	496667.718	4559088.336	259.3205261	12/2/2011	531.9	-0.0762	-0.1524	Y	N	
Group 8 MRS	GRP8	636	496668.6	4559125.3			27.77192688	12/2/2011	0	0	0	N	N	No peak cultural interference from building
Group 8 MRS	GRP8	640	496669	4559100.3	496668.7933	4559100.093	33.15777588	12/2/2011	75.2	-0.192024	-0.192024	Y	N	
Group 8 MRS	GRP8	646	496669.7	4559111.3	496669.7	4559111.3	160.2658539	12/2/2011	230.9	0	0	Y	N	
Group 8 MRS	GRP8	648	496670.2	4559065.8	496669.9933	4559065.8	198.9095001	12/2/2011	264.6	-0.192024	0	Y	N	
Group 8 MRS	GRP8	652	496670.9	4559101.1	496670.9	4559101.1	119.8094025	12/2/2011	187.6	0	0	Y	N	
Group 8 MRS	GRP8	656	496671.4	4559126.3			13.79144287	12/2/2011	0	0	0	N	N	No peak cultural interference from building
Group 8 MRS	GRP8	659	496671.7	4559112.2	496671.7	4559112.2	837.3984983	12/2/2011	1375.2	0	0	Y	N	
Group 8 MRS	GRP8	679	496674.1	4559110.4	496674.1	4559110.4	532.6014404	12/2/2011	764.9	0	0	Y	N	
Group 8 MRS	GRP8	680	496674.2	4559096.2	496674.2	4559096.036	94.15918726	12/2/2011	134.6	0	-0.1524	Y	N	
Group 8 MRS	GRP8	709	496676.4	4559110.9	496676.4	4559110.9	717.5839232	12/2/2011	1041.4	0	0	Y	N	
Group 8 MRS	GRP8	710	496676.5	4559114.4	496676.5	4559114.4	152.7343445	12/2/2011	344.4	0	0	Y	N	
Group 8 MRS	GRP8	720	496678.4	4559106.8	496678.4	4559106.8	687.4250489	12/2/2011	746.1	0	0	Y	N	
Group 8 MRS	GRP8	724	496678.7	4559098.6	496678.7	4559098.6	54.81467436	12/2/2011	99.9	0	0	Y	N	
Group 8 MRS	GRP8	725	496678.8	4559100.8	496678.636	4559100.636	10.71365356	12/2/2011	13.2	-0.1524	-0.1524	Y	N	
Group 8 MRS	GRP8	739	496681.1	4559121.1	496681.1	4559121.1	17.30859374	12/2/2011	24.8	0	0	Y	N	
Group 8 MRS	GRP8	742	496681.3	4559115	496681.0933	4559115.41	579.9637451	12/2/2011	1646.7	-0.192024	0.381	Y	N	
Group 8 MRS	GRP8	748	496681.7	4559107.2	496681.7	4559107.2	694.9436646	12/2/2011	1118.7	0	0	Y	N	
Group 8 MRS	GRP8	750	496682.3	4559122.6	496682.0933	4559122.393	1308.943482	12/2/2011	2015.5	-0.192024	-0.192024	Y	N	
Group 8 MRS	GRP8	757	496683.8	4559131	496683.8	4559131	13.50318908	12/2/2011	0	0	0	Y	N	No peak cultural interference from building
Group 8 MRS	GRP8	772	496685.2	4559113.9	496685.2	4559113.9	136.6089172	12/2/2011	285.4	0	0	Y	N	
Group 8 MRS	GRP8	774	496685.5	4559106.6	496685.5	4559106.6	13.39793396	12/2/2011	32.1	0	0	Y	N	
Group 8 MRS	GRP8	787	496686.8	4559122.3	496686.882	4559122.218	14.34339905	12/2/2011	17.5	0.0762	-0.0762	Y	N	
Group 8 MRS	GRP8	798	496688.3	4559124.9	496688.464	4559124.9	630.4572146	12/2/2011	1015.3	0.1524	0	Y	N	
Group 8 MRS	GRP8	801	496688.6	4559117.9	496688.436	4559117.9	356.6684265	12/2/2011	339.4	-0.1524	0	Y	N	
Group 8 MRS	GRP8	807	496689.1	4559116.5	496689.4281	4559116.172	174.7827759	12/2/2011	246.7	0.3048	-0.3048	Y	N	
Group 8 MRS	GRP8	810	496689.4	4559114.8	496689.4	4559115.046	38.14530182	12/2/2011	149.5	0	0.2286	Y	N	
Group 8 MRS	GRP8	825	496691.9	4559115	496692.064	4559115	58.80900578	12/2/2011	206.3	0.1524	0	Y	N	
Group 8 MRS	GRP8	836	496693.7	4559124.9	496693.9067	4559124.693	49.59705352	12/2/2011	73.7	0.192024	-0.192024	Y	N	
Group 8 MRS	GRP8	845	496695.9	4559126.4	496695.9	4559126.4	198.5601959	12/2/2011	231.2	0	0	Y	N	
Group 8 MRS	GRP8	848	496696.3	4559124.6	496696.0933	4559124.6	38.08663941	12/2/2011	67.7	-0.192024	0	Y	N	
Group 8 MRS	GRP8	857	496698.2	4559126.7	496698.2	4559126.7	58.71730038	12/2/2011	97.1	0	0	Y	N	
Group 8 MRS	GRP8	866	496699.3	4559110.4	496699.136	4559110.4	13.59794616	12/2/2011	11.1	-0.1524	0	Y	N	

Table G-1
Anomaly Reacquisition and Intrusive Investigation Results for Individual Target Anomalies
Group 8 MRS
Ravenna Army Ammunition Plant

Location	Work Unit	Anomaly ID	Anomaly Easting	Anomaly Northing	Item Northing	Item Easting	Initial Peak (Ch 2, mV)	Peak Reac Date	Reac Peak (Ch 2, mV)	Reac Offset East (m)	Reac Offset North (m)	Reac Successful	Surface Item	Reac Comments
Group 8 MRS	GRP8	867	496699.6	4559132.7	496699.6	4559132.7	34.55146025	12/2/2011	57.7	0	0	Y	N	
Group 8 MRS	GRP8	868	496700.2	4559127.6	496700.364	4559127.682	16.47952269	12/2/2011	16.1	0.1524	0.0762	Y	N	
Group 8 MRS	GRP8	871	496700.5	4559139.8	496700.5	4559139.636	415.1777954	12/2/2011	497.2	0	-0.1524	Y	N	
Group 8 MRS	GRP8	874	496701.4	4559137.6	496701.4	4559137.6	20.10972594	12/2/2011	25.1	0	0	Y	N	
Group 8 MRS	GRP8	878	496701.9	4559078.3	496701.9	4559078.3	368.1895141	12/2/2011	140	0	0	Y	N	Removed 2-ft strand of 0.25-inch wire from surface. 140 mV remains to be dug
Group 8 MRS	GRP8	880	496702.5	4559127.6	496702.5	4559127.6	328.6474913	12/2/2011	439.2	0	0	Y	N	
Group 8 MRS	GRP8	883	496702.8	4559109.2	496703.1281	4559109.2	45.90135954	12/2/2011	98.8	0.3048	0	Y	N	
Group 8 MRS	GRP8	895	496705.7	4559113.3	496705.8083	4559113.3	8.446151733	12/2/2011	13.9	0.100584	0	Y	N	
Group 8 MRS	GRP8	899	496706.1	4559130.3	496706.3461	4559130.093	1291.405029	12/2/2011	1337.6	0.2286	-0.192024	Y	N	
Group 8 MRS	GRP8	903	496706.7	4559090.4	496706.0438	4559090.4	39.51985931	12/2/2011	182.5	-0.6096	0	Y	N	
Group 8 MRS	GRP8	903	496706.7	4559090.4	496706.0438	4559090.4	39.51985931	12/2/2011	182.5	-0.6096	0	Y	N	
Group 8 MRS	GRP8	906	496707.3	4559080.1	496707.3	4559080.1	49.10509489	12/2/2011	149.7	0	0	Y	N	
Group 8 MRS	GRP8	907	496707.5	4559116.55	496707.5	4559116.55	582.4386596	12/2/2011	47	0	0	Y	N	Initial reac value 2781.1 mV steel bracket 18-in removed. 47 mV remains to be dug
Group 8 MRS	GRP8	913	496708.25	4559118.05	496708.25	4559118.05	128.0180969	12/2/2011	383.8	0	0	Y	N	
Group 8 MRS	GRP8	919	496710.3	4559091.1	496710.3	4559091.1	20.50439452	12/2/2011	113.5	0	0	Y	N	
Group 8 MRS	GRP8	919	496710.3	4559091.1	496710.3	4559091.1	20.50439452	12/2/2011	113.5	0	0	Y	N	
Group 8 MRS	GRP8	925	496711	4559109.5	496711.2461	4559109.746	39.69724272	12/2/2011	107.6	0.2286	0.2286	Y	N	
Group 8 MRS	GRP8	927	496711.5	4559081.3	496711.5	4559081.3	128.4425354	12/2/2011	327.6	0	0	Y	N	
Group 8 MRS	GRP8	935	496713	4559096.8	496713	4559096.8	11.35160828	12/2/2011	84.7	0	0	Y	N	
Group 8 MRS	GRP8	940	496713.6	4559109.4	496713.764	4559109.482	45.88133239	12/2/2011	61.6	0.1524	0.0762	Y	N	
Group 8 MRS	GRP8	945	496714.75	4559111.35	496714.75	4559111.35	15.13821411	12/2/2011	43.7	0	0	Y	N	
Group 8 MRS	GRP8	951	496715.7	4559084	496715.782	4559083.918	74.77816773	12/2/2011	110.7	0.0762	-0.0762	Y	N	
Group 8 MRS	GRP8	952	496715.9	4559145.1	496715.818	4559144.772	8.784301759	12/2/2011	11.8	-0.0762	-0.3048	Y	N	
Group 8 MRS	GRP8	957	496716.3	4559121.6	496716.3	4559121.6	157.6394805	12/2/2011	201.7	0	0	Y	N	
Group 8 MRS	GRP8	971	496717.6	4559113	496717.3539	4559112.754	14.49113464	12/2/2011	11.9	-0.2286	-0.2286	Y	N	
Group 8 MRS	GRP8	987	496718.9	4559119.8	496718.5719	4559119.882	60.80502319	12/2/2011	87.8	-0.3048	0.0762	Y	N	
Group 8 MRS	GRP8	1003	496720.7	4559108.4	496720.7	4559108.564	23.20903014	12/2/2011	29.2	0	0.1524	Y	N	
Group 8 MRS	GRP8	1008	496721.4	4559129.4	496721.4	4559129.4	41.36652373	12/2/2011	50.3	0	0	Y	N	
Group 8 MRS	GRP8	1019	496722.8	4559102.7	496723.1281	4559102.7	28.99845886	12/2/2011	51.2	0.3048	0	Y	N	
Group 8 MRS	GRP8	1031	496724	4559122.4	496724.164	4559122.4	97.91552731	12/2/2011	117.6	0.1524	0	Y	N	
Group 8 MRS	GRP8	1034	496724.6	4559110.8	496724.6	4559110.964	79.73906707	12/2/2011	108.2	0	0.1524	Y	N	
Group 8 MRS	GRP8	1046	496725.3	4559142.8	496725.3	4559142.8	18.98097229	12/6/2011	27.8	0	0	Y	N	
Group 8 MRS	GRP8	1057	496726.1	4559112.5	496725.8933	4559112.582	18.70924376	12/6/2011	30.5	-0.192024	0.0762	Y	N	
Group 8 MRS	GRP8	1058	496726.2	4559134.9	496726.036	4559135.064	201.9729309	12/6/2011	422.6	-0.1524	0.1524	Y	N	
Group 8 MRS	GRP8	1060	496726.35	4559107.15	496726.35	4559107.15	14.32959747	12/2/2011	27.6	0	0	Y	N	
Group 8 MRS	GRP8	1062	496726.4	4559138.1	496726.4	4559138.1	4741.395507	12/6/2011	117.5	0	0	Y	N	Initial reac peak 4372.5 mV removed. 75% of drum lid. 117.5 mV anomaly remains to be dug
Group 8 MRS	GRP8	1067	496726.8	4559115.1	496726.9378	4559114.936	85.80818177	12/6/2011	236.1	0.128016	-0.1524	Y	N	
Group 8 MRS	GRP8	1073	496727.1	4559125.2	496727.1	4559125.2	95.48856351	12/6/2011	139.4	0	0	Y	N	
Group 8 MRS	GRP8	1087	496727.9	4559118.9	496727.9	4559118.736	14.92698669	12/6/2011	33.2	0	-0.1524	Y	N	
Group 8 MRS	GRP8	1097	496728.8	4559106.5	496729.1281	4559106.746	84.16214753	12/2/2011	116.2	0.3048	0.2286	Y	N	
Group 8 MRS	GRP8	1102	496728.9	4559095.75	496729.1067	4559095.75	17.09249878	12/2/2011	39.7	0.192024	0	Y	N	
Group 8 MRS	GRP8	1105	496729	4559089	496729	4559089	252.1795348	12/2/2011	368.3	0	0	Y	N	
Group 8 MRS	GRP8	1112	496729.5	4559137.1	496729.7461	4559136.444	786.7054442	12/6/2011	1814.4	0.2286	-0.6096	Y	N	
Group 8 MRS	GRP8	1117	496730	4559120.9	496729.918	4559120.818	76.51250458	12/6/2011	136.2	-0.0762	-0.0762	Y	N	
Group 8 MRS	GRP8	1124	496730.5	4559089.7	496730.5	4559090.028	210.8081207	12/2/2011	438.4	0	0.3048	Y	N	
Group 8 MRS	GRP8	1131	496731.2	4559097.5	496730.9933	4559097.254	138.4960175	12/6/2011	255.7	-0.192024	-0.2286	Y	N	
Group 8 MRS	GRP8	1132	496731.2	4559149.5	496731.0622	4559149.664	8.035568234	12/6/2011	11.2	-0.128016	0.1524	Y	N	
Group 8 MRS	GRP8	1133	496731.3	4559131	496731.3	4559131	21.47100829	12/6/2011	52.9	0	0	Y	N	
Group 8 MRS	GRP8	1134	496731.3	4559116.4	496731.464	4559116.728	21.90106201	12/6/2011	61.6	0.1524	0.3048	Y	N	
Group 8 MRS	GRP8	1148	496732.5	4559139.4	496732.336	4559139.4	875.5104369	12/6/2011	1415.6	-0.1524	0	Y	N	
Group 8 MRS	GRP8	1149	496732.6	4559105.2	496732.436	4559105.364	42.18015286	12/6/2011	73	-0.1524	0.1524	Y	N	
Group 8 MRS	GRP8	1159	496733.8	4559114.9	496733.964	4559115.107	8.371704103	12/6/2011	18.6	0.1524	0.192024	Y	N	
Group 8 MRS	GRP8	1161	496734	4559091.1	496734	4559091.1	84.60473632	12/6/2011	309.5	0	0	Y	N	
Group 8 MRS	GRP8	1165	496734.2	4559093.2	496734.036	4559093.2	109.5511093	12/6/2011	193.9	-0.1524	0	Y	N	
Group 8 MRS	GRP8	1170	496734.6	4559150.4	496734.6	4559150.4	14.27688599	12/6/2011	19.2	0	0	Y	N	
Group 8 MRS	GRP8	1178	496735.4	4559096	496735.4	4559096	614.2976072	12/6/2011	782.6	0	0	Y	N	
Group 8 MRS	GRP8	1179	496735.4	4559117.8	496735.4	4559117.8	478.7780762	12/6/2011	683.6	0	0	Y	N	
Group 8 MRS	GRP8	1182	496735.6	4559141.7	496735.6	4559141.7	891.6317133	12/6/2011	1239.8	0	0	Y	N	
Group 8 MRS	GRP8	1187	496735.95	4559105.6	496735.95	4559105.6	390.3053132	12/6/2011	846.5	0	0	Y	N	
Group 8 MRS	GRP8	1189	496736.4	4559114.9	496736.4	4559115.038	734.8383785	12/6/2011	904.3	0	0.128016	Y	N	
Group 8 MRS	GRP8	1201	496737.7	4559110.8	496737.7	4559110.8	1581.169312	12/6/2011	2320.8	0	0	Y	N	
Group 8 MRS	GRP8	1206	496738.4	4559096.9	496738.4	4559096.9	243.5589447	12/6/2011	303.2	0	0	Y	N	
Group 8 MRS	GRP8	1207	496738.5	4559114.4	496738.5	4559114.4	1073.702759	12/6/2011	1292.2	0	0	Y	N	
Group 8 MRS	GRP8	1207	496738.5	4559114.4	496738.5	4559114.4	1073.702759	12/6/2011	1292.2	0	0	Y	N	

Table G-1
Anomaly Reacquisition and Intrusive Investigation Results for Individual Target Anomalies
Group 8 MRS
Ravenna Army Ammunition Plant

Location	Work Unit	Anomaly ID	Anomaly Easting	Anomaly Northing	Item Northing	Item Easting	Initial Peak (Ch 2, mV)	Peak Reac Date	Reac Peak (Ch 2, mV)	Reac Offset East (m)	Reac Offset North (m)	Reac Successful	Surface Item	Reac Comments
Group 8 MRS	GRP8	1207	496738.5	4559114.4	496738.5	4559114.4	1073.702759	12/6/2011	1292.2	0	0	Y	N	
Group 8 MRS	GRP8	1210	496738.7	4559098.6	496738.7	4559098.764	19.46356202	12/6/2011	48.8	0	0.1524	Y	N	
Group 8 MRS	GRP8	1213	496739.1	4559144.9	496739.1	4559145.284	45.46308897	12/6/2011	54.4	0	0.356616	Y	N	
Group 8 MRS	GRP8	1219	496739.6	4559142.9	496739.518	4559142.818	19.89553833	12/6/2011	27.3	-0.0762	-0.0762	Y	N	
Group 8 MRS	GRP8	1220	496739.9	4559136.5	496740.2018	4559136.5	12.64781188	12/6/2011	22.8	0.280416	0	Y	N	
Group 8 MRS	GRP8	1222	496739.9	4559102.7	496740.2281	4559102.372	570.7983395	12/6/2011	1113.8	0.3048	-0.3048	Y	N	
Group 8 MRS	GRP8	1230	496740.4	4559116.7	496740.4	4559116.7	29.58566285	12/6/2011	42.2	0	0	Y	N	
Group 8 MRS	GRP8	1233	496740.7	4559113.4	496740.7	4559113.4	182.2427368	12/6/2011	237.7	0	0	Y	N	
Group 8 MRS	GRP8	1236	496741	4559110.6	496741	4559110.6	9.307418824	12/6/2011	30.5	0	0	Y	N	
Group 8 MRS	GRP8	1240	496741.5	4559148.2	496741.336	4559148.446	12.83981323	12/6/2011	35.9	-0.1524	0.2286	Y	N	
Group 8 MRS	GRP8	1244	496741.9	4559136.3	496741.9	4559136.507	22.78359985	12/6/2011	34.9	0	0.192024	Y	N	
Group 8 MRS	GRP8	1247	496742.2	4559129.6	496742.2	4559129.6	14.56129455	12/6/2011	25.3	0	0	Y	N	
Group 8 MRS	GRP8	1249	496742.3	4559115.9	496742.3	4559115.9	73.94157409	12/6/2011	110.5	0	0	Y	N	
Group 8 MRS	GRP8	1256	496742.8	4559156.1	496742.8	4559156.1	17.93682861	12/6/2011	25.5	0	0	Y	N	
Group 8 MRS	GRP8	1258	496742.9	4559147.9	496742.9	4559147.9	10.91992187	12/6/2011	16.3	0	0	Y	N	
Group 8 MRS	GRP8	1266	496743.5	4559103.1	496743.5	4559103.1	1182.429443	12/6/2011	1431.1	0	0	Y	N	Pile of washers. Too many to remove. Dig anways.
Group 8 MRS	GRP8	1267	496743.5	4559142.7	496743.9921	4559142.372	14.20146179	12/6/2011	32.1	0.4572	-0.3048	Y	N	
Group 8 MRS	GRP8	1270	496743.8	4559151.5	496743.8	4559151.336	78.48332212	12/6/2011	172.9	0	-0.1524	Y	N	
Group 8 MRS	GRP8	1271	496743.8	4559124.7	496743.8	4559124.7	12.06840515	12/6/2011	29.2	0	0	Y	N	
Group 8 MRS	GRP8	1277	496744.05	4559145.25	496744.05	4559145.25	7.673465728	12/6/2011	18.3	0	0	Y	N	
Group 8 MRS	GRP8	1296	496745.2	4559136.7	496745.4461	4559136.536	9.552734373	12/6/2011	13.2	0.2286	-0.1524	Y	N	
Group 8 MRS	GRP8	1305	496746	4559105	496746	4559105	138.6386718	12/6/2011	348.6	0	0	Y	N	
Group 8 MRS	GRP8	1307	496746.1	4559113	496746.182	4559113	186.3351745	12/6/2011	343.6	0.0762	0	Y	N	
Group 8 MRS	GRP8	1324	496747.2	4559152.7	496747.2	4559152.7	29.41900634	12/6/2011	46.7	0	0	Y	N	
Group 8 MRS	GRP8	1329	496747.4	4559148.9	496747.4	4559148.9	110.473236	12/6/2011	122.6	0	0	Y	N	
Group 8 MRS	GRP8	1331	496747.5	4559137.6	496747.5	4559137.6	18.47760009	12/6/2011	41.8	0	0	Y	N	
Group 8 MRS	GRP8	1344	496748.5	4559133	496748.7067	4559133.207	9.857833859	12/6/2011	15.2	0.192024	0.192024	Y	N	
Group 8 MRS	GRP8	1348	496748.8	4559124.9	496748.882	4559124.818	216.7859802	12/6/2011	297.7	0.0762	-0.0762	Y	N	
Group 8 MRS	GRP8	1349	496748.9	4559150.8	496748.9	4559150.662	25.95266724	12/6/2011	48.2	0	-0.128016	Y	N	
Group 8 MRS	GRP8	1351	496749	4559152.2	496749	4559152.2	44.81210326	12/6/2011	73.9	0	0	Y	N	
Group 8 MRS	GRP8	1354	496749.2	4559101.6	496748.9933	4559101.6	142.9237976	12/6/2011	280.8	-0.192024	0	Y	N	
Group 8 MRS	GRP8	1356	496749.3	4559157.6	496749.3	4559157.6	20.76365661	12/6/2011	30.7	0	0	Y	N	
Group 8 MRS	GRP8	1370	496750.1	4559134.7	496750.018	4559135.11	60.10174558	12/6/2011	64.2	-0.0762	0.381	Y	N	
Group 8 MRS	GRP8	1373	496750.4	4559114.8	496749.5798	4559114.226	951.9967651	12/6/2011	1551.7	-0.762	-0.5334	Y	N	
Group 8 MRS	GRP8	1378	496750.9	4559111.8	496750.9	4559111.472	344.8334961	12/6/2011	523.5	0	-0.3048	Y	N	
Group 8 MRS	GRP8	1383	496751.05	4559103.5	496751.3781	4559103.5	130.1966553	12/6/2011	422.1	0.3048	0	Y	N	
Group 8 MRS	GRP8	1395	496751.9	4559108.9	496752.1461	4559108.9	767.9152828	12/6/2011	1093.3	0.2286	0	Y	N	
Group 8 MRS	GRP8	1399	496752	4559132.1	496751.918	4559132.428	12.55607604	12/6/2011	19.5	-0.0762	0.3048	Y	N	
Group 8 MRS	GRP8	1419	496753.8	4559153.8	496753.5539	4559153.636	147.9978485	12/6/2011	279.5	-0.2286	-0.1524	Y	N	
Group 8 MRS	GRP8	1420	496753.9	4559143.5	496754.2281	4559143.418	168.0805969	12/6/2011	297.3	0.3048	-0.0762	Y	N	
Group 8 MRS	GRP8	1432	496755.1	4559130.1	496755.1	4559130.1	104.3660202	12/6/2011	150.6	0	0	Y	N	
Group 8 MRS	GRP8	1441	496756	4559163.4	496756.3018	4559163.4	12.72584533	12/6/2011	31.3	0.280416	0	Y	N	
Group 8 MRS	GRP8	1442	496756.1	4559114	496756.3461	4559113.836	2248.815673	12/6/2011	2783.7	0.2286	-0.1524	Y	N	
Group 8 MRS	GRP8	1442	496756.1	4559114	496756.3461	4559113.836	2248.815673	12/6/2011	2783.7	0.2286	-0.1524	Y	N	
Group 8 MRS	GRP8	1452	496756.7	4559144.35	496756.864	4559144.596	51.78333663	12/6/2011	197.2	0.1524	0.2286	Y	N	
Group 8 MRS	GRP8	1460	496757.3	4559141.8	496757.6281	4559141.8	12.68338013	12/6/2011	28.8	0.3048	0	Y	N	
Group 8 MRS	GRP8	1462	496757.5	4559151.3	496757.418	4559151.218	30.3551712	12/6/2011	79.9	-0.0762	-0.0762	Y	N	
Group 8 MRS	GRP8	1463	496757.5	4559130.5	496757.664	4559130.664	21.28961182	12/6/2011	33.9	0.1524	0.1524	Y	N	
Group 8 MRS	GRP8	1466	496757.8	4559107.1	496757.636	4559107.1	185.7875061	12/6/2011	235.2	-0.1524	0	Y	N	
Group 8 MRS	GRP8	1474	496758.4	4559129.6	496758.236	4559129.6	51.88546751	12/6/2011	98.8	-0.1524	0	Y	N	
Group 8 MRS	GRP8	1476	496758.4	4559131.1	496758.6067	4559131.182	14.48896789	12/6/2011	18.5	0.192024	0.0762	Y	N	
Group 8 MRS	GRP8	1483	496758.7	4559141.4	496758.3719	4559141.974	28.313385	12/6/2011	31.1	-0.3048	0.5334	Y	N	
Group 8 MRS	GRP8	1486	496759	4559126.7	496759	4559126.536	20.65167236	12/6/2011	29.1	0	-0.1524	Y	N	
Group 8 MRS	GRP8	1491	496759.5	4559117.7	496759.5	4559117.7	570.182922	12/6/2011	721.2	0	0	Y	N	
Group 8 MRS	GRP8	1509	496760.8	4559122.9	496760.882	4559122.818	38.88735198	12/6/2011	52.2	0.0762	-0.0762	Y	N	
Group 8 MRS	GRP8	1513	496761	4559126.5	496761	4559126.5	145.4219055	12/6/2011	177.6	0	0	Y	N	
Group 8 MRS	GRP8	1520	496761.6	4559124.8	496761.4917	4559124.8	91.00769805	12/6/2011	138.2	-0.100584	0	Y	N	
Group 8 MRS	GRP8	1529	496762.2	4559113	496762.2	4559113	1032.107422	12/6/2011	1399.5	0	0	Y	N	
Group 8 MRS	GRP8	1533	496762.7	4559118.3	496763.6022	4559118.628	50.99436951	12/6/2011	163.3	0.8382	0.3048	Y	N	
Group 8 MRS	GRP8	1541	496763.5	4559109.3	496763.582	4559109.464	173.5424652	12/6/2011	245.4	0.0762	0.1524	Y	N	
Group 8 MRS	GRP8	1545	496764.1	4559145.6	496763.4701	4559145.19	18.24121094	12/6/2011	21	-0.585216	-0.381	Y	N	

Table G-1
Anomaly Reacquisition and Intrusive Investigation Results for Individual Target Anomalies
Group 8 MRS
Ravenna Army Ammunition Plant

Location	Work Unit	Anomaly ID	Anomaly Easting	Anomaly Northing	Item Northing	Item Easting	Initial Peak (Ch 2, mV)	Peak Reac Date	Reac Peak (Ch 2, mV)	Reac Offset East (m)	Reac Offset North (m)	Reac Successful	Surface Item	Reac Comments
Group 8 MRS	GRP8	1550	496764.5	4559119.9	496764.664	4559119.9	363.0783386	12/6/2011	428.9	0.1524	0	Y	N	
Group 8 MRS	GRP8	1554	496764.7	4559115.8	496764.7	4559115.593	18.99993897	12/6/2011	77	0	-0.192024	Y	N	
Group 8 MRS	GRP8	1556	496764.9	4559106.9	496764.9	4559106.9	689.611389	12/6/2011	1077.5	0	0	Y	N	
Group 8 MRS	GRP8	1557	496764.9	4559116.9	496764.9	4559116.9	110.1724167	12/6/2011	196.1	0	0	Y	N	
Group 8 MRS	GRP8	1588	496768.2	4559112.2	496768.2	4559112.2	285.5311889	12/6/2011	503.7	0	0	Y	N	
Group 8 MRS	GRP8	1610	496771.4	4559110.2	496771.4	4559109.872	463.2384337	12/6/2011	1049.1	0	-0.3048	Y	N	
Group 8 MRS	GRP8	1611	496771.9	4559125.1	496771.9558	4559125.264	52.31105041	12/6/2011	76.7	0.051816	0.1524	Y	N	
Group 8 MRS	GRP8	1636	496775.7	4559110.6	496774.7157	4559110.6	3929.006836	12/6/2011	7468.8	-0.9144	0	Y	N	
Group 8 MRS	GRP8	1637	496772.5	4559118.1	496772.664	4559118.1	2766.913329	12/15/2011	4194.5	0.1524	0	Y	N	
Group 8 MRS	GRP8	1640	496723.8	4559097.05	496723.8	4559097.05	2776.038208	12/2/2011	3509.2	0	0	Y	N	
Group 8 MRS	GRP8	1641	496731.2	4559093.5	496731.282	4559093.444	577.7564698	12/6/2011	904.8	0.0762	-0.051816	Y	N	Linear feature
Group 8 ADD	GRP8	1642	496614.3	4559047.6	496614.3	4559047.6	889.6501464	12/15/2011	980.2	0	0	Y	N	
Group 8 ADD	GRP8	1643	496695.2	4559137.2	496695.2	4559137.2	29.11088562	12/15/2011	63.7	0	0	Y	N	Same target as 1,644
Group 8 ADD	GRP8	1644	496695	4559136.5	496695	4559136.802	44.9247055	12/15/2011	63.7	0	0.280416	Y	N	
Group 8 ADD	GRP8	1645	496696.4	4559138.9	496696.4	4559138.9	10.7733612	12/15/2011	27.5	0	0	Y	N	
Group 8 ADD	GRP8	1646	496732.5	4559153.9	496732.5	4559153.9	199.7452545	12/15/2011	227.4	0	0	Y	N	
Group 8 ADD	GRP8	1647	496734.6	4559154.9			34.12281035	12/15/2011	49.3	-0.3048	0	Y	N	
Group 8 ADD	GRP8	1648	496742.6	4559158.1	496742.8461	4559158.018	21.60144043	12/15/2011	58.3	0.2286	-0.0762	Y	N	
Group 8 ADD	GRP8	1649	496748.7	4559160.9	496748.7	4559160.9	16.97155761	12/15/2011	53.4	0	0	Y	N	
Group 8 ADD	GRP8	1650	496745.2	4559159	496745.2	4559159	8.466796874	12/15/2011	16.7	0	0	Y	N	
Group 8 ADD	GRP8	1651	496751.7	4559162.5	496751.6442	4559162.293	57.51064302	12/15/2011	135.5	-0.051816	-0.192024	Y	N	
Group 8 ADD	GRP8	1652	496753.2	4559163	496753.2	4559163	20.70755004	12/15/2011	49.4	0	0	Y	N	
Group 8 ADD	GRP8	1653	496753.9	4559162.9	496754.2281	4559163.146	19.38989257	12/15/2011	62.5	0.3048	0.2286	Y	N	
Group 8 ADD	GRP8	1654	496759.3	4559146.3	496758.9719	4559146.3	10.02386475	12/15/2011	26.2	-0.3048	0	Y	N	
Group 8 ADD	GRP8	1655	496759.9	4559147.6	496759.9	4559147.6	182.6238707	12/15/2011	188.8	0	0	Y	N	
Group 8 ADD	GRP8	1656	496761.8	4559148.6	496761.8	4559148.6	18.75823975	12/15/2011	44.4	0	0	Y	N	
Group 8 ADD	GRP8	1657	496762.4	4559147.3	496762.564	4559147.3	13.16572571	12/15/2011	27.8	0.1524	0	Y	N	
Group 8 ADD	GRP8	1658	496763	4559143.2	496763	4559143.2	34.2168808	12/15/2011	59.1	0	0	Y	N	
Group 8 ADD	GRP8	1659	496763.6	4559143.8	496764.0101	4559143.744	20.43458557	12/15/2011	23.8	0.381	-0.051816	Y	N	
Group 8 ADD	GRP8	1660	496762.7	4559144.9	496762.4539	4559144.9	17.14915467	12/15/2011	15.7	-0.2286	0	Y	N	
Group 8 ADD	GRP8	1661	496764.3	4559142.1	496764.6281	4559142.1	114.289238	12/15/2011	138.9	0.3048	0	Y	N	
Group 8 ADD	GRP8	1662	496764.2333	4559139.667	496763.9052	4559139.749	22.34013371	12/15/2011	23.5	-0.3048	0.0762	Y	N	
Group 8 ADD	GRP8	1663	496690.8	4559072.9	496691.2101	4559072.982	257.9975281	12/15/2011	391.1	0.381	0.0762	Y	N	
Group 8 ADD	GRP8	1664	496738.7	4559149.5	496738.7	4559149.5	729.4978637	12/15/2011	872.5	0	0	Y	N	

Table G-1
Anomaly Reacquisition and Intrusive Investigation Results for Individual Target Anomalies
Group 8 MRS
Ravenna Army Ammunition Plant

Summary	Quantity	Estimated Weight
Munitions Debris:	82 ea	238.5 lbs
MPPEH:	0 ea	NA
Other Debris:	1810 ea	3020 lbs

Number of Anomalies Investigated: 272

Location	Work Unit	Anomaly ID	Dig Priority	Dig Initiated Date	Total Depth Dug (in)	Item Located	Item ID	Subsurface Anomaly Type*	MEC Type**	MD Type***	Intact	Nomenclature	Item Comments	Item Depth (in)	Qty	Weight (lbs)	Orientation	Inclination	Disposition****
Group 8 MRS	GRP8	12	Y	12/21/2011	2	Y	1	OD	NA	NA		Pipe		2	1	8	0	0	LIP
Group 8 MRS	GRP8	14	Y	12/20/2011	4	Y	1	OD	NA	NA		Wire	metal ring and slag	4	1	0.25	0	0	LIP
Group 8 MRS	GRP8	15	Y	12/20/2011	3	Y	1	OD	NA	NA		Scrap Metal	slag	3	5	1	0	0	LIP
Group 8 MRS	GRP8	24	Y	12/20/2011	6	Y	1	OD	NA	NA		Scrap Metal	slag	6	5	0.5	0	0	LIP
Group 8 MRS	GRP8	32	Y	12/21/2011	18	Y	1	OD	NA	NA		Fence Post		18	1	8	0	0	LIP
Group 8 MRS	GRP8	39	Y	12/20/2011	8	Y	1	OD	NA	NA		Scrap Steel	scrap steel and slag	8	1	2	0	0	LIP
Group 8 MRS	GRP8	44	N																
Group 8 MRS	GRP8	54	Y	12/20/2011	6	Y	1	OD	NA	NA		Scrap Steel	bolts, spikes and hardware attached to 2 rr ties. plus slag	6	3	5	0	0	LIP
Group 8 MRS	GRP8	55	Y	12/16/2011	2	Y	1	OD	NA	NA		Scrap Metal	cast iron	2	1	7	0	0	LIP
Group 8 MRS	GRP8	66	Y	12/16/2011	3	Y	1	OD	NA	NA		Scrap Metal	cast iron grate	3	1	4	0	0	LIP
Group 8 MRS	GRP8	84	Y	12/16/2011	6	Y	1	OD	NA	NA		Scrap Metal	cast iron	6	3	10	0	0	LIP
Group 8 MRS	GRP8	86	Y	12/16/2011	2	Y	1	OD	NA	NA		Pipe	steel pipe coupler	2	1	2	0	0	LIP
Group 8 MRS	GRP8	89	N																
Group 8 MRS	GRP8	110	Y	12/16/2011	6	Y	1	OD	NA	NA		Scrap Steel		4	1	2	0	0	LIP
Group 8 MRS	GRP8	110	Y	12/16/2011	6	Y	2	OD	NA	NA		Scrap Metal	slag	6	1	1	0	0	LIP
Group 8 MRS	GRP8	115	Y	12/16/2011	3	Y	1	OD	NA	NA		Scrap Steel	steel rod	3	1	3	0	0	LIP
Group 8 MRS	GRP8	121	Y	2/7/2012	12	Y	1	OD	NA	NA	N	Fence Material	fence post	12	1	5	0	0	LIP
Group 8 MRS	GRP8	130	Y	12/16/2011	6	Y	1	OD	NA	NA	N	Scrap Metal	handle	6	1	3	0	0	LIP
Group 8 MRS	GRP8	136	Y	12/21/2011	0	Y	1	OD	NA	NA		Pipe		0	1	2	0	0	LIP
Group 8 MRS	GRP8	155	Y	12/21/2011	1	Y	1	OD	NA	NA		Scrap Steel	steel washers	1	4	1	0	0	LIP
Group 8 MRS	GRP8	156	Y	12/21/2011	24	Y	1	OD	NA	NA		Scrap Steel	steel hexagonal stock drill bit.	24	1	20	0	0	LIP
Group 8 MRS	GRP8	160	Y	12/16/2011	6	Y	1	OD	NA	NA		Scrap Metal	temperature sender	6	1	0.25	0	0	LIP
Group 8 MRS	GRP8	172	Y	2/7/2012	6	Y	1	OD	NA	NA	N	Bolt	wire, angle iron, bolt	6	2	4	0	0	LIP
Group 8 MRS	GRP8	186	Y	12/16/2011	1	Y	1	OD	NA	NA		Scrap Metal	slag	1	1	1	0	0	LIP
Group 8 MRS	GRP8	190	Y	12/21/2011	4	Y	1	OD	NA	NA		Scrap Steel	steel fitting	4	1	1.5	0	0	LIP
Group 8 MRS	GRP8	200	Y	2/7/2012	24	Y	1	OD	NA	NA	N	Cable		24	1	5	0	0	LIP
Group 8 MRS	GRP8	201	Y	12/21/2011	6	Y	1	OD	NA	NA		Scrap Metal	1/2" 18x12 aluminum plate	6	1	15	0	0	LIP
Group 8 MRS	GRP8	201	Y	12/21/2011	6	Y	2	OD	NA	NA		Scrap Steel	1/8 steel plate	6	1	5	0	0	LIP
Group 8 MRS	GRP8	203	Y	12/16/2011	2	Y	1	OD	NA	NA		Scrap Steel		2	1	1	0	0	LIP
Group 8 MRS	GRP8	214	Y	12/16/2011	3	Y	1	OD	NA	NA		Bolt		3	1	1	0	0	LIP
Group 8 MRS	GRP8	238	Y	12/20/2011	12	Y	3	OD	NA	NA		Scrap Steel	trash pit. plus slag	12	3	25	0	0	LIP
Group 8 MRS	GRP8	238	Y	12/20/2011	12	Y	1	OD	NA	NA		Can	ammo can lid	6	1	1.5	0	0	Scrap Bin
Group 8 MRS	GRP8	238	Y	12/20/2011	12	Y	2	MD	NA	Other		Assorted MD Components	cartridge flash tube	6	1	0.5	0	0	Scrap Bin
Group 8 MRS	GRP8	243	Y	12/16/2011	2	Y	1	OD	NA	NA		Scrap Steel		2	1	2	0	0	LIP
Group 8 MRS	GRP8	246	Y	12/21/2011	24	Y	1	OD	NA	NA		Fence Post		24	1	10	0	0	LIP
Group 8 MRS	GRP8	252	Y	12/21/2011	24	Y	1	OD	NA	NA		Trash Pit		24	1	50	0	0	LIP
Group 8 MRS	GRP8	257	Y	12/21/2011	1	Y	1	OD	NA	NA		Nails		1	10	0.1	0	0	LIP
Group 8 MRS	GRP8	264	N																
Group 8 MRS	GRP8	280	Y	12/20/2011	12	Y	2	OD	NA	NA		Scrap Steel	8" x 1" spring found on surface	0	1	1.5	0	0	LIP
Group 8 MRS	GRP8	280	Y	12/20/2011	12	Y	3	OD	NA	NA		Scrap Steel	various hardware, slag	12	10	3	0	0	LIP
Group 8 MRS	GRP8	280	Y	12/20/2011	12	Y	1	MD	NA	F		small arms, 50cal	.50 cartridge	6	1	0.5	0	0	Scrap Bin
Group 8 MRS	GRP8	286	Y	12/16/2011	1	Y	1	OD	NA	NA		Scrap Steel	1/4 steel plate	1	1	15	0	0	LIP
Group 8 MRS	GRP8	304	Y	12/21/2011	12	Y	1	OD	NA	NA		Fence Post		12	1	10	0	0	LIP
Group 8 MRS	GRP8	317	Y	12/16/2011	1	Y	1	OD	NA	NA		Scrap Steel	steel spike	1	1	1.5	0	0	LIP
Group 8 MRS	GRP8	331	Y	2/8/2012	2	Y	1	OD	NA	NA	N	Bolt		2	1	5	0	0	LIP
Group 8 MRS	GRP8	340	Y	12/20/2011	12	Y	1	OD	NA	NA		Scrap Metal	slag spread over a over a one meter area	12	1	20	0	0	LIP
Group 8 MRS	GRP8	359	Y	2/8/2012	2	Y	1	OD	NA	NA	N	Pipe	t junction for pipe	2	1	3	0	0	LIP
Group 8 MRS	GRP8	367	Y	2/7/2012	6	Y	2	OD	NA	NA	N	Scrap Metal	slag	6	10	10	0	0	LIP
Group 8 MRS	GRP8	367	Y	2/7/2012	6	Y	1	MD	NA	F	N	Assorted MD Components	mortar safety rings	6	5	5	0	0	Scrap Bin
Group 8 MRS	GRP8	369	Y	2/8/2012	2	Y	1	OD	NA	NA	N	Scrap Metal	aluminum and scrap metal	2	3	2	0	0	LIP
Group 8 MRS	GRP8	370	Y	2/8/2012	1	Y	1	OD	NA	NA	N	Spool of Barbed Wire		1	1	2	0	0	LIP
Group 8 MRS	GRP8	382	Y	12/21/2011	3	Y	1	MD	NA	F		Assorted MD Components	steel safety clip/ positive block	3	1	0.5	0	0	Scrap Bin
Group 8 MRS	GRP8	393	Y	2/8/2012	3	Y	1	OD	NA	NA	N	Fence Material	3 fence posts	3	3	60	0	0	LIP
Group 8 MRS	GRP8	397	Y	2/8/2012	2	Y	1	OD	NA	NA	N	Scrap Metal		2	1	2	0	0	LIP
Group 8 MRS	GRP8	412	Y	12/16/2011	4	Y	1	OD	NA	NA		Scrap Steel	shear blade	4	1	10	0	0	LIP
Group 8 MRS	GRP8	413	Y	12/21/2011	3	Y	1	OD	NA	NA		Scrap Steel	steel roller and wire	3	1	4	0	0	LIP
Group 8 MRS	GRP8	416	Y	12/21/2011	6	Y	1	OD	NA	NA	N	Pipe		6	1	2	0	0	LIP
Group 8 MRS	GRP8	419	Y	2/8/2012	3	Y	1	OD	NA	NA	N	Scrap Metal		3	2	3	0	0	LIP
Group 8 MRS	GRP8	419	Y	2/8/2012	3	Y	2	OD	NA	NA	N	Other	slag mixed in with scrap metal	3	1	5	0	0	LIP
Group 8 MRS	GRP8	422	Y	12/21/2011	6	Y	1	OD	NA	NA		Scrap Metal	slag	6	5	1	0	0	LIP
Group 8 MRS	GRP8	426	Y	12/21/2011	6	Y	1	OD	NA	NA	N	Bolt		6	2	5	0	0	LIP
Group 8 MRS	GRP8	429	Y	12/16/2011	2	Y	1	OD	NA	NA		Scrap Steel	rr spike	2	1	1	0	0	LIP
Group 8 MRS	GRP8	431	Y	2/8/2012	2	Y	1	OD	NA	NA	N	Bolt		2	1	2	0	0	LIP

Table G-1
Anomaly Reacquisition and Intrusive Investigation Results for Individual Target Anomalies
Group 8 MRS
Ravenna Army Ammunition Plant

Location	Work Unit	Anomaly ID	Dig Priority	Dig Initiated Date	Total Depth Dug (in)	Item Located	Item ID	Subsurface Anomaly Type*	MEC Type**	MD Type***	Intact	Nomenclature	Item Comments	Item Depth (in)	Qty	Weight (lbs)	Orientation	Inclination	Disposition****
Group 8 MRS	GRP8	439	Y	2/8/2012	2	Y	1	OD	NA	NA	N	Nails	pit of nails	2	50	3	0	0	LIP
Group 8 MRS	GRP8	446	Y	2/8/2012	2	Y	1	OD	NA	NA	N	Pipe		2	2	5	0	0	LIP
Group 8 MRS	GRP8	449	Y	2/8/2012	5	Y	1	MD	NA	F	N	fuze, projectile, PD, M557	tbar fuze	5	1	2	0	0	Scrap Bin
Group 8 MRS	GRP8	453	Y	12/21/2011	3	Y	1	OD	NA	NA		Scrap Steel	large link of roller chain	3	1	1	0	0	LIP
Group 8 MRS	GRP8	463	Y	12/21/2011	4	Y	1	OD	NA	NA	N	Scrap Metal		4	6	10	0	0	LIP
Group 8 MRS	GRP8	464	N																
Group 8 MRS	GRP8	483	Y	12/20/2011	12	Y	1	OD	NA	NA		Scrap Steel	large hunk of rusty steel with a 2" diameter hose attached. broke into pieces during excavation	12	1	20	0	0	LIP
Group 8 MRS	GRP8	489	Y	2/7/2012	6	Y	1	OD	NA	NA	N	Scrap Metal		6	3	5	0	0	LIP
Group 8 MRS	GRP8	493	Y	2/8/2012	2	Y	1	OD	NA	NA	N	Other	slag	2	3	4	0	0	LIP
Group 8 MRS	GRP8	498	Y	2/7/2012	6	Y	2	OD	NA	NA	N	Scrap Metal		6	6	10	0	0	LIP
Group 8 MRS	GRP8	498	Y	2/7/2012	6	Y	1	MD	NA	F	N	Assorted MD Components	unknown projectile plates	6	1	5	0	0	Scrap Bin
Group 8 MRS	GRP8	501	Y	2/8/2012	3	Y	1	OD	NA	NA	N	Fence Post		3	1	25	0	0	LIP
Group 8 MRS	GRP8	503	Y	2/8/2012	1	Y	1	OD	NA	NA	N	Scrap Metal		1	1	4	0	0	LIP
Group 8 MRS	GRP8	510	Y	12/21/2011	4	Y	1	OD	NA	NA		Scrap Metal	pot metal pulley, stainless sheet.	4	3	2	0	0	LIP
Group 8 MRS	GRP8	516	Y	12/21/2011	3	Y	1	OD	NA	NA		Scrap Steel	2x3x4 steel billet	3	1	4	0	0	LIP
Group 8 MRS	GRP8	541	Y	2/7/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	4	5	0	0	LIP
Group 8 MRS	GRP8	547	Y	12/20/2011	18	Y	2	OD	NA	NA		Scrap Steel		6	1	15	0	0	LIP
Group 8 MRS	GRP8	547	Y	12/20/2011	18	Y	3	OD	NA	NA		Trash Pit	trash pit full of metal, plumbing,nails banding slag etc.	18	1	50	0	0	LIP
Group 8 MRS	GRP8	547	Y	12/20/2011	18	Y	1	MD	NA	F		projo, 20mm, AP-I, M53		1	1	0.5	0	0	Scrap Bin
Group 8 MRS	GRP8	549	Y	2/8/2012	2	Y	1	OD	NA	NA	N	Cable		2	1	0.5	0	0	LIP
Group 8 MRS	GRP8	555	Y	2/7/2012	6	Y	1	OD	NA	NA	N	Cable	grounding cable	6	1	10	0	0	LIP
Group 8 MRS	GRP8	560	Y	2/8/2012	4	Y	1	OD	NA	NA	N	Wire		4	1	1	0	0	LIP
Group 8 MRS	GRP8	561	Y	2/8/2012	6	Y	1	OD	NA	NA	Y	Rebar		6	1	15	0	0	LIP
Group 8 MRS	GRP8	564	Y	12/21/2011	6	Y	1	OD	NA	NA	N	Scrap Metal		6	4	5	0	0	LIP
Group 8 MRS	GRP8	572	Y	2/8/2012	2	Y	1	OD	NA	NA	N	Bolt		2	1	2	0	0	LIP
Group 8 MRS	GRP8	576	Y	2/8/2012	1	Y	1	OD	NA	NA	N	Wire		1	1	1	0	0	LIP
Group 8 MRS	GRP8	587	Y	2/8/2012	3	Y	1	OD	NA	NA	N	Other	multiple pieces of slag	3	5	10	0	0	LIP
Group 8 MRS	GRP8	598	Y	2/7/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	6	10	0	0	LIP
Group 8 MRS	GRP8	609	N																
Group 8 MRS	GRP8	616	Y	2/7/2012	6	Y	1	OD	NA	NA	N	Scrap Metal		6	4	5	0	0	LIP
Group 8 MRS	GRP8	621	Y	2/7/2012	1	Y	1	OD	NA	NA	N	Scrap Metal		1	1	5	0	0	LIP
Group 8 MRS	GRP8	626	Y	2/7/2012	1	Y	1	OD	NA	NA	N	Scrap Metal		1	1	2	0	0	LIP
Group 8 MRS	GRP8	627	Y	2/7/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	6	5	0	0	LIP
Group 8 MRS	GRP8	628	Y	2/7/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	5	25	0	0	LIP
Group 8 MRS	GRP8	636	N																
Group 8 MRS	GRP8	640	Y	2/8/2012	3	Y	1	OD	NA	NA	N	Other	slag road base encountered at 3 inches.	3	1	10	0	0	LIP
Group 8 MRS	GRP8	646	Y	2/7/2012	1	Y	1	OD	NA	NA	N	Bolt		1	3	5	0	0	LIP
Group 8 MRS	GRP8	648	Y	12/20/2011	24	Y	1	OD	NA	NA		Trash Pit	trash pit, mostly nails	24	1	25	0	0	LIP
Group 8 MRS	GRP8	652	Y	2/7/2012	3	Y	1	OD	NA	NA	N	Scrap Metal		3	1	5	0	0	LIP
Group 8 MRS	GRP8	656	N																
Group 8 MRS	GRP8	659	Y	2/7/2012	1	Y	1	OD	NA	NA	N	Bolt	bolts and scrap metal	1	5	40	0	0	LIP
Group 8 MRS	GRP8	679	Y	2/7/2012	1	Y	1	OD	NA	NA	N	Bolt		1	6	25	0	0	LIP
Group 8 MRS	GRP8	680	Y	2/7/2012	1	Y	1	OD	NA	NA	N	Scrap Metal		1	3	5	0	0	LIP
Group 8 MRS	GRP8	709	Y	2/7/2012	1	Y	1	OD	NA	NA	N	Bolt		1	8	25	0	0	LIP
Group 8 MRS	GRP8	710	Y	2/7/2012	1	Y	1	OD	NA	NA	N	Bolt		1	10	20	0	0	LIP
Group 8 MRS	GRP8	720	Y	2/7/2012	1	Y	1	OD	NA	NA	N	Scrap Metal		1	7	45	0	0	LIP
Group 8 MRS	GRP8	724	Y	2/7/2012	1	Y	1	OD	NA	NA	N	Scrap Metal	banding	1	1	3	0	0	LIP
Group 8 MRS	GRP8	725	Y	2/7/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	1	1	0	0	LIP
Group 8 MRS	GRP8	739	Y	12/21/2011	2	Y	1	OD	NA	NA		Wire		2	1	0.5	0	0	LIP
Group 8 MRS	GRP8	742	Y	12/21/2011	6	Y	1	OD	NA	NA		Trash Pit	trash pit w 6x 12x.5 bolts, washers nails	6	1	25	0	0	LIP
Group 8 MRS	GRP8	748	Y	2/7/2012	1	Y	1	OD	NA	NA	N	Scrap Metal	bolts and scrap metal	1	5	40	0	0	LIP
Group 8 MRS	GRP8	750	Y	12/21/2011	0	Y	1	OD	NA	NA		Fence Post	fence post on surface	0	1	10	0	0	LIP
Group 8 MRS	GRP8	757	Y	2/8/2012	0	N	1	Other	NA	NA	Y	Other	to close to national guard building. did not dig for safety reasons. reac peak was zero	0	0	0	0	0	LIP
Group 8 MRS	GRP8	772	Y	12/21/2011	0	Y	1	OD	NA	NA		Scrap Steel	8" bolt and 3 x4 sheet steel on surface	0	2	4	0	0	LIP
Group 8 MRS	GRP8	774	Y	2/7/2012	3	Y	1	OD	NA	NA	Y	Bolt		3	2	2	0	0	LIP
Group 8 MRS	GRP8	787	Y	12/21/2011	2	Y	1	OD	NA	NA		Scrap Steel	steel rod	2	1	0.2	0	0	LIP
Group 8 MRS	GRP8	798	Y	12/21/2011	6	Y	1	OD	NA	NA		Fence Post		6	1	10	0	0	LIP
Group 8 MRS	GRP8	801	Y	12/21/2011	0	Y	1	OD	NA	NA		Bolt	10" bolt on surface	0	1	2.5	0	0	LIP
Group 8 MRS	GRP8	807	Y	12/21/2011	4	Y	1	OD	NA	NA		Trash Pit	trash pit steel hardware	4	1	10	0	0	LIP
Group 8 MRS	GRP8	810	Y	12/21/2011	5	Y	1	OD	NA	NA		Scrap Metal	slag	5	4	3	0	0	LIP
Group 8 MRS	GRP8	825	Y	12/21/2011	6	Y	1	OD	NA	NA		Trash Pit	trash pit with steel hardware, bolts, nails	6	1	10	0	0	LIP
Group 8 MRS	GRP8	836	Y	12/21/2011	1	Y	1	OD	NA	NA	N	Bolt		1	1	2	0	0	LIP
Group 8 MRS	GRP8	845	Y	12/21/2011	3	Y	1	OD	NA	NA		Scrap Steel		3	1	12	0	0	LIP
Group 8 MRS	GRP8	848	Y	12/21/2011	2	Y	1	OD	NA	NA		Scrap Steel	washers and slag	2	5	2	0	0	LIP
Group 8 MRS	GRP8	857	Y	12/21/2011	0	Y	1	OD	NA	NA		Scrap Steel	steel ring on surface	0	1	0.5	0	0	LIP
Group 8 MRS	GRP8	866	Y	12/21/2011	1	Y	1	OD	NA	NA		Scrap Metal	slag	1	2	0.5	0	0	LIP

Table G-1
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Group 8 MRS
Ravenna Army Ammunition Plant

Location	Work Unit	Anomaly ID	Dig Priority	Dig Initiated Date	Total Depth Dug (in)	Item Located	Item ID	Subsurface Anomaly Type*	MEC Type**	MD Type***	Intact	Nomenclature	Item Comments	Item Depth (in)	Qty	Weight (lbs)	Orientation	Inclination	Disposition****
Group 8 MRS	GRP8	867	Y	12/21/2011	0	Y	1	OD	NA	NA		Scrap Steel	rr spike on surface	0	1	2	0	0	LIP
Group 8 MRS	GRP8	868	Y	12/21/2011	3	Y	1	OD	NA	NA		Scrap Metal	slag	3	3	2	0	0	LIP
Group 8 MRS	GRP8	871	Y	12/21/2011	12	Y	1	OD	NA	NA	N	Other	slag spread over a 3 foot area	12	5	15	0	0	LIP
Group 8 MRS	GRP8	874	Y	12/21/2011	2	Y	1	OD	NA	NA		Wire	wire and slag	2	1	0.5	0	0	LIP
Group 8 MRS	GRP8	878	Y	12/20/2011	24	Y	1	OD	NA	NA		Trash Pit	trash pit w slag	24	1	25	0	0	LIP
Group 8 MRS	GRP8	880	Y	12/21/2011	4	Y	1	OD	NA	NA		Scrap Steel	6x8x6 steel billet	4	1	25	0	0	LIP
Group 8 MRS	GRP8	883	Y	12/21/2011	1	Y	1	OD	NA	NA		Scrap Steel		1	2	1.5	0	0	LIP
Group 8 MRS	GRP8	895	Y	12/21/2011	1	Y	1	OD	NA	NA		Scrap Steel	washer	1	1	0.2	0	0	LIP
Group 8 MRS	GRP8	899	Y	12/21/2011	3	Y	1	OD	NA	NA		Scrap Steel	cast steel pig	3	1	65	0	0	LIP
Group 8 MRS	GRP8	903	Y	2/8/2012	4	Y	1	OD	NA	NA	N	Scrap Steel		3	5	5	0	0	LIP
Group 8 MRS	GRP8	903	Y	2/8/2012	4	Y	2	OD	NA	NA	N	Other	slag spread over a 3 foot area	4	10	10	0	0	LIP
Group 8 MRS	GRP8	906	Y	12/20/2011	24	Y	1	OD	NA	NA		Trash Pit	trash pit w/ slag	24	1	25	0	0	LIP
Group 8 MRS	GRP8	907	Y	12/21/2011	0	Y	1	OD	NA	NA		Scrap Steel	cast iron fence part on surface	0	1	4	0	0	LIP
Group 8 MRS	GRP8	913	Y	12/21/2011	3	Y	1	OD	NA	NA		Scrap Steel	cast iron fence part	3	1	3	0	0	LIP
Group 8 MRS	GRP8	919	Y	2/8/2012	4	Y	1	OD	NA	NA	N	Bolt		3	4	3	0	0	LIP
Group 8 MRS	GRP8	919	Y	2/8/2012	4	Y	2	OD	NA	NA	N	Other	slag spread over a 3 foot area	4	25	10	0	0	LIP
Group 8 MRS	GRP8	925	Y	2/8/2012	2	Y	1	OD	NA	NA	N	Scrap Metal		2	3	4	0	0	LIP
Group 8 MRS	GRP8	927	Y	12/20/2011	24	Y	1	OD	NA	NA		Trash Pit	trash pit w/ slag	24	1	25	0	0	LIP
Group 8 MRS	GRP8	935	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	bracket	6	4	2	0	0	LIP
Group 8 MRS	GRP8	940	Y	2/6/2012	3	Y	1	OD	NA	NA	N	Bolt		3	1	1	0	0	LIP
Group 8 MRS	GRP8	945	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	road base	6	1	1	0	0	LIP
Group 8 MRS	GRP8	951	Y	12/20/2011	24	Y	1	OD	NA	NA		Trash Pit	trash pit w / slag	24	1	25	0	0	LIP
Group 8 MRS	GRP8	952	Y	12/21/2011	2	Y	1	OD	NA	NA		Scrap Metal	slag	2	2	1	0	0	LIP
Group 8 MRS	GRP8	957	Y	12/21/2011	4	Y	1	OD	NA	NA		Scrap Steel	2x2x4 steel billet	4	1	5	0	0	LIP
Group 8 MRS	GRP8	971	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	1	1	0	0	LIP
Group 8 MRS	GRP8	987	Y	12/21/2011	3	Y	1	OD	NA	NA		Scrap Steel	4x4x1 steel billet	3	1	5	0	0	LIP
Group 8 MRS	GRP8	1003	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	1	2	0	0	LIP
Group 8 MRS	GRP8	1008	Y	12/21/2011	4	Y	1	OD	NA	NA		Scrap Metal	slag	4	5	3	0	0	LIP
Group 8 MRS	GRP8	1019	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	1	2	0	0	LIP
Group 8 MRS	GRP8	1031	Y	12/21/2011	2	Y	1	OD	NA	NA		Scrap Metal	slag	2	3	6	0	0	LIP
Group 8 MRS	GRP8	1034	Y	2/6/2012	2	Y	1	OD	NA	NA	Y	Scrap Metal		2	1	5	0	0	LIP
Group 8 MRS	GRP8	1046	Y	12/21/2011	0	Y	1	OD	NA	NA		Scrap Steel	steel bracket	0	1	1	0	0	LIP
Group 8 MRS	GRP8	1057	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	1	5	0	0	LIP
Group 8 MRS	GRP8	1058	Y	12/21/2011	0	Y	1	OD	NA	NA		Scrap Steel	2x10 steel bar on surface	0	1	3	0	0	LIP
Group 8 MRS	GRP8	1060	Y	2/6/2012	1	Y	1	OD	NA	NA	N	Scrap Metal	slag	1	1	3	0	0	LIP
Group 8 MRS	GRP8	1062	Y	12/21/2011	4	Y	1	OD	NA	NA		Scrap Steel	scrap metal	4	10	5	0	0	LIP
Group 8 MRS	GRP8	1067	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal		6	1	3	0	0	LIP
Group 8 MRS	GRP8	1073	Y	12/21/2011	3	Y	1	OD	NA	NA		Scrap Metal	slag	3	3	5	0	0	LIP
Group 8 MRS	GRP8	1087	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	1	5	0	0	LIP
Group 8 MRS	GRP8	1097	Y	2/6/2012	12	Y	1	MD	NA	Other	N	Assorted MD Components	flash tubes	12	15	5	0	0	Scrap Bin
Group 8 MRS	GRP8	1102	Y	2/8/2012	4	Y	1	OD	NA	NA	Y	Other	slag chunks found at 4 inchhes	4	2	5	0	0	LIP
Group 8 MRS	GRP8	1105	Y	12/20/2011	8	Y	1	OD	NA	NA		Other	rr tie bridge with spikes and hardware attached . additional reinforced concrete beneath.	8	1	100	0	0	LIP
Group 8 MRS	GRP8	1112	Y	12/21/2011	0	Y	1	OD	NA	NA		Fence Post	fence post on surface	0	1	10	0	0	LIP
Group 8 MRS	GRP8	1117	Y	2/6/2012	2	Y	1	MD	NA	Other	N	Assorted MD Components	flash tubes	2	1	4	0	0	Scrap Bin
Group 8 MRS	GRP8	1124	Y	12/20/2011	12	Y	1	OD	NA	NA		Other	rr tie bridge, with spkes, bolts and hardware.	12	1	100	0	0	LIP
Group 8 MRS	GRP8	1131	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	1	15	0	0	LIP
Group 8 MRS	GRP8	1132	Y	12/21/2011	1	Y	1	OD	NA	NA		Scrap Metal	slag	1	4	1	0	0	LIP
Group 8 MRS	GRP8	1133	Y	12/21/2011	4	Y	1	OD	NA	NA		Bolt		4	1	1	0	0	LIP
Group 8 MRS	GRP8	1134	Y	2/6/2012	6	Y	1	MD	NA	Other	N	Assorted MD Components	flash tubes	6	8	2	0	0	Scrap Bin
Group 8 MRS	GRP8	1148	Y	12/21/2011	24	Y	1	OD	NA	NA		Fence Material	cast iron fence parts. 30" x 12" diameter concrete plug w/ fence post cast in center.	24	6	60	0	0	LIP
Group 8 MRS	GRP8	1149	Y	2/6/2012	6	Y	1	MD	NA	Other	N	Assorted MD Components	flash tubes	6	6	2	0	0	Scrap Bin
Group 8 MRS	GRP8	1159	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	1	5	0	0	LIP
Group 8 MRS	GRP8	1161	Y	12/20/2011	24	Y	1	OD	NA	NA		Trash Pit	trash pit w slag	24	1	25	0	0	LIP
Group 8 MRS	GRP8	1165	Y	12/20/2011	12	Y	1	OD	NA	NA		Other	rr tie bridge with spikes and hardware attached .	12	1	100	0	0	LIP
Group 8 MRS	GRP8	1170	Y	12/21/2011	0	Y	1	OD	NA	NA		Scrap Metal	slag	0	1	0.5	0	0	LIP
Group 8 MRS	GRP8	1178	Y	12/20/2011	8	Y	1	MD	NA	Other		Assorted MD Components	75mm cartridge	8	1	5	0	0	Scrap Bin
Group 8 MRS	GRP8	1179	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Fence Material	fence post	6	1	3	0	0	LIP
Group 8 MRS	GRP8	1182	Y	12/21/2011	2	Y	1	OD	NA	NA		Scrap Steel	8x8x8 triangle steel lid. 12x12 steel sheet	2	2	6	0	0	LIP
Group 8 MRS	GRP8	1187	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	within 6 feet of large metal post. large washers	6	3	5	0	0	LIP
Group 8 MRS	GRP8	1189	Y	2/6/2012	1	Y	1	OD	NA	NA	N	Fence Material	fence post	1	1	3	0	0	LIP
Group 8 MRS	GRP8	1201	Y	2/6/2012	1	Y	1	OD	NA	NA	N	Fence Material	fence post	1	1	3	0	0	LIP
Group 8 MRS	GRP8	1206	Y	12/20/2011	6	Y	1	MD	NA	F		projo, 75mm, Shrapnel, MK I		6	1	8	0	0	Scrap Bin
Group 8 MRS	GRP8	1207	Y	2/6/2012	6	Y	2	OD	NA	NA	N	Scrap Metal		6	4	20	0	0	LIP
Group 8 MRS	GRP8	1207	Y	2/6/2012	6	Y	1	MD	NA	Other	N	Assorted MD Components	flash tube	6	2	1	0	0	Scrap Bin

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Group 8 MRS
Ravenna Army Ammunition Plant

Location	Work Unit	Anomaly ID	Dig Priority	Dig Initiated Date	Total Depth Dug (in)	Item Located	Item ID	Subsurface Anomaly Type*	MEC Type**	MD Type***	Intact	Nomenclature	Item Comments	Item Depth (in)	Qty	Weight (lbs)	Orientation	Inclination	Disposition****
Group 8 MRS	GRP8	1207	Y	2/6/2012	6	Y	3	MD	NA	F	N	fuze, projectile, PD, M557	t-bar parts	6	10	5	0	0	Scrap Bin
Group 8 MRS	GRP8	1210	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Wire	3 feet from fence post and wire	6	1	5	0	0	LIP
Group 8 MRS	GRP8	1213	Y	12/21/2011	3	Y	1	MD	NA	Other		Assorted MD Components	shipping /lifting plug fo projectile	3	1	3	0	0	Scrap Bin
Group 8 MRS	GRP8	1219	Y	12/21/2011	3	Y	1	OD	NA	NA		Scrap Metal	slag	3	5	2	0	0	LIP
Group 8 MRS	GRP8	1220	Y	12/21/2011	1	Y	1	OD	NA	NA		Scrap Metal	slag	1	4	1	0	0	LIP
Group 8 MRS	GRP8	1222	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Fence Material	fence post	6	2	10	0	0	LIP
Group 8 MRS	GRP8	1230	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	1	5	0	0	LIP
Group 8 MRS	GRP8	1233	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	lids	6	5	5	0	0	LIP
Group 8 MRS	GRP8	1236	Y	2/6/2012	1	Y	1	OD	NA	NA	N	Wire		1	1	1	0	0	Scrap Bin
Group 8 MRS	GRP8	1240	Y	12/21/2011	3	Y	1	OD	NA	NA		Scrap Metal	slag	3	1	3	0	0	LIP
Group 8 MRS	GRP8	1244	Y	12/21/2011	1	Y	1	OD	NA	NA		Scrap Steel	washer and slag	1	3	1	0	0	LIP
Group 8 MRS	GRP8	1247	Y	2/6/2012	2	Y	1	OD	NA	NA	N	Miscellaneous OD	spark plug	2	1	0.5	0	0	Scrap Bin
Group 8 MRS	GRP8	1249	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	5	5	0	0	LIP
Group 8 MRS	GRP8	1256	Y	12/21/2011	8	Y	1	OD	NA	NA		Other	chunk of reinforced concrete	8	1	30	0	0	LIP
Group 8 MRS	GRP8	1258	Y	12/21/2011	1	Y	1	OD	NA	NA		Scrap Metal	slag	1	2	0.5	0	0	LIP
Group 8 MRS	GRP8	1266	Y	2/6/2012	12	Y	1	OD	NA	NA	N	Scrap Metal	pit of washers	12	1000	20	0	0	LIP
Group 8 MRS	GRP8	1267	Y	12/21/2011	2	Y	1	OD	NA	NA		Scrap Metal	slag	2	3	3	0	0	LIP
Group 8 MRS	GRP8	1270	Y	12/21/2011	0	Y	1	OD	NA	NA		Scrap Steel	scrap steel on surface, 1 bolt at 2" and reinforced concrete at 6"	0	1	3	0	0	LIP
Group 8 MRS	GRP8	1271	Y	2/6/2012	3	Y	1	MD	NA	F	N	Assorted MD Components	burster tube	3	1	1	0	0	Scrap Bin
Group 8 MRS	GRP8	1277	Y	12/21/2011	3	Y	1	OD	NA	NA		Scrap Metal	slag	3	2	1	0	0	LIP
Group 8 MRS	GRP8	1296	Y	12/21/2011	1	Y	1	OD	NA	NA		Scrap Metal	slag	1	1	1	0	0	LIP
Group 8 MRS	GRP8	1305	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag and lid	6	1	4	0	0	Scrap Bin
Group 8 MRS	GRP8	1307	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	lids	6	8	10	0	0	Scrap Bin
Group 8 MRS	GRP8	1324	Y	12/21/2011	6	Y	1	OD	NA	NA		Scrap Metal	slag	6	5	1	0	0	LIP
Group 8 MRS	GRP8	1329	Y	12/21/2011	6	Y	1	OD	NA	NA		Scrap Steel	leaf spring	6	1	12	0	0	LIP
Group 8 MRS	GRP8	1331	Y	12/21/2011	1	Y	1	OD	NA	NA		Scrap Steel		1	1	1	0	0	LIP
Group 8 MRS	GRP8	1344	Y	12/21/2011	1	Y	1	OD	NA	NA		Pipe	pipe end cap	1	1	0.5	0	0	LIP
Group 8 MRS	GRP8	1348	Y	2/8/2012	3	Y	1	OD	NA	NA	N	Scrap Metal		3	8	25	0	0	LIP
Group 8 MRS	GRP8	1349	Y	12/21/2011	4	Y	1	OD	NA	NA		Scrap Steel	scrap metal from nearby power transformer tower	4	4	2	0	0	LIP
Group 8 MRS	GRP8	1351	Y	12/21/2011	3	Y	1	OD	NA	NA		Wire	double conductor cable and slag	3	1	2	0	0	LIP
Group 8 MRS	GRP8	1354	Y	2/6/2012	1	Y	1	OD	NA	NA	N	Scrap Metal	banding	1	1	2	0	0	Scrap Bin
Group 8 MRS	GRP8	1356	Y	12/21/2011	4	Y	1	OD	NA	NA		Bolt	bolt, nail, slag	4	1	0.25	0	0	LIP
Group 8 MRS	GRP8	1370	Y	12/21/2011	3	Y	1	OD	NA	NA		Bolt		3	1	2	0	0	LIP
Group 8 MRS	GRP8	1373	Y	2/6/2012	2	Y	1	OD	NA	NA	N	Scrap Metal	lids and banding	2	5	10	0	0	LIP
Group 8 MRS	GRP8	1378	Y	2/6/2012	1	Y	1	OD	NA	NA	N	Scrap Metal		1	5	3	0	0	Scrap Bin
Group 8 MRS	GRP8	1383	Y	2/6/2012	1	Y	1	OD	NA	NA	N	Scrap Metal		1	1	5	0	0	Scrap Bin
Group 8 MRS	GRP8	1395	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Pipe		6	1	20	0	0	LIP
Group 8 MRS	GRP8	1399	Y	12/21/2011	1	Y	1	OD	NA	NA		Bolt		1	1	0.25	0	0	LIP
Group 8 MRS	GRP8	1419	Y	12/21/2011	1	Y	1	OD	NA	NA		Bolt		1	1	1	0	0	LIP
Group 8 MRS	GRP8	1420	Y	12/22/2011	4	Y	1	OD	NA	NA		Scrap Steel	circular steel bracket with a large bolt	4	1	5	0	0	LIP
Group 8 MRS	GRP8	1432	Y	2/6/2012	12	Y	1	OD	NA	NA	N	Scrap Metal		12	3	5	0	0	Scrap Bin
Group 8 MRS	GRP8	1441	Y	12/21/2011	0	Y	1	OD	NA	NA		Bolt	nut and bolt	0	1	0.25	0	0	LIP
Group 8 MRS	GRP8	1442	Y	2/6/2012	12	Y	2	OD	NA	NA	N	Scrap Metal	pieces of scrap metal	12	20	30	0	0	Scrap Bin
Group 8 MRS	GRP8	1442	Y	2/6/2012	12	Y	1	MD	NA	F	N	Assorted MD Components	pieces of unidentified fuze components	12	15	50	0	0	Scrap Bin
Group 8 MRS	GRP8	1452	Y	12/22/2011	4	Y	1	OD	NA	NA		Bolt	3 large boots and a steel bracket	4	3	6	0	0	LIP
Group 8 MRS	GRP8	1460	Y	12/22/2011	1	Y	1	OD	NA	NA		Wire		1	1	0.1	0	0	LIP
Group 8 MRS	GRP8	1462	Y	12/22/2011	3	Y	1	OD	NA	NA		Cable	loop of 1/16" cable	3	1	0.5	0	0	LIP
Group 8 MRS	GRP8	1463	Y	2/6/2012	12	Y	1	OD	NA	NA	N	Scrap Metal		12	3	3	0	0	Scrap Bin
Group 8 MRS	GRP8	1466	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	slag	6	20	20	0	0	LIP
Group 8 MRS	GRP8	1474	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	road base	6	20	20	0	0	LIP
Group 8 MRS	GRP8	1476	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal		6	1	1	0	0	Scrap Bin
Group 8 MRS	GRP8	1483	Y	12/22/2011	3	Y	1	OD	NA	NA		Scrap Steel		3	1	0.75	0	0	LIP
Group 8 MRS	GRP8	1486	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	road base	6	5	5	0	0	LIP
Group 8 MRS	GRP8	1491	Y	12/22/2011	8	Y	1	MD	NA	Other		Trash Pit	trash pit containing 2 x 20mm cartridge steel ammo can residue reinforced concrete rubble	8	1	10	0	0	Scrap Bin
Group 8 MRS	GRP8	1509	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	road base	6	20	5	0	0	LIP
Group 8 MRS	GRP8	1513	Y	2/6/2012	4	Y	1	OD	NA	NA	N	Scrap Metal		4	1	5	0	0	Scrap Bin
Group 8 MRS	GRP8	1520	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	scrap metal and nail	6	5	5	0	0	Scrap Bin
Group 8 MRS	GRP8	1529	Y	12/22/2011	8	Y	1	MD	NA	Other		Trash Pit	trash pit containing 2 x 20mm cartridge steel ammo can residue reinforced concrete rubble	8	1	10	0	0	Scrap Bin
Group 8 MRS	GRP8	1533	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	scrap metal and nails	6	20	10	0	0	Scrap Bin
Group 8 MRS	GRP8	1541	Y	12/22/2011	8	Y	1	MD	NA	Other		Trash Pit	trash pit containing 2 x 20mm cartridge steel ammo can residue reinforced concrete rubble	8	1	10	0	0	Scrap Bin
Group 8 MRS	GRP8	1545	Y	12/22/2011	1	Y	1	OD	NA	NA		Wire		1	1	0.2	0	0	LIP

Table G-1
Anomaly Reacquisition and Intrusive Investigation Results for Individual Target Anomalies
Group 8 MRS
Ravenna Army Ammunition Plant

Location	Work Unit	Anomaly ID	Dig Priority	Dig Initiated Date	Total Depth Dug (in)	Item Located	Item ID	Subsurface Anomaly Type*	MEC Type**	MD Type***	Intact	Nomenclature	Item Comments	Item Depth (in)	Qty	Weight (lbs)	Orientation	Inclination	Disposition****
Group 8 MRS	GRP8	1550	Y	2/6/2012	3	Y	1	OD	NA	NA	N	Nails	pit of nails and bar	3	50	10	0	0	Scrap Bin
Group 8 MRS	GRP8	1554	Y	2/6/2012	12	Y	1	OD	NA	NA	N	Nails	pit of nails	12	20	5	0	0	Scrap Bin
Group 8 MRS	GRP8	1556	Y	12/22/2011	8	Y	1	MD	NA	Other		Assorted MD Components	trash pit with 2x 20mm cartridge steel ammo can residue reinforced concrete rubble	8	1	10	0	0	Scrap Bin
Group 8 MRS	GRP8	1557	Y	2/6/2012	6	Y	1	OD	NA	NA	N	Scrap Metal	small arms pieces	6	20	5	0	0	Scrap Bin
Group 8 MRS	GRP8	1588	Y	12/22/2011	6	Y	1	MD	NA	Other		Assorted MD Components	trash pit containing 1 x 20mm cartridge 5 x amo can lids	6	1	30	0	0	Scrap Bin
Group 8 MRS	GRP8	1610	Y	12/22/2011	36	Y	1	MD	NA	Other		Trash Pit	trash pit. 2 x 75mm he 4 x 20mm cartridge 15 x ammo can lids 1 x 75mm balistic windscreen	36	1	50	0	0	Scrap Bin
Group 8 MRS	GRP8	1611	Y	12/22/2011	4	Y	1	MD	NA	F		fuze, projectile, PD, M557		4	1	2	0	0	Scrap Bin
Group 8 MRS	GRP8	1636	Y	12/22/2011	4	Y	1	OD	NA	NA		Pipe	cast iron water main	4	1	200	0	0	LIP
Group 8 MRS	GRP8	1637	Y	12/22/2011	4	Y	1	OD	NA	NA		Pipe	10" steel culvert unable to remove anomaly	4	1	100	0	0	LIP
Group 8 MRS	GRP8	1640	Y	2/8/2012	8	Y	1	OD	NA	NA	Y	Other	culvert burried at 8 inches	8	1	100	0	0	LIP
Group 8 MRS	GRP8	1641	Y	12/20/2011	30	Y	1	OD	NA	NA		Pipe	10" culvert unable to remove	30	1	100	0	0	LIP
Group 8 ADD	GRP8	1642	Y	12/20/2011	30	Y	1	OD	NA	NA		Pipe	10" culvert. unable to remove	30	1	100	0	0	LIP
Group 8 ADD	GRP8	1643	Y	12/21/2011	4	Y	1	OD	NA	NA		Scrap Steel	rr spike and slag	4	1	2	0	0	LIP
Group 8 ADD	GRP8	1644	Y	12/21/2011	6	Y	1	OD	NA	NA		Scrap Steel	rr spike and slag . same anomaly as 1643	6	1	2	0	0	LIP
Group 8 ADD	GRP8	1645	Y	12/21/2011	6	Y	1	OD	NA	NA		Scrap Metal	slag	6	5	5	0	0	LIP
Group 8 ADD	GRP8	1646	Y	12/21/2011	8	Y	1	MD	NA	F		projo, 75mm, HE, M309		8	1	10	0	0	Scrap Bin
Group 8 ADD	GRP8	1647	Y	12/21/2011	1	N													
Group 8 ADD	GRP8	1648	Y	12/21/2011	2	Y	1	OD	NA	NA		Scrap Steel	steel ring	2	1	1.5	0	0	LIP
Group 8 ADD	GRP8	1649	Y	12/21/2011	3	Y	1	OD	NA	NA		Nails	pit of nails	3	12	0.5	0	0	LIP
Group 8 ADD	GRP8	1650	Y	12/21/2011	6	Y	1	OD	NA	NA		Scrap Metal	slag	6	5	2.5	0	0	LIP
Group 8 ADD	GRP8	1651	Y	12/21/2011	6	Y	1	OD	NA	NA		Other	chunks of reinforced concrete	6	3	50	0	0	LIP
Group 8 ADD	GRP8	1652	Y	12/21/2011	3	Y	1	OD	NA	NA		Other	chunks of reinforced concrete	3	3	50	0	0	LIP
Group 8 ADD	GRP8	1653	Y	12/21/2011	3	Y	1	OD	NA	NA		Other	chunks of reinforced concrete	3	3	50	0	0	LIP
Group 8 ADD	GRP8	1654	Y	12/22/2011	3	Y	1	OD	NA	NA		Cable	1/4" cable	3	1	0.75	0	0	LIP
Group 8 ADD	GRP8	1655	Y	12/22/2011	36	Y	1	OD	NA	NA		Anchor, ground		36	1	30	0	0	LIP
Group 8 ADD	GRP8	1656	Y	12/22/2011	3	Y	1	OD	NA	NA		Scrap Metal		3	3	2	0	0	LIP
Group 8 ADD	GRP8	1657	Y	12/22/2011	4	Y	1	OD	NA	NA		Bolt		4	1	0.5	0	0	LIP
Group 8 ADD	GRP8	1658	Y	12/22/2011	4	Y	1	MD	NA	Other		Assorted MD Components	shipping/lifting plug for projectile	4	1	5	0	0	Scrap Bin
Group 8 ADD	GRP8	1659	Y	12/22/2011	1	Y	1	OD	NA	NA		Wire		1	1	0.2	0	0	LIP
Group 8 ADD	GRP8	1660	Y	12/22/2011	2	Y	1	OD	NA	NA		Scrap Steel		2	1	0.3	0	0	LIP
Group 8 ADD	GRP8	1661	Y	12/22/2011	4	Y	1	OD	NA	NA		Scrap Steel	thin steel plates, wire, nails	4	3	3	0	0	LIP
Group 8 ADD	GRP8	1662	Y	12/22/2011	4	Y	1	OD	NA	NA		Scrap Steel	thin steel plates	4	3	1.5	0	0	LIP
Group 8 ADD	GRP8	1663	Y	12/20/2011	24	Y	1	OD	NA	NA		Trash Pit	trash pit	24	1	25	0	0	LIP
Group 8 ADD	GRP8	1664	Y	12/21/2011	24	Y	1	OD	NA	NA		Pipe	unable to remove anomaly. 10" steel culvert	24	1	100	0	0	LIP

Table G-1
Anomaly Reacquisition and Intrusive Investigation Results for Individual Target Anomalies
Group 8 MRS
Ravenna Army Ammunition Plant

Summary	Quantity	Estimated Weight
Munitions Debris:	82 ea	238.5 lbs
MPPEH:	0 ea	NA
Other Debris:	1810 ea	3020 lbs

Number of Anomalies Investigated: 272

Location	Work Unit	Anomaly ID	Post Excavation QC Pick	Post Excavation Response (Ch 2) ‡	Post Excavation Response Units	QC Passed	Post Excavation QC Comments	Item Length (in)	Item Diameter/Width (in)	Anomaly Comments	Agreement Dig Results To Geo
Group 8 MRS	GRP8	12	Y	0.2	mV	Y		30	1		Y
Group 8 MRS	GRP8	14	N	NA	NA	Y		10	0.1		Y
Group 8 MRS	GRP8	15	N	NA	NA	Y		0.25	0.25		Y
Group 8 MRS	GRP8	24	N	NA	NA	Y		0.25	0.25		Y
Group 8 MRS	GRP8	32	N	NA	NA	Y		72	1		Y
Group 8 MRS	GRP8	39	N	NA	NA	Y		12	6		Y
Group 8 MRS	GRP8	44	N	NA	NA						
Group 8 MRS	GRP8	54	Y	2.7	mV	Y		8	1		Y
Group 8 MRS	GRP8	55	N	NA	NA	Y		12	4		Y
Group 8 MRS	GRP8	66	N	NA	NA	Y		10	8		Y
Group 8 MRS	GRP8	84	N	NA	NA	Y		24	4		Y
Group 8 MRS	GRP8	86	Y	1.8	mV	Y		2	8		Y
Group 8 MRS	GRP8	89	N	NA	NA						
Group 8 MRS	GRP8	110	Y	1.3	mV	Y		3	1.5		Y
Group 8 MRS	GRP8	110	Y	1.3	mV	Y		1	1		Y
Group 8 MRS	GRP8	115	N	NA	NA	Y		8	1		Y
Group 8 MRS	GRP8	121	N	NA	NA	Y		36	2		Y
Group 8 MRS	GRP8	130	N	NA	NA	Y		10	1		Y
Group 8 MRS	GRP8	136	N	NA	NA	Y		10	1.5		Y
Group 8 MRS	GRP8	155	N	NA	NA	Y		3	3		Y
Group 8 MRS	GRP8	156	Y	2.4	mV	Y		36	1		Y
Group 8 MRS	GRP8	160	Y	1.9	mV	Y		0.5	0.5		Y
Group 8 MRS	GRP8	172	Y	0.7	mV	Y		24	1		Y
Group 8 MRS	GRP8	186	N	NA	NA	Y		1	1		Y
Group 8 MRS	GRP8	190	N	NA	NA	Y		6	6		Y
Group 8 MRS	GRP8	200	N	NA	NA	Y		8	1		Y
Group 8 MRS	GRP8	201	Y	0.5	mV	Y		18	12		Y
Group 8 MRS	GRP8	201	Y	0.5	mV	Y		18	3		Y
Group 8 MRS	GRP8	203	N	NA	NA	Y		8	1		Y
Group 8 MRS	GRP8	214	N	NA	NA	Y		10	0.5		Y
Group 8 MRS	GRP8	238	N	NA	NA	Y		14	6		Y
Group 8 MRS	GRP8	238	N	NA	NA	Y		12	6		Y
Group 8 MRS	GRP8	238	N	NA	NA	Y		10	0.125		Y
Group 8 MRS	GRP8	243	Y	1.2	mV	Y		8	0.5		Y
Group 8 MRS	GRP8	246	N	NA	NA	Y		72	1		Y
Group 8 MRS	GRP8	252	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	257	N	NA	NA	Y		5	0.1		Y
Group 8 MRS	GRP8	264	N	NA	NA						
Group 8 MRS	GRP8	280	N	NA	NA	Y		8	1		Y
Group 8 MRS	GRP8	280	N	NA	NA	Y		6	1		Y
Group 8 MRS	GRP8	280	N	NA	NA	Y		3	0.5		Y
Group 8 MRS	GRP8	286	N	NA	NA	Y		12	6		Y
Group 8 MRS	GRP8	304	N	NA	NA	Y		72	1		Y
Group 8 MRS	GRP8	317	N	NA	NA	Y		13	0.5		Y
Group 8 MRS	GRP8	331	N	NA	NA	Y		36	0.5		Y
Group 8 MRS	GRP8	340	Y	1.1	mV	Y		1	1		Y
Group 8 MRS	GRP8	359	N	NA	NA	Y		4	1		Y
Group 8 MRS	GRP8	367	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	367	N	NA	NA	Y		6	6		Y
Group 8 MRS	GRP8	369	N	NA	NA	Y		8	0.5		Y
Group 8 MRS	GRP8	370	N	NA	NA	Y		36	0.5		Y
Group 8 MRS	GRP8	382	N	NA	NA	Y		4	3		Y
Group 8 MRS	GRP8	393	N	NA	NA	Y		36	2		Y
Group 8 MRS	GRP8	397	Y	0.4	mV	Y		5	1		Y
Group 8 MRS	GRP8	412	N	NA	NA	Y		24	3		Y
Group 8 MRS	GRP8	413	N	NA	NA	Y		6	1.5		Y
Group 8 MRS	GRP8	416	N	NA	NA	Y		24	1		Y
Group 8 MRS	GRP8	419	N	NA	NA	Y		7	1		Y
Group 8 MRS	GRP8	419	N	NA	NA	Y		4	3		Y
Group 8 MRS	GRP8	422	N	NA	NA	Y		0.25	0.25		Y
Group 8 MRS	GRP8	426	Y	2.7	mV	Y		24	1		Y
Group 8 MRS	GRP8	429	Y	1.7	mV	Y		8	1		Y
Group 8 MRS	GRP8	431	Y	1.1	mV	Y		8	1		Y

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Anomaly Reacquisition and Intrusive Investigation Results for Individual Target Anomalies
Group 8 MRS
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Location	Work Unit	Anomaly ID	Post Excavation QC Pick	Post Excavation Response (Ch 2) ‡	Post Excavation Response Units	QC Passed	Post Excavation QC Comments	Item Length (in)	Item Diameter/Width (in)	Anomaly Comments	Agreement Dig Results To Geo
Group 8 MRS	GRP8	439	N	NA	NA	Y		4	0.2		Y
Group 8 MRS	GRP8	446	N	NA	NA	Y		6	2		Y
Group 8 MRS	GRP8	449	N	NA	NA	Y		4	3		Y
Group 8 MRS	GRP8	453	N	NA	NA	Y		4	3		Y
Group 8 MRS	GRP8	463	N	NA	NA	Y		8	2		
Group 8 MRS	GRP8	464	N	NA	NA						
Group 8 MRS	GRP8	483	N	NA	NA	Y		12	4		Y
Group 8 MRS	GRP8	489	N	NA	NA	Y		6	2		Y
Group 8 MRS	GRP8	493	N	NA	NA	Y		3	3		Y
Group 8 MRS	GRP8	498	N	NA	NA	Y		12	12		Y
Group 8 MRS	GRP8	498	N	NA	NA	Y		6	6		Y
Group 8 MRS	GRP8	501	N	NA	NA	Y		48	2		Y
Group 8 MRS	GRP8	503	N	NA	NA	Y		6	3		Y
Group 8 MRS	GRP8	510	Y	1.1	mV	Y		5	5		Y
Group 8 MRS	GRP8	516	N	NA	NA	Y		4	3		Y
Group 8 MRS	GRP8	541	N	NA	NA	Y		12	12		Y
Group 8 MRS	GRP8	547	N	NA	NA	Y		12	12		Y
Group 8 MRS	GRP8	547	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	547	N	NA	NA	Y		0.25	0.25		Y
Group 8 MRS	GRP8	549	N	NA	NA	Y		3	1		Y
Group 8 MRS	GRP8	555	N	NA	NA	Y		24	1		Y
Group 8 MRS	GRP8	560	N	NA	NA	Y		12	0.2		Y
Group 8 MRS	GRP8	561	N	NA	NA	Y		36	2		Y
Group 8 MRS	GRP8	564	Y	1.8	mV	Y		12	12		Y
Group 8 MRS	GRP8	572	N	NA	NA	Y		8	1		Y
Group 8 MRS	GRP8	576	N	NA	NA	Y		18	0.5		Y
Group 8 MRS	GRP8	587	N	NA	NA	Y		6	6		Y
Group 8 MRS	GRP8	598	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	609	N	NA	NA						
Group 8 MRS	GRP8	616	N	NA	NA	Y		12	12		Y
Group 8 MRS	GRP8	621	N	NA	NA	Y		8	3		Y
Group 8 MRS	GRP8	626	Y	2.2	mV	Y		8	1		Y
Group 8 MRS	GRP8	627	N	NA	NA	Y		6	6		Y
Group 8 MRS	GRP8	628	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	636	N	NA	NA						
Group 8 MRS	GRP8	640	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	646	Y	1.7	mV	Y		18	1		Y
Group 8 MRS	GRP8	648	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	652	Y	1.1	mV	Y		12	6		Y
Group 8 MRS	GRP8	656	N	NA	NA						
Group 8 MRS	GRP8	659	N	NA	NA	Y		36	6		Y
Group 8 MRS	GRP8	679	N	NA	NA	Y		24	1		Y
Group 8 MRS	GRP8	680	N	NA	NA	Y		6	6		Y
Group 8 MRS	GRP8	709	N	NA	NA	Y		30	3		Y
Group 8 MRS	GRP8	710	N	NA	NA	Y		24	1		Y
Group 8 MRS	GRP8	720	N	NA	NA	Y		10	10		Y
Group 8 MRS	GRP8	724	N	NA	NA	Y		8	2		Y
Group 8 MRS	GRP8	725	N	NA	NA	Y		3	3		Y
Group 8 MRS	GRP8	739	N	NA	NA	Y		18	0.1		Y
Group 8 MRS	GRP8	742	Y	1.9	mV	Y		36	36		Y
Group 8 MRS	GRP8	748	Y	0.2	mV	Y		24	6		Y
Group 8 MRS	GRP8	750	N	NA	NA	Y		72	1		Y
Group 8 MRS	GRP8	757	N	NA	NA	Y		0	0		
Group 8 MRS	GRP8	772	N	NA	NA	Y		4	3		Y
Group 8 MRS	GRP8	774	N	NA	NA	Y		5	0.5		Y
Group 8 MRS	GRP8	787	N	NA	NA	Y		6	0.1		Y
Group 8 MRS	GRP8	798	N	NA	NA	Y		72	1		Y
Group 8 MRS	GRP8	801	N	NA	NA	Y		10	0.5		Y
Group 8 MRS	GRP8	807	Y	2	mV	Y		36	36		Y
Group 8 MRS	GRP8	810	N	NA	NA	Y		1	1		Y
Group 8 MRS	GRP8	825	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	836	N	NA	NA	Y		8	1		Y
Group 8 MRS	GRP8	845	N	NA	NA	Y		12	4		Y
Group 8 MRS	GRP8	848	N	NA	NA	Y		2	2		Y
Group 8 MRS	GRP8	857	N	NA	NA	Y		8	8		Y
Group 8 MRS	GRP8	866	N	NA	NA	Y		0.25	0.25		Y

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Group 8 MRS
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Location	Work Unit	Anomaly ID	Post Excavation QC Pick	Post Excavation Response (Ch 2) ‡	Post Excavation Response Units	QC Passed	Post Excavation QC Comments	Item Length (in)	Item Diameter/Width (in)	Anomaly Comments	Agreement Dig Results To Geo
Group 8 MRS	GRP8	867	N	NA	NA	Y		8	1		Y
Group 8 MRS	GRP8	868	N	NA	NA	Y		0.75	0.75		Y
Group 8 MRS	GRP8	871	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	874	N	NA	NA	Y		14	0.1		Y
Group 8 MRS	GRP8	878	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	880	N	NA	NA	Y		8	6		Y
Group 8 MRS	GRP8	883	N	NA	NA	Y		8	3		Y
Group 8 MRS	GRP8	895	N	NA	NA	Y		3	3		Y
Group 8 MRS	GRP8	899	N	NA	NA	Y		18	6		Y
Group 8 MRS	GRP8	903	N	NA	NA	Y		8	1		Y
Group 8 MRS	GRP8	903	N	NA	NA	Y		4	4		Y
Group 8 MRS	GRP8	906	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	907	Y	0.7	mV	Y		14	3		Y
Group 8 MRS	GRP8	913	N	NA	NA	Y		14	2		Y
Group 8 MRS	GRP8	919	N	NA	NA	Y		4	1		Y
Group 8 MRS	GRP8	919	N	NA	NA	Y		6	6		Y
Group 8 MRS	GRP8	925	N	NA	NA	Y		8	1		Y
Group 8 MRS	GRP8	927	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	935	N	NA	NA	Y		3	3		Y
Group 8 MRS	GRP8	940	N	NA	NA	Y		9	0.5		Y
Group 8 MRS	GRP8	945	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	951	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	952	N	NA	NA	Y		0.5	0.5		Y
Group 8 MRS	GRP8	957	N	NA	NA	Y		4	2		Y
Group 8 MRS	GRP8	971	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	987	N	NA	NA	Y		4	4		Y
Group 8 MRS	GRP8	1003	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	1008	Y	0.3	mV	Y		0.5	0.5		Y
Group 8 MRS	GRP8	1019	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	1031	N	NA	NA	Y		4	3		Y
Group 8 MRS	GRP8	1034	Y	1.1	mV	Y		8	1		Y
Group 8 MRS	GRP8	1046	N	NA	NA	Y		5	5		Y
Group 8 MRS	GRP8	1057	Y	1	mV	Y		24	24		Y
Group 8 MRS	GRP8	1058	N	NA	NA	Y		10	3		Y
Group 8 MRS	GRP8	1060	N	NA	NA	Y		4	4		Y
Group 8 MRS	GRP8	1062	N	NA	NA	Y		3	3		
Group 8 MRS	GRP8	1067	N	NA	NA	Y		36	1		Y
Group 8 MRS	GRP8	1073	N	NA	NA	Y		3	3		Y
Group 8 MRS	GRP8	1087	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	1097	Y	2.9	mV	Y		6	1		Y
Group 8 MRS	GRP8	1102	N	NA	NA	Y		4	4		Y
Group 8 MRS	GRP8	1105	N	NA	NA	Y		96	10		Y
Group 8 MRS	GRP8	1112	N	NA	NA	Y		72	1		Y
Group 8 MRS	GRP8	1117	N	NA	NA	Y		6	0.5		Y
Group 8 MRS	GRP8	1124	N	NA	NA	Y		120	10		Y
Group 8 MRS	GRP8	1131	N	NA	NA	Y		12	16		Y
Group 8 MRS	GRP8	1132	N	NA	NA	Y		0.25	0.25		Y
Group 8 MRS	GRP8	1133	N	NA	NA	Y		8	0.5		Y
Group 8 MRS	GRP8	1134	N	NA	NA	Y		6	0.5		Y
Group 8 MRS	GRP8	1148	N	NA	NA	Y		36	3		Y
Group 8 MRS	GRP8	1149	N	NA	NA	Y		6	1		Y
Group 8 MRS	GRP8	1159	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	1161	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	1165	N	NA	NA	Y		120	10		Y
Group 8 MRS	GRP8	1170	N	NA	NA	Y		0.5	0.5		Y
Group 8 MRS	GRP8	1178	N	NA	NA	Y		13	2.5		Y
Group 8 MRS	GRP8	1179	N	NA	NA	Y		48	1		Y
Group 8 MRS	GRP8	1182	Y	2.2	mV	Y		12	12		Y
Group 8 MRS	GRP8	1187	Y	0.5	mV	Y		8	8		Y
Group 8 MRS	GRP8	1189	N	NA	NA	Y		48	1		Y
Group 8 MRS	GRP8	1201	N	NA	NA	Y		48	1		Y
Group 8 MRS	GRP8	1206	N	NA	NA	Y		14	3.5		Y
Group 8 MRS	GRP8	1207	N	NA	NA	Y		4	4		Y
Group 8 MRS	GRP8	1207	N	NA	NA	Y		6	0.5		Y

Table G-1
Anomaly Reacquisition and Intrusive Investigation Results for Individual Target Anomalies
Group 8 MRS
Ravenna Army Ammunition Plant

Location	Work Unit	Anomaly ID	Post Excavation QC Pick	Post Excavation Response (Ch 2) ‡	Post Excavation Response Units	QC Passed	Post Excavation QC Comments	Item Length (in)	Item Diameter/Width (in)	Anomaly Comments	Agreement Dig Results To Geo
Group 8 MRS	GRP8	1207	N	NA	NA	Y		3	3		Y
Group 8 MRS	GRP8	1210	N	NA	NA	Y		24	0.25		Y
Group 8 MRS	GRP8	1213	N	NA	NA	Y		5	4		Y
Group 8 MRS	GRP8	1219	Y	0.4	mV	Y		0.5	0.5		Y
Group 8 MRS	GRP8	1220	N	NA	NA	Y		0.25	0.25		Y
Group 8 MRS	GRP8	1222	N	NA	NA	Y		48	2		Y
Group 8 MRS	GRP8	1230	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	1233	N	NA	NA	Y		8	8		Y
Group 8 MRS	GRP8	1236	N	NA	NA	Y		7	0.25		Y
Group 8 MRS	GRP8	1240	N	NA	NA	Y		6	3		Y
Group 8 MRS	GRP8	1244	N	NA	NA	Y		3	3		Y
Group 8 MRS	GRP8	1247	N	NA	NA	Y		3	1		Y
Group 8 MRS	GRP8	1249	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	1256	N	NA	NA	Y		18	12		Y
Group 8 MRS	GRP8	1258	N	NA	NA	Y		0.5	0.5		Y
Group 8 MRS	GRP8	1266	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	1267	N	NA	NA	Y		1	1		Y
Group 8 MRS	GRP8	1270	N	NA	NA	Y		10	3		Y
Group 8 MRS	GRP8	1271	N	NA	NA	Y		6	0.5		Y
Group 8 MRS	GRP8	1277	N	NA	NA	Y		0.5	0.5		Y
Group 8 MRS	GRP8	1296	N	NA	NA	Y		1	1		Y
Group 8 MRS	GRP8	1305	Y	1.7	mV	Y		12	12		Y
Group 8 MRS	GRP8	1307	N	NA	NA	Y		4	4		Y
Group 8 MRS	GRP8	1324	Y	0.2	mV	Y		1	1		Y
Group 8 MRS	GRP8	1329	N	NA	NA	Y		14	3		Y
Group 8 MRS	GRP8	1331	Y	0.9	mV	Y		4	1		Y
Group 8 MRS	GRP8	1344	Y	0.5	mV	Y		1	0.75		Y
Group 8 MRS	GRP8	1348	Y	1.7	mV	Y		8	4		Y
Group 8 MRS	GRP8	1349	N	NA	NA	Y		4	4		Y
Group 8 MRS	GRP8	1351	N	NA	NA	Y		120	0.125		Y
Group 8 MRS	GRP8	1354	N	NA	NA	Y		9	1		Y
Group 8 MRS	GRP8	1356	N	NA	NA	Y		3	0.375		Y
Group 8 MRS	GRP8	1370	N	NA	NA	Y		12	1		Y
Group 8 MRS	GRP8	1373	N	NA	NA	Y		12	12		Y
Group 8 MRS	GRP8	1378	N	NA	NA	Y		12	12		Y
Group 8 MRS	GRP8	1383	N	NA	NA	Y		12	12		Y
Group 8 MRS	GRP8	1395	Y	1.9	mV	Y		48	6		Y
Group 8 MRS	GRP8	1399	N	NA	NA	Y		2	0.25		Y
Group 8 MRS	GRP8	1419	N	NA	NA	Y		24	0.5		Y
Group 8 MRS	GRP8	1420	N	NA	NA	Y		2	8		Y
Group 8 MRS	GRP8	1432	N	NA	NA	Y		12	12		Y
Group 8 MRS	GRP8	1441	N	NA	NA	Y		3	0.25		Y
Group 8 MRS	GRP8	1442	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	1442	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	1452	N	NA	NA	Y		12	0.5		Y
Group 8 MRS	GRP8	1460	N	NA	NA	Y		12	0.1		Y
Group 8 MRS	GRP8	1462	N	NA	NA	Y		12	0.125		Y
Group 8 MRS	GRP8	1463	Y	1.2	mV	Y		6	6		Y
Group 8 MRS	GRP8	1466	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	1474	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	1476	N	NA	NA	Y		2	2		Y
Group 8 MRS	GRP8	1483	N	NA	NA	Y		3	2		Y
Group 8 MRS	GRP8	1486	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	1491	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	1509	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	1513	N	NA	NA	Y		12	8		Y
Group 8 MRS	GRP8	1520	N	NA	NA	Y		6	8		Y
Group 8 MRS	GRP8	1529	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	1533	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	1541	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	1545	N	NA	NA	Y		12	0.1		Y

Table G-1
Anomaly Reacquisition and Intrusive Investigation Results for Individual Target Anomalies
Group 8 MRS
Ravenna Army Ammunition Plant

Location	Work Unit	Anomaly ID	Post Excavation QC Pick	Post Excavation Response (Ch 2) ‡	Post Excavation Response Units	QC Passed	Post Excavation QC Comments	Item Length (in)	Item Diameter/Width (in)	Anomaly Comments	Agreement Dig Results To Geo
Group 8 MRS	GRP8	1550	Y	44	mV	Y	trash pit- 36 inch by 36 inch hole unable to clear due to trash in surrounding area	24	24		Y
Group 8 MRS	GRP8	1554	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	1556	Y	200	mV	Y	metal rod could not be removed in target area	36	36		Y
Group 8 MRS	GRP8	1557	N	NA	NA	Y		24	24		Y
Group 8 MRS	GRP8	1588	N	NA	NA	Y		36	36		Y
Group 8 MRS	GRP8	1610	N	NA	NA	Y		13	3		Y
Group 8 MRS	GRP8	1611	Y	0.4	mV	Y		3	3		Y
Group 8 MRS	GRP8	1636	N	NA	NA	Y		98	8		Y
Group 8 MRS	GRP8	1637	N	NA	NA	Y		36	10		Y
Group 8 MRS	GRP8	1640	N	NA	NA	Y		36	8		Y
Group 8 MRS	GRP8	1641	N	NA	NA	Y		36	10	10" culvert unable to remove	Y
Group 8 ADD	GRP8	1642	N	NA	NA	Y		120	10	10" culvert. unable to remove .	Y
Group 8 ADD	GRP8	1643	N	NA	NA	Y		8	1		Y
Group 8 ADD	GRP8	1644	N	NA	NA	Y		8	1		Y
Group 8 ADD	GRP8	1645	N	NA	NA	Y		1	1		Y
Group 8 ADD	GRP8	1646	Y	1.4	mV	Y		13	3		Y
Group 8 ADD	GRP8	1647	N	NA	NA	Y				asphalt, unable to dig below. unable to remove anomaly.	Y
Group 8 ADD	GRP8	1648	N	NA	NA	Y		6	6		
Group 8 ADD	GRP8	1649	N	NA	NA	Y		5	0.1		
Group 8 ADD	GRP8	1650	N	NA	NA	Y		1	1		Y
Group 8 ADD	GRP8	1651	N	NA	NA	Y		12	12		Y
Group 8 ADD	GRP8	1652	N	NA	NA	Y		12	12		Y
Group 8 ADD	GRP8	1653	N	NA	NA	Y		12	12		Y
Group 8 ADD	GRP8	1654	N	NA	NA	Y		8	0.25		Y
Group 8 ADD	GRP8	1655	N	NA	NA	Y		48	0.5		Y
Group 8 ADD	GRP8	1656	N	NA	NA	Y		1	1		Y
Group 8 ADD	GRP8	1657	N	NA	NA	Y		5	0.25		Y
Group 8 ADD	GRP8	1658	N	NA	NA	Y		5	3		Y
Group 8 ADD	GRP8	1659	Y	0.4	mV	Y		12	0.1		Y
Group 8 ADD	GRP8	1660	N	NA	NA	Y		3	2		Y
Group 8 ADD	GRP8	1661	N	NA	NA	Y		8	6		Y
Group 8 ADD	GRP8	1662	N	NA	NA	Y		6	4		Y
Group 8 ADD	GRP8	1663	N	NA	NA	Y		36	36		Y
Group 8 ADD	GRP8	1664	N	NA	NA	Y		36	10	unable to remove anomaly. 10" steel culvert	Y

‡ - NA - The anomaly was NOT selected for a random hole check using the Acceptance Sampling Tables provided by the USACE
* - MD=Munitions Debris; OD=Other Debris
** NA=Not Applicable
***-F=Frag; NA=Not Applicable
****-CP=Consolidation Point; LIP=Left In Place

Coordinate system: UTM, NAD1983, Meters, Zone 17N

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Table G-2
Summary of Intrusive Investigation Results for High-Density Areas
Group 8 MRS
Ravenna Army Ammunition Plant

Summary	Quantity	Estimated Weight
Munitions Debris:	277 ea	~1180 lbs
MPPEH:	0 ea	NA
Other Debris:	1074 ea	1281 lbs

Trench Number	Other Debris		Munitions Debris		MPPEH	
	Quantity	Weight (lbs)	Quantity	Weight (lbs)	Quantity	Weight (lbs)
01-1	50	50	0	0	0	0
02-1	200	400	0	0	0	0
03-1	15	25	24	15	0	0
04-1	100	25	2	8	0	0
05-1	19	50	0	0	0	0
06-1	10	15	13	19	0	0
07-1	50	50	1	1	0	0
08-1	532	65	0	0	0	0
09-1	25	50	11	30	0	0
10-1	41	100	1	1	0	0
11-1	0	0	75	1,054.25	0	0
12-1	30	100	0	0	0	0
13-1	1	50	1	2	0	0
14-1	0	0	150	50	0	0
Total:	**1,073**	**980**	**278**	**1,180**	**0**	**0**

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Table G-3
Anomaly Reacquisition and Intrusive Investigation Results for High-Density Areas
Group 8 MRS
Ravenna Army Ammunition Plant

Location	Trench Number	Date	Item ID	Total Depth Dug	Depth of Result Type	Quantity (each)	Weight (lbs)	Result Type*	Description	Comments	Disposition**	Condition
Group 8 MRS	01-1	12/15/2011	1-1	48	48	50	350	OD	Scrap Steel	parts from a tracked vehicle, including idler wheels, bearings, springs, and hydraulic motors, actuators and valves. No MD encountered .	LIP	Inert
Group 8 MRS	02-1	12/15/2011	1-1	48	12	200	400	OD	Scrap Steel	scrap metal encountered from 0"-12". Dump of a large variety of items including fencing materials, wheels, actuators, bearings, steel rods, various hardware, various plumbing items and metal	LIP	Inert
Group 8 MRS	03-1	12/15/2011	2-1	48	12	15	25	OD	Scrap Steel	scrap steel found from 0" to 12". Steel rods, washers, and	LIP	Inert
Group 8 MRS	03-1	12/15/2011	1-1	48	48	24	15	MD	Assorted MD Components	unidentified baseplates located from 1" to 12". trench dug to 48	Scrap Bin	Expended
Group 8 MRS	04-1	12/15/2011	1-2	48	24	100	25	OD	Scrap Steel	washers, wingnuts, and steel rods found from 0" to 24". trench	LIP	Inert
Group 8 MRS	04-1	12/15/2011	2-1	12	12	2	8	MD	Assorted MD Components	2 x lifting eyes /shipping plugs for projectiles found at 12".	Scrap Bin	Expended
Group 8 MRS	05-1	12/15/2011	2-1	12	12	15	25	OD	Scrap Steel	various scrap metal encountered from 0" to 12".	LIP	Inert
Group 8 MRS	05-1	12/15/2011	2-2	12	12	4	25	OD	Scrap Metal	large slag found at 12"	LIP	Inert
Group 8 MRS	06-1	12/16/2011	2-1	48	12	10	15	OD	Scrap Steel	scrap metal encountered from 0 to 12 inches. trench dug to 48	LIP	Inert
Group 8 MRS	06-1	12/16/2011	1-1	48	12	5	5	MD	Assorted MD Components	screw in tracer element	Scrap Bin	Expended
Group 8 MRS	06-1	12/16/2011	1-2	48	12	5	5	MD	Assorted MD Components	extended tracer element	Scrap Bin	Expended
Group 8 MRS	06-1	12/16/2011	1-3	48	12	3	9	MD	Assorted MD Components	lifting eyes/ shipping plugs for projectiles	Scrap Bin	Expended
Group 8 MRS	07-1	12/15/2011	2-1	48	12	50	50	OD	Scrap Steel	scrap metal found from 0" to 12".	LIP	Inert
Group 8 MRS	07-1	12/15/2011	1-1	48	6	1	1	MD	Cartridge, 40mm, HE, M397	1/2 of a 40mm cartridge. inert	Scrap Bin	Expended
Group 8 MRS	08-1	12/16/2011	2-1	48	24	500	25	OD	Nails	pit of nails found from 1" to 24".	LIP	Inert
Group 8 MRS	08-1	12/16/2011	3-1	48	36	1	10	OD	Pipe		LIP	Inert
Group 8 MRS	08-1	12/16/2011	4-1	48	12	1	5	OD	Scrap Metal	aluminum sign	LIP	Inert
Group 8 MRS	08-1	12/16/2011	5-1	48	36	30	25	OD	Scrap Steel	scrap metal encountered from 0 to 36 inches. trench dug to 48	LIP	Inert
Group 8 MRS	09-1	12/16/2011	2-1	12	12	25	50	OD	Scrap Steel	scrap metal encountered from 0 to 12 inches.	LIP	Inert
Group 8 MRS	09-1	12/16/2011	1-4	12	12	1	1	MD	Assorted MD Components	flash tube	Scrap Bin	Expended
Group 8 MRS	09-1	12/16/2011	1-5	12	12	1	1.5	MD	Assorted MD Components	fuze adapter	Scrap Bin	Expended
Group 8 MRS	09-1	12/16/2011	1-6	12	12	1	1.5	MD	Fuze, projectile, MT, M43 series		Scrap Bin	Expended
Group 8 MRS	09-1	12/16/2011	1-3	12	12	1	2	MD	Assorted MD Components	unidentified HEAT warhead. inert filled	Scrap Bin	Expended
Group 8 MRS	09-1	12/16/2011	1-2	12	12	1	4	MD	Assorted MD Components	lifting eye, shipping plug for projectile	Scrap Bin	Expended
Group 8 MRS	09-1	12/16/2011	1-1	12	12	6	20	MD	projo, 60mm, mortar, HE, M49 series		Scrap Bin	Expended
Group 8 MRS	10-1	12/16/2011	2-1	12	12	40	80	OD	Scrap Steel	rr spikes	LIP	Inert
Group 8 MRS	10-1	12/16/2011	2-2	12	12	1	20	OD	Scrap Steel	scrap metal encountered from 0 to 12 inches	LIP	Inert
Group 8 MRS	10-1	12/16/2011	1-1	12	12	1	1	MD	Fuze, projectile, PTTF, M84 series		Scrap Bin	Expended
Group 8 MRS	11-1	12/16/2011	1-1	48	48	70	1050	MD	projo, 75mm, AP-T, M72		Scrap Bin	Expended
Group 8 MRS	11-1	12/16/2011	1-2	48	18	3	2	MD	Assorted MD Components	flash tubes for projectile cartridges.	Scrap Bin	Expended
Group 8 MRS	11-1	12/16/2011	1-3	48	18	1	2	MD	Fuze, projo, prox., M532	vt fuze	Scrap Bin	Expended
Group 8 MRS	11-1	12/16/2011	1-4	48	6	1	0.25	MD	Cartridge case, 40mm		Scrap Bin	Expended
Group 8 MRS	12-1	12/16/2011	1-1	48	12	30	100	OD	Scrap Metal	fence parts, pipe and scrap found from 0 to 12 inches. trench dug to 48 inches	LIP	Inert
Group 8 MRS	13-1	12/16/2011	2-1	48	12	1	50	OD	Scrap Steel	scrap metal encountered from 0 to 12 inches . trench dug to 48 inches .	LIP	Inert
Group 8 MRS	13-1	12/16/2011	1-1	48	12	1	2	MD	Fuze, projectile, PD, M557		Scrap Bin	Expended
Group 8 MRS	14-1	12/15/2011	1-1	48	4	150	50	MD	Assorted MD Components	shipping clips and washers from 0 to 4 inches. trench dug to 48 inches. No additional MD encountered	Scrap Bin	Expended

* MD=Munitions Debris; OD=Other Debris
**CP=Consolidation Point; LIP=Left In Place

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Appendix H
Statistical Analysis of Intrusive Findings at the Group 8 MRS

Statistical Analysis of Intrusive Findings at the Group 8 MRS

It is challenging to predict the occurrence of munitions and explosives of concern (MEC) in a population of anomalies when only a portion of the anomalies are investigated and no MEC are identified in the sample population. In order to meet this challenge, a Bayesian statistical approach is warranted instead of a classical statistical approach. The Bayesian approach is applicable, as it uses the information from the sampled anomaly population in conjunction with previous knowledge regarding the occurrence of MEC to predict the occurrence of MEC in the unsampled population of anomalies. For the investigation at the Group 8 Munitions Response Site (MRS), an assumption was made that the percentage of MEC items is between 1 and 0.1 percent (i.e., between 1 in 100 and 1 in 1,000 anomalies are MEC).

The Bayesian approach is a valid method to predict the occurrence of MEC for the anomalies that were not investigated at the Group 8 MRS during the intrusive investigation activities. In total, 1,641 individual target anomalies were identified using digital geophysical mapping. Using the hypergeometrics statistics module, 248 of these were anomalies originally randomly selected for intrusive investigation. An additional 24 anomalies were biased based on recommendations provided by the Ohio Environmental Protection Agency and were recommended for intrusive investigation as well. In all, a total of 272 individual target anomalies were originally proposed for intrusive investigation; however, only 264 individual target anomalies were successfully reaquired as is discussed in the Remedial Investigation Report.

For comparative purposes, the mean value of the MEC among the 264 individual target anomalies reacquired was estimated to be 1 percent, 2.5 percent, 4 percent, or 50 percent before any intrusive information was acquired. The assumption that 2.5 percent, 4 percent, or 50 percent of the anomalies at the MRS are MEC is intended to provide information that errs on the side of conservatism. **Table H-1** presents a summary of the Bayesian approach and estimations used to predict the probability of MEC at unsampled anomalies at the Group 8 MRS.

If the mean MEC population at the MRS is estimated to be 1 percent, 2.5 percent, and 4 percent, then the predicted probability that there is no MEC in the remaining 1,377 samples using the actual intrusive results is 99, 95, and 92 percent, respectively. In the case where the mean MEC population is estimated to be 50 percent, there is only a 15 percent prediction probability that there is no MEC in the remaining 1,377 anomalies based on the intrusive results. In this scenario, 1,555 of the 1,641 anomalies would need to be sampled to obtain a prediction probability of 95 percent that there is no MEC in the remaining 94 samples. Based on the results of the intrusive investigation as well as previous investigations, a priori that MEC was at 1 percent or less was assumed.

After observing the initial *m* sample anomalies and counting the number of anomalies, *y*, that are MEC, the Bayesian estimator of the mean proportion, $\hat{p}_B$,of MEC is as follows:

$$\hat{p}_B = \left(\frac{m}{\alpha+\beta+m}\right)\left(\frac{y}{m}\right) + \left(\frac{\alpha+\beta}{\alpha+\beta+m}\right)\left(\frac{\alpha}{\alpha+\beta}\right)$$

This estimator is a weighted linear combination of the sample proportion, *y/m*, and the *a priori* beta distribution mean of $\alpha/(\alpha+\beta)$. Thus, the Bayesian estimator can never be zero even when *y/m* is zero. Note however, that as *m* gets larger, the estimated proportion approaches *y/m*.

Once the proportion is estimated in the Bayesian framework, the predictive distribution for the count of MEC in the unsampled anomalies is readily obtained and follows a beta-binomial distribution. This distribution can be used to predict the count of MEC in the remaining unsampled anomalies. Assuming *a priori* that MEC was at 1 percent or less, no MEC items are anticipated in the remainder of samples.

Table H-1
Probabilities of Remaining MEC for Unsampled Anomalies

Estimated Mean Population of MEC	Probability that there is no MEC in Remaining 1,377 Unsampled Anomalies	95th Percentile of Prediction Distribution for Count of MEC in Remaining 1,377 Unsampled Anomalies	99th Percentile of Prediction Distribution for Count of MEC in Remaining 1,377 Unsampled Anomalies
1%	0.99	0	0
2.5 %	0.95	0	3
4%	0.92	1	4
50%	0.15	17	25

MEC denotes munitions and explosives of concern.

References:

Casella, George and R. Berger, 1990. *Statistical Inference*, Wadsworth & Brooks, New York, New York.

Lee, Peter M., 1989. *Bayesian Statistics*, Oxford University Press, New York, New York.

Wright, Tommy, 1992. *A Note on Sampling to Locate Rare Defectives with Strong Prior Evidence*, Biometrika 79, 4, pp. 685–91.

Appendix I
Waste Shipment and Disposal Records for Munitions Debris

Phone: 812 275-6883
Fax: 812 277-3527

Bedford Recycling

904 Summit Lane
Bedford, IN 47421

Customer No: 4265
Customer: DEMIL METALS
Address: PO BOX 126
GLENCOE, IL 60022

Ticket Date: Jun 05, 2012
Ticket No: 512092
Weight: 3,763
Total: $0.00

Start Dt 06/05/12 04:22 PM **End Dt** 06/05/12 04:33 PM

Driver:
Truck No:
Vehicle Info:

Scalemaster: RSAUNDERS

Description: Old Dominion Freight
Container In:
Container Out:

Notes: 7 drums range residue on 3 skids
RAVENNA ARMY AMMO PLANT

Commercial Ticket - Number: 512092

Commodity	Gross	Tare	Tare2	Deduct	Net	UM	Price	Total
Sheet Iron	3,763				3,763	P		.00
	3,763				3,763			.00

Driver Signature________________________________

DEMIL METALS, Inc – INERT / DEMILITARIZATION / CHAIN OF CUSTODY CERTIFICATION FOR NON-HAZARDOUS AEDA / RANGE RESIDUE SCRAP

Load No. RVAAP-002

GENERAL

1. Releasing Generators (RG) Name and Mailing Address	1a. RG's Phone No.	2. RG's Site Manager
Robert Harrison-SUXOS-Ravenna AAP, 8451 State Rte 5, Ravenna, OH 44266	253-486-2687	Robert Harrison

3. Releasing Generators (RG) Project Name and Location	3a. RG's Project Phone No.	4. RG's SUXOS
RVAAP/SHAW, OH Project#136147	330-358-0058	Robert Harrison

5. Transporter Name and Mailing Address	5a. Transporter Phone No.	6. Dispatcher's Name
Old Dominion Freight Line, Inc. 500 Old Dominion Way Thomasville, NC 27360	(800) 432 6335	

RELEASING GENERATOR

7. Processor / Recycler / Demilitarization – Qualified Recycler (QR)	7a. QR Phone	8. QRQC's Manager
Demil Metals, Inc., PO BOX 126 Glencoe, IL 60022		

9. Box No.	10. Seal No.'s	11. Gross Weight	12. Tare Weight	13. Net Weight
55 Gallon Drums: 11, 12, 13, 14, 15, 16, 17	2864631, 2864633, 2864634, 2864635, 2864636, 2864637, 2864640			

14. Description	15. Material Type	16. Units (Wt. Volume)
Munitions Debris (MD), Material Documented As Safe (MDAS)	Steel	(7ea) 55 Gallon Drums

Inert Certification: **"I CERTIFY AND VERIFY THAT THE AEDA RESIDUE, RANGE RESIDUE, AND/OR EXPLOSIVE CONTAMINATED PROPERTY LISTED HAS BEEN 100 PERCENT INSPECTED BY ME AND TO THE BEST OF MY KNOWLEDGE AND BELIEF, ARE INERT AND/OR FREE OF EXPLOSIVES OR OTHER DANGEROUS MATERIALS."**

17. Inspector / Certifier Project UXO/QC

Print/Type Name	Signature	Month/Day/Year
Braden M. Livingstone: Shaw Environmental, Inc., UXOQCS	[signature]	5 / 11 / 2012

18. Inspector / Certifier Site Senior UXO Supervisor (SUXOS)

Print/Type Name	Signature	Month/Day/Year
Robert F. Harrison: Shaw Environmental, Inc., SUXOS	[signature]	5 / 11 / 2012

19. Material Released to the Transporter By RG's Site Manager

Print/Type Name	Signature	Month/Day/Year
R Harrison	[signature]	5 / 11 / 2012

TRANSPORTER

20. Transporter: I ACKNOWLEDGE THE RECEIPT OF MATERIAL (Receiving Signature Verifies that Seals are Intact)

Print/Type Name	Signature	Month/Day/Year
Phillip FRENCH	Phil French	5 / 11 / 2012

21. Material Released to QR By Transporter

Print/Type Name	Signature	Month/Day/Year
		/ /

RECEIVING PROCESSOR - RECYCLER

22. QR Storage Manager: I ACKNOWLEDGE THE RECEIPT OF MATERIAL (Receiving Signature Verifies that Seals are Intact)

Print/Type Name	Signature	Month/Day/Year
TRISH LEWIS	[signature]	5 / 16 / 12

23. Material Released to new QR (if needed)

Print/Type Name	Signature	Month/Day/Year
		/ /

24. Current QR: I ACKNOWLEDGE THE RECEIPT OF MATERIAL

Print/Type Name	Signature	Month/Day/Year
		/ /

Demilitarization / Destruction Certification: **"I CERTIFY THAT EACH ITEM OR ITEMS LISTED HEREON WERE DEMILITARIZED / DESTROYED, SO AS TO NO LONGER RESEMBLE AEDA / ORDNANCE, BEYOND THE REQUIREMENTS LISTED IN DOD 4160.21-M-1."**

25. Qualified Recycling (QR) Manager

Print/Type Name	Signature	Month/Day/Year
LARRY PARSONS	[signature]	6 / 8 / 12

26. List Discrepancies Indication Here

Demil Metals FORM COC20080209

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

PREVIOUS EDITION MAY BE USED

1. TOTAL PRICE	
2. SHIP FROM	Ravenna APP 8451 state Rte 5 Bldg 1038 Ravenna OH 44266 330-358-0058
3. SHIP TO	Demil Metals Inc. P.O.Box 126 Glencoe, IL 60022
4. MARK FOR	
5. DOC DATE	5/11/2012
6. NMFC	
7. FRT RATE	
8. TYPE CARGO	
9. PS	
10. QTY. REC'D	
11. UP	
12. UNIT WEIGHT	
13. UNIT CUBE	
14. UFC	
15. SL	
16. FREIGHT CLASSIFICATION NOMENCLATURE	Munitions debris - Steel
17. ITEM NOMENCLATURE	Material Documented As Safe (MDAS) Munitions debris (MD)
18. TY CONT	
19. NO CONT	7
20. TOTAL WEIGHT	Approx: 4900 lbs
21. TOTAL CUBE	
22. RECEIVED BY	
23. DATE RECEIVED	

1 2 3 4 5 6 7 23 24 25 26 27 28 29 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

DOC IDENT | RI FROM | M & S | UNIT | UI S S | QUANTITY | SER | SUPPLEMENTARY ADDRESS | SIG | FUND | DISTRIBUTION | PROJECT | PRI | REQD | DEL DATE | ADV | RI | O/P | COND | MGT | UNIT PRICE DOLLARS CTS | DOLLARS | CTS

24. DOCUMENT NUMBER & SUFFIX (30-44)

From: Shaw environmental Inc.
Ravenna AAP
8451 state rte 5
BLDG 1038
Ravenna OH 44266
330-358-0058

Document # RVAAP-002

25. NATIONAL STOCK NO. & ADD (8-22)

CONTAINER SEAL NUMBERS:

Drum11 - 2864631	Drum15 - 2864633
Drum12 - 2864634	Drum16 - 2864635
Drum13 - 2864636	Drum17 - 2864640
Drum14 - 2864632	

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

"THIS CERTIFIES THAT THE MATERIAL LISTED HAS BEEN 100 PER CENT INSPECTED AND TO THE BEST OF OUR KNOWLEDGE AND BELIEF, IS FREE OF EXPLOSIVES HAZARDS, ENGINE FLUIDS, ILLUMINATING DIALS, AND OTHER VISIBLE LIQUID HAZARDOUS, TOXIC AND RADIOACTIVE WASTE MATERIALS."

Rec'd @ Bedford Heights for the account of

27. ADDITIONAL DATA

Robert F. Harrison
SUXOS
SHAW E & I
253-486-2687
Date: 5/11/2012

DEMIL METALS, INC
P.O. BOX 126
GLENCOE, IL 60022

5/16/12

Braden M. Livingstone
UXOQCS
SHAW E and I
OFFICE # 330-358-0058
Date: 5/11/2012

Adobe Designer 7.0

2

OLD DOMINION FREIGHT LINE, INC. (ODFL)
PO BOX 198475, - ATLANTA, GA 30384-8475 USA
(336) 889 5000 Visit us at WWW.ODFL.COM

CUSTOMER COPY

Dest Term	Orig Term	Shipper's B/L Number	Purchase Order No	Type	Copy
LOU	YNG	NS	NS		

D Car Cd	O Car Rev	ODFL Rev	O Car W/B No	Bill to Cd	Trl No	W/B Date	Waybill Number
					531234	5/11/12	7772939840

BEDFORD RECYCLING WAREHOUSE
904 SUMMIT AND H ST
BEDFORD IN 47421

Dest I/L Car

RAVENNA ARMY AMMO PLANT
8451 STATE RT 5 /GUARD SHACK
RAVENNA OH 44266

Page No 1

P/C P

B/C DRI

Waybill Number 77729398402

Pieces	HM	Description	Class	Weight	Rate	Prepaid	Collect
		HANDLING UNITS: 7 OF TYPE DRUM					
		DELIVERY: SECURED OR LIMITED ACCESS					
		HYDRAULIC LIFTGATE SERVICE-DELIVERY					
		Reference# 20631195					
7		RESIDUE	055	7290			
		FUEL INCREASE					
		WIW					
		ODFL LOU PHONE (502)-772-0124					
		ODFL LOU TOLL-FREE (800)-433-6335					

C.O.D.

CONTD.

RECEIVED IN GOOD CONDITION EXCEPT AS NOTED

By:

Company:

Date:

Driver:

Total Prepaid | Total Collect

CASH ☐ CHK ☐ CHG ☐

☐ Inside Delivery ☐ Residential Delivery ☐ Lift Gate ☐ Other

Pcs. Del'd

Date Del'd

2

OLD DOMINION FREIGHT LINE, INC. (ODFL)
PO BOX 198475, - ATLANTA, GA 30384-8475 USA
(336) 889 5000 Visit us at WWW.ODFL.COM

CUSTOMER COPY

Dest Trm	Orig Trm	Shipper B/L Number	Purchase Ord No	Type	Copy
LOU	YNG	NS	NS		

					531234	5/11/12	77729398402

BEDFORD IN 47421

8451 STATE RT 5 /GUARD SHACK
RAVENNA OH 44266

2

Sec 7	SHM

P/C	C/D
P	

B/C	R/C
DRI	**

D Car Cd	D Car Rev	ODFL Rev	Ack No

Waybill Number	O/Agt	D/Agt	Master Bill No
77729398402			

LOAD# NS
CONSIGNEE PHONE#: 812 275 6883
APPT 05/15/12 07:30 TO 16:00
CONTACT TRISH

VISIT WWW.ODFL.COM

Ttl Pcs	Consignee Cd	Shipper	Tariff	Due ODFL (USD)	Ttl Weight	Ttl AS Wgt		
7			559		7290			C.O.D.

RECEIVED IN GOOD CONDITION EXCEPT AS NOTED

By:

Company:

Date:

Driver:

Total Prepaid | Total Collect: .00

CASH ☐ CHK ☐ CHG ☐

☐ Inside Delivery ☐ Residential Delivery ☐ Lift Gate ☐ Other

Pcs. Del'd

JV: 1133

FREIGHT CHARGES ARE PREPAID ON THIS BILL OF LADING UNLESS MARKED COLLECT

OLD DOMINION FREIGHT LINE, INC

PHONE: 800-432-6335 WEB: www.odfl.com

INTERNET STRAIGHT BILL OF LADING

ORIGINAL - NOT NEGOTIABLE

Page 1 of 1

77729398402

FREIGHT CHARGES: Prepaid

DATE: 05/11/2012

B/L# -

Pickup Reference # - DEMIL METALS SHIPMENT

PO#:

SHIPPER

RAVENNA ARMY AMMO PLANT
8451 STATE RT 5/GUARD SHACK
RAVENNA, OH 44266
USA Ph#: 253-486-2687
ROBERT HARRISON

CONSIGNEE

BEDFORD RECYCLING WAREHOUSE
904 SUMMIT & H ST.
BEDFORD, IN 47421
USA Ph#: 812-275-6883

COD

Amount:

COD Fee:

Subject to section 7 of the conditions, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement: The carrier shall not make delivery of this shipment without payment of freight and all other lawful changes.

(Signature of Consignor)

BILL THIRD PARTY FREIGHT CHARGES TO:

SOUTHEAST TRANSPORT SERVICES INC
DBA JUPITER TRANSPORT SERVICES
JUPITER, FL 33468
USA Ph#: 561-746-1634
JIM THUM

REMIT TO (COD):

Pieces	HM	Description	Type	NMFC No.	Class	Weight (lbs)
7		RESIDUE	DRUM		55	4,900

SPECIAL INSTRUCTIONS

LIFT GATE & SECURE ACCESS REQUIRED FOR SHIPPER ONLY, NOT FOR CONSIGNEE

Rate Ref: 20631195

HAZARDOUS MATERIALS EMERGENCY CONTACT: -

Total Weight: 4,900

Total Shipping Units: 7 - Drums

Received and mutually agreed by the shipper and his assigns, any additional party with an interest to any of said property hereto and each carrier of all or any of said property over all or any portion of said route to destination, that every service to be performed hereunder shall be subject to the National Motor Freight classifications (NMF 100 Series) including the Rules, packaging and the Uniform Bill of Lading Terms and Conditions, the applicable regulations of the US Department of Transportation (DOT), the ATA Hazardous Materials Rules Guide Book, the Household Goods Mileage Guides, the Carrier's tariffs, the Carrier's pricing schedules, terms, conditions and rules maintained at Carrier's general offices all of which are in effect as of the date of issue of this Bill of Lading. Shipper certifies that the consigned merchandise is properly weighed, classified, described, packaged, marked, labeled, destined as indicated, in apparent good order except as noted (contents and conditions of contents of packages unknown), and in proper condition for transportation according to the DOT and the NMF 100 Series. Carrier (Carrier being understood throughout this contract as meaning any person or corporation in possession of the property under this contract) agrees to carry to said destination if on its route, otherwise to deliver to another carrier on the route to said destination. Carrier shall in no event be liable for loss of profit, income, interest, attorney fees, or any special, incidental or consequential damages.

NOTE-Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property.

The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding $ ______ per ______

Carrier liability in the 48 contiguous states only: Shipments valued at more than $20.00 per pound are of extraordinary value. Carrier's maximum liability is $20.00 per pound per package subject to $50,000.00 maximum total liability per occurrence. The agreed value on household goods, used machinery, or personal effects does not exceed ten cents per pound per article, unless otherwise specified.

ACCESSORIAL SERVICES REQUESTED

☑ HYD ☑ LDC

SHIPPER: RAVENNA ARMY AMMO PLANT

AUTHORIZED SIGNATURE: (Shipper)

DATE: 5/11/12

H/U RECEIVED: 7 Drums

TRAILER NO.: 551234

CARRIER: OLD DOMINION FREIGHT LINE, INC.

AUTHORIZED SIGNATURE: (Driver) Phil French

DMI DEMIL METALS, INC.

P.O. Box 126
Glencoe, Illinois 60022
www.demilmetals.com

CERTIFICATE OF DESTRUCTION

To: Mr. Robert Harrison
Shaw Environmental, Inc.
Ravenna Army Ammunition Plant
8451 State Route 5
Ravenna, OH 44266

From: Barry R. Schaffer
President
Demil Metals, Inc.

Re: PO No. 13547

Demilitarization & Recycling of RVAAP MDAS

Shipment No. 02: 3,763 LB

I hereby certify that the above referenced material shipped from Ravenna Army Ammunition Plant, Ravenna, OH was demilitarized by means of shearing at Bedford Recycling, Bedford, IN and were only identified by their basic contents; further recycling was accomplished by smelting the material at Waupaca Foundry, Tell City, IN and are now only identifiable by their basic contents.

This certification is made in accordance with and subject to the penalties of law under the United States Code, Crimes and Criminal Procedures; Title 18, Section 1001.

Signature: Barry R. Schaffer

Name: Barry R. Schaffer

Title: President

Company: Demil Metals, Inc.

Date: June 8, 2012

Tel: 847.266.0117 Email: brs261@demilmetals.com Fax: 847.266.0119

Shaw Environmental & Infrastructure, Inc.

DEMIL METALS, INC.

P.O. Box 126
Glencoe, Illinois 60022
www.demilmetals.com

BLANKET END USE CERTIFICATION

SHAW ENVIRONMENTAL, INC.

UXO INSPECTED MDAS SCRAP
EX RAVENNA ARMY AMMUNTION PLANT
RAVENNA, OHIO

SHAW PROJECT No. 136147
PRIME CONTRACT No: W91DR-09-D0005
SHIPMENT No: 2 WEIGHT: 3,763 LB

Upon receiving the sealed truck with its unique identified and unbroken seal ensuring a continued chain of custody, and after reviewing and concurring with all the provided supporting documentation, sign for having received and agreeing with the provided documentation that the sealed truck contained no explosive hazards when received.

The contents of the sealed containers will not be sold, traded or otherwise given to another party until the contents have been smelted and are only identifiable by their basic contents.

It is hereby certified that Demil Metals, Inc., Glencoe, IL and it's subcontractor, Bedford Recycling, Bedford, IN, has complied with all applicable federal, state and local ordinances and regulations with respect to the care, handling, storage, shipment, resale, export, and other use of the material hereby purchased, and that both companies are users in said materials and are capable of complying with all applicable federal, state, and local laws. It is further certified that the material has been recycled into new products by means of mechanically shredding and smelting within the continental United States of America and that the material was only identifiable by its basic contents. This certification is made in accordance with and subject to the penalties of Title 18, Section 1001, of the United States Code, Crimes and Criminal Procedures.

SIGNATURE: Barry R. Schaffer
Barry R. Schaffer

DATE: June 8, 2012

TITLE: President

COMPANY: Demil Metals, Inc.

Tel: 847.266.0117 Email: brs261@demilmetals.com Fax: 847.266.0119

Appendix J
MEC Hazard Assessment Workbook

MEC HA Workbook v1.02

December-07

Overview

This workbook is a tool for project teams to assess explosive hazards to human receptors at munitions response sites (MRSs) following the Munitions and Explosives of Concern Hazard Assessment (MEC HA) methodology. The MEC HA allows a project team to evaluate potential explosive hazard associated with a site, given current site conditions, under various cleanup, land use activities, and land use control alternatives. A complete description of the methodology can be found in the MEC HA Guidance (Public Review Draft, November 2006). Please reference this guidance when completing the worksheets.

Instructions

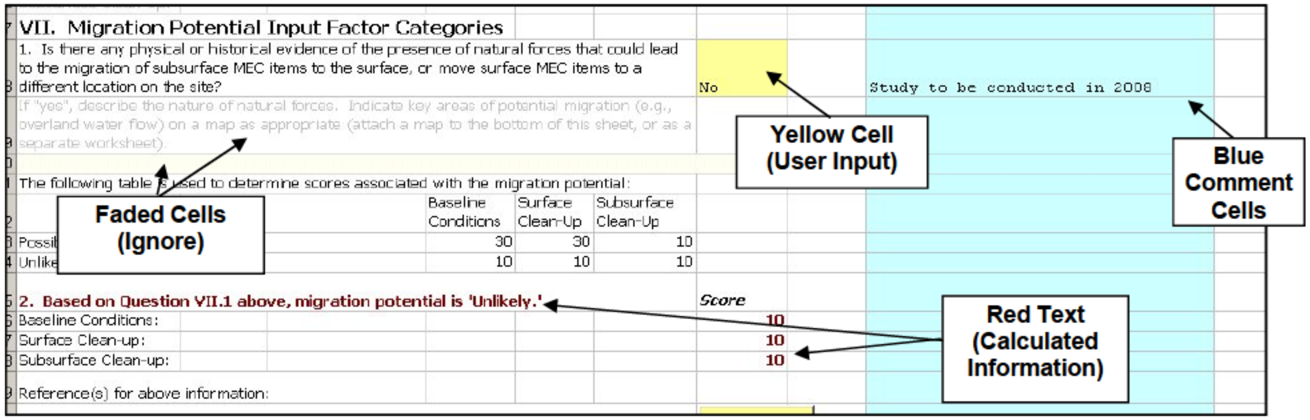
1. Open this file. Enable macros if prompted to do so. This spreadsheet will not work if your security setting is set to 'high' or 'very high'. To change your security level, go to the menu bar and select Tools/Macro/Security. Then close and reopen this spreadsheet.

2. This MS Excel workbook contains 9 worksheets, designed to be used in order. After the '***Instructions***' sheet, the first 5 sheets ask for information about the following topics:

Summary Info - General information regarding the site.
Munitions/Explosive Info - MECs and bulk explosives present at the site.
Current and Future Activities - Current land use activites as well as planned future activities, if any.
Remedial-Removal Action - General information regarding remediation/removal alternatives being considered for the site.
Post-Response Land Use - Land use activities associated with the alternatives listed in the 'Remedial-Removal Action' sheet.

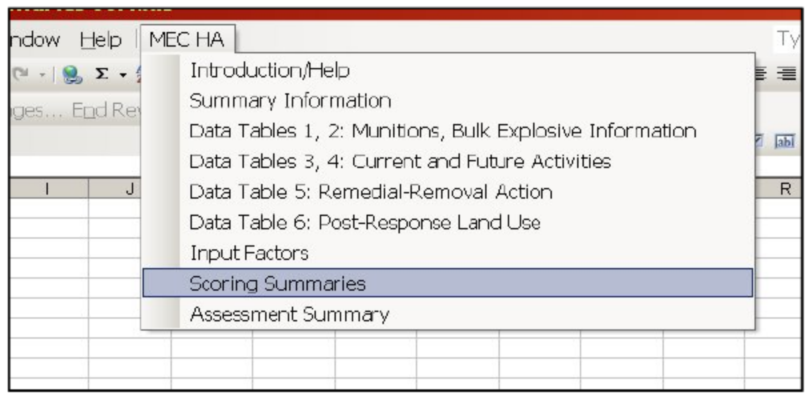
The remaining 3 sheets calculate and summarize the scores. The ***Input Factors*** sheet performs the Input Factor Score calculations, which are summarized in the ***Scoring Summaries*** sheet. The ***Hazard Level*** sheet presents the Hazard Level Category for current use activities, future use activities, and each response alternative based on the respective scores.

3. Starting with the ***Summary Info*** sheet, fill in any yellow cells. Some cells have drop-down lists from which you can select an answer. Select the cell. A down arrow to the right indicates that a drop-down list is available. Yellow buttons can be used to enter reference information. Blue cells can be used for any general comments you wish to make. Any faded cells can be ignored--these are questions that the spreadsheet has determined are not relevant for your situation.

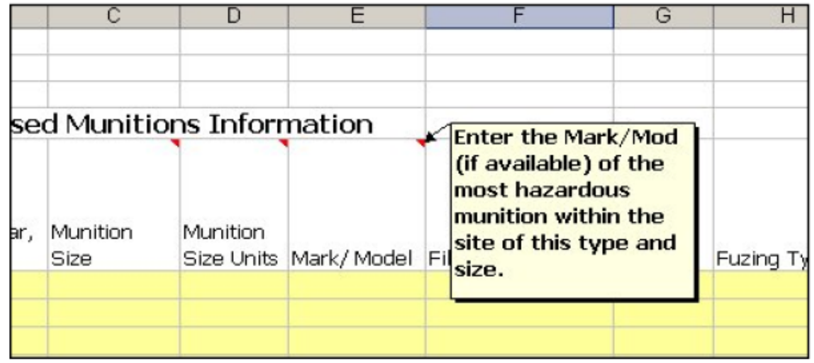


The computer will calculate information based on your inputs. Calculated information will appear as red text.

4. The MEC HA menu bar can be used to navigate to different worksheets.



5. Small red triangles in the upper-right corners indicate that help text is available by putting the mouse cursor on that cell.



MEC HA Summary Information

Comments

Site ID: OH5210020736, RVAAP-063-R-01
Date: 8/23/2012

Please identify the single specific area to be assessed in this hazard assessment. From this point forward, all references to "site" or "MRS" refer to the specific area that you have defined.

A. Enter a unique identifier for the site:

Ravenna Army Ammunition Plant Group 8 MRS (RVAAP-063-R-01) Remedial Investigation

Provide a list of information sources used for this hazard assessment. As you are completing the worksheets, use the "Select Ref(s)" buttons at the ends of each subsection to select the applicable information sources from the list below.

Ref. No.	Title (include version, publication date)
1	Preliminary Draft Remedial Investigation Report for RVAAP 063-R-01 Group 8 MRS, February 2013
2	Final Site Inspection Report, Ravenna Army Ammunition Plant, Ravenna, Ohio, Military Munitions Response Site, May 2008
3	Final Military Munitions Response Program Historical Records Review, Ravenna Army Ammunition Plant, Ohio, January 2007
4	Final Human Health Cleanup Goals for the RVAAP, March 2010

B. Briefly describe the site:

1. Area (include units): 2.65 acres
2. Past munitions-related use:

OB/OD Area

3. Current land-use activities (list all that occur):

MRS is used for security and maintenance activities and is also used as a through way for military vehicles to access nearby buildings.

4. Are changes to the future land-use planned? Yes
5. What is the basis for the site boundaries?

Acreage and area determined by HRR as the area between two buildings (Building 846 and 849). Confirmed by SI and RI field activities.

6. How certain are the site boundaries?

Certain. MEC and MD identified during HRR and SI in this area. MD only found during RI field activities. The MRS is bound by roadways and buildings.

Reference(s) for Part B:

Preliminary Draft Remedial Investigation Report for RVAAP-063-R-01 Group 8 MRS, February 2013

Select Ref(s)

C. Historical Clearances

1. Have there been any historical clearances at the site? No, none
2. If a clearance occurred:
   a. What year was the clearance performed?

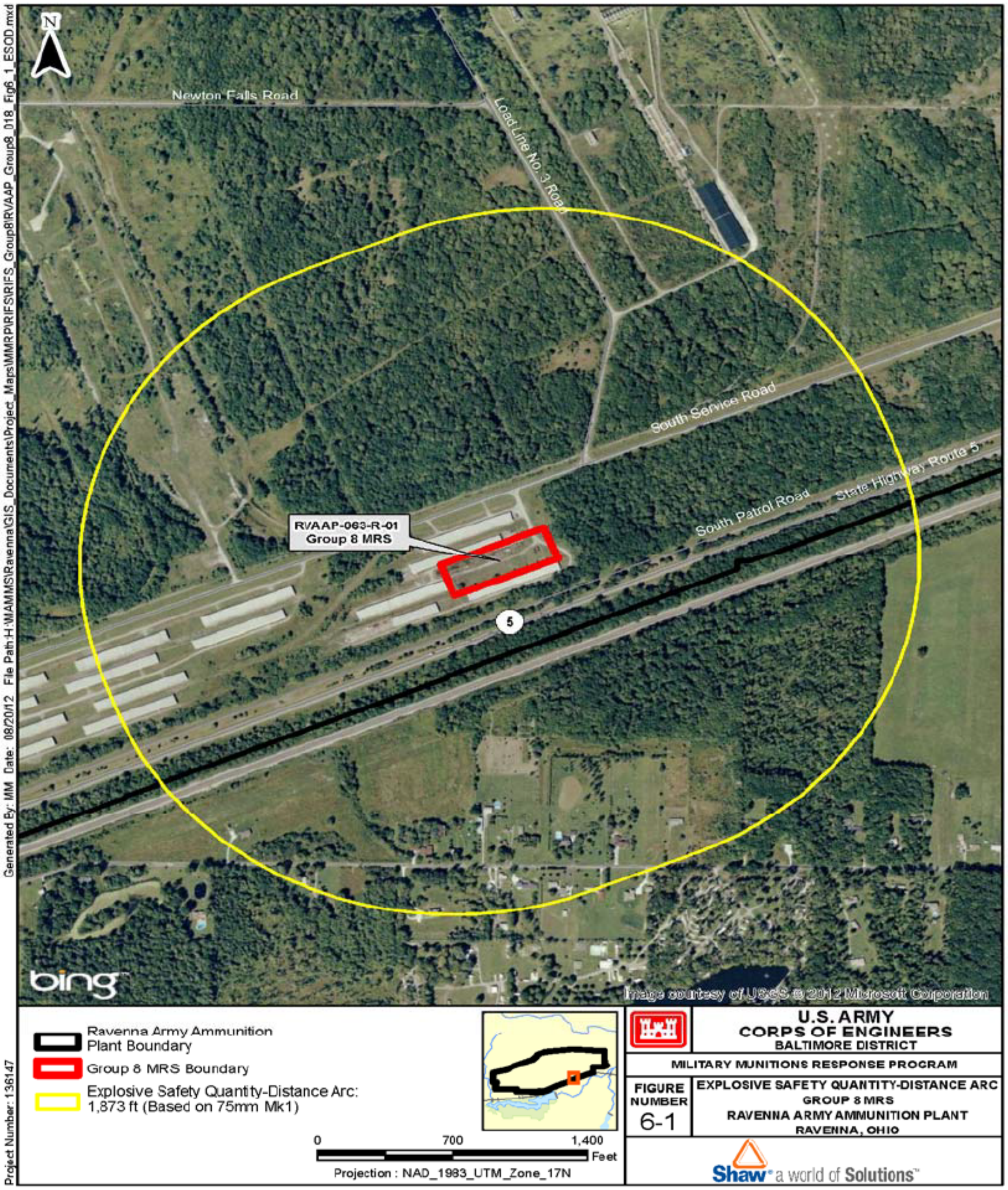
   b. Provide a description of the clearance activity (e.g., extent, depth, amount of munitions-related items removed, types and sizes of removed items, and whether metal detectors were used):

Reference(s) for Part C:

Preliminary Draft Remedial Investigation Report for RVAAP-063-R-01 Group 8 MRS, February 2013

Select Ref(s)

D. Attach maps of the site below (select 'Insert/Picture' on the menu bar.)



Site ID: **OH5210020736, RVAAP-063-R-01**
Date: **8/23/2012**

Cased Munitions Information

Item No.	Munition Type (e.g., mortar, projectile, etc.)	Munition Size	Munition Size Units	Mark/ Model	Energetic Material Type	Is Munition Fuzed?	Fuzing Type	Fuze Condition	Minimum Depth for Munition (ft)	Location of Munitions	Comments (include rationale for munitions that are "subsurface only")
1	Grenades	40	mm	M397	High Explosive	No			0.25	Subsurface Only	No MEC/MD was found the ground surface during the RI.
2	Artillery	60	mm	M49	High Explosive	No			1	Subsurface Only	No MEC/MD was found the ground surface during the RI.
3	Artillery	75	mm	M309	High Explosive	No			0.66	Subsurface Only	No MEC/MD was found the ground surface during the RI.
4	Artillery	20	mm	M53	Incendiary	No			1.5	Subsurface Only	No MEC/MD was found the ground surface during the RI.
5	Artillery	75	mm	MK1	High Explosive	No			0.5	Subsurface Only	No MEC/MD was found the ground surface during the RI.
6	Artillery	75	mm	M72	Propellant	No			4	Subsurface Only	No MEC/MD was found the ground surface during the RI.
7	Fuzes			M43					1	Subsurface Only	No MEC/MD was found the ground surface during the RI.
8	Fuzes			M84			Time	Unarmed	1	Subsurface Only	No MEC/MD was found the ground surface during the RI.
9	Fuzes			M532			Proximity	Unarmed	1.5	Subsurface Only	No MEC/MD was found the ground surface during the RI.
10	Fuzes			M557			Time	Unarmed	0.33	Subsurface Only	No MEC/MD was found the ground surface during the RI.
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

Reference(s) for table above:
Preliminary Draft Remedial Investigation Report for RVAAP-063-R-01 Group 8 MRS, February 2013

Select Ref(s)

Bulk Explosive Information

Item No.	Explosive Type	Comments
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Reference(s) for table above:

Preliminary Draft Remedial Investigation Report for RVAAP-063-R-01 Group 8 MRS, February 2013

Select Ref(s)

Site ID: **OH5210020736, RVAAP-063-R-01**
Date: **8/23/2012**

Activities Currently Occurring at the Site

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours per year a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1	Security Guard/Maintenance Worker	1	250	**250**	0	
2	Trespassers	125	2	**250**	0	
3					0	
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr): **500**

Maximum intrusive depth at site (ft): **0**

Reference(s) for table above:

Preliminary Draft Remedial Investigation Report for RVAAP-063-R-01 Group 8 MRS, February 2013

Select Ref(s)

Activities Planned for the Future at the Site (If any are planned: see 'Summary Info' Worksheet, Question 4)

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours per year a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1	National Guard Trainee	8	936	**7,488**	7	39 days/year x 24 hours/day
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
	Total Potential Contact Time (receptor hrs/yr):			**7,488**		
	Maximum intrusive depth at site (ft):				**7**	

Reference(s) for table above:

Preliminary Draft Remedial Investigation Report for RVAAP-063-R-01 Group 8 MRS, February 2013
Final Human Health Cleanup Goals for the RVAAP (March, 2010).

Select Ref(s)

Site ID: **OH5210020736, RVAAP-063-R-01**
Date: **8/23/2012**

Planned Remedial or Removal Actions

Response Action No.	Response Action Description	Expected Resulting Minimum MEC Depth (ft)	Expected Resulting Site Accessibility	Will land use activities change if this response action is implemented?	What is the expected scope of cleanup?	Comments
1						
2						
3						
4						
5						
6						

For those alternatives where you answered 'No' in Column E, are land-use activities to be assessed against current or future land uses?

Reference(s) for table above:

Preliminary Draft Remedial Investigation Report for RVAAP-063-R-01 Group 8 MRS, February 2013

Select Ref(s)

Site ID: **OH5210020736, RVAAP-063-R-01**
Date: **8/23/2012**

This worksheet needs to be completed for each remedial/removal action alternative listed in the 'Remedial-Removal Action' worksheet that will cause a change in land use.

Land Use Activities Planned After Response Alternative #1:

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):
Maximum intrusive depth at site (ft):

Reference(s) for table above:

Select Ref(s)

Remedial Investigation Report, Draft, 2011

Site ID: **OH5210020736, RVAAP-063-R-01**
Date: **8/23/2012**

Energetic Material Type Input Factor Categories

Comments

The following table is used to determine scores associated with the energetic materials. Materials are listed in order from most hazardous to least hazardous.

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
High Explosive and Low Explosive Filler in Fragmenting Rounds	100	100	100
White Phosphorus	70	70	70
Pyrotechnic	60	60	60
Propellant	50	50	50
Spotting Charge	40	40	40
Incendiary	30	30	30

The most hazardous type of energetic material listed in the 'Munitions, Bulk Explosive Info' Worksheet falls under the category 'High Explosive and Low Explosive Filler in Fragmenting Rounds'.

	Score
Baseline Conditions:	**100**
Surface Cleanup:	**100**
Subsurface Cleanup:	**100**

Location of Additional Human Receptors Input Factor Categories

1. What is the Explosive Safety Quantity Distance (ESQD) from the Explosive Siting Plan or the Explosive Safety Submission for the MRS? 1,873 feet — 75mm MK1
2. Are there currently any features or facilities where people may congregate within the MRS, or within the ESQD arc? Yes
3. Please describe the facility or feature.

Controlled humidity storage buildings adjacent to the MRS are actively used by OHARNG.

MEC Item(s) used to calculate the ESQD for current use activities

Select MEC(s)

Item #5. Artillery (75mm)

The following table is used to determine scores associated with the location of additional human receptors (current use activities):

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Inside the MRS or inside the ESQD arc	30	30	30
Outside of the ESQD arc	0	0	0

4. Current use activities are 'Inside the MRS or inside the ESQD arc', based on Question 2.

	Score
Baseline Conditions:	**30**
Surface Cleanup:	**30**
Subsurface Cleanup:	**30**

5. Are there future plans to locate or construct features or facilities where people may congregate within the MRS, or within the ESQD arc? Yes
6. Please describe the facility or feature.

Military use and training facilities.

MEC Item(s) used to calculate the ESQD for future use activities

Select MEC(s)

Item #5. Artillery (75mm)

The following table is used to determine scores associated with the location of additional human receptors (future use activities):

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Inside the MRS or inside the ESQD arc	30	30	30
Outside of the ESQD arc	0	0	0

7. Future use activities are 'Inside the MRS or inside the ESQD arc', based on Question 5.'

	Score
Baseline Conditions:	**30**
Surface Cleanup:	**30**
Subsurface Cleanup:	**30**

Site Accessibility Input Factor Categories

The following table is used to determine scores associated with site accessibility:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Full Accessibility	No barriers to entry, including signage but no fencing	80	80	80
Moderate Accessibility	Some barriers to entry, such as barbed wire fencing or rough terrain	55	55	55
Limited Accessibility	Significant barriers to entry, such as unguarded chain link fence or requirements for special transportation to reach the site	15	15	15
Very Limited Accessibility	A site with guarded chain link fence or terrain that requires special equipment and skills (e g., rock climbing) to access	5	5	5

Current Use Activities ***Score***

Select the category that best describes the site accessibility under the current use scenario:

Full Accessibility

Baseline Conditions:	**80**
Surface Cleanup:	**80**
Subsurface Cleanup:	**80**

Future Use Activities

Select the category that best describes the site accessibility under the future use scenario:

Full Accessibility

Baseline Conditions:	**80**
Surface Cleanup:	**80**
Subsurface Cleanup:	**80**

Reference(s) for above information:

Preliminary Draft Remedial Investigation Report for RVAAP-063-R-01 Group 8 MRS, February 2013

Select Ref(s)

Response Alternative No. 1:
Please enter site accessibility information in the 'Planned Remedial or Removal Actions' Worksheet to continue.
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 2:
Please enter site accessibility information in the 'Planned Remedial or Removal Actions' Worksheet to continue.
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 3:
Please enter site accessibility information in the 'Planned Remedial or Removal Actions' Worksheet to continue.
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 4:
Please enter site accessibility information in the 'Planned Remedial or Removal Actions' Worksheet to continue.
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 5:
Please enter site accessibility information in the 'Planned Remedial or Removal Actions' Worksheet to continue.
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 6:
Please enter site accessibility information in the 'Planned Remedial or Removal Actions' Worksheet to continue.
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Potential Contact Hours Input Factor Categories

The following table is used to determine scores associated with the total potential contact time:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Many Hours	≥1,000,000 receptor-hrs/yr	120	90	30
Some Hours	100,000 to 999,999 receptor hrs/yr	70	50	20
Few Hours	10,000 to 99,999 receptor-hrs/yr	40	20	10
Very Few Hours	<10,000 receptor-hrs/yr	15	10	5

Current Use Activities:

Input factors are only determined for baseline conditions for current use activities. Based on the 'Current and Future Activities' Worksheet, the Total Potential Contact Time is: **500** receptor hrs/yr
Based on the table above, this corresponds to a input factor score for baseline conditions of: **15** Score

Future Use Activities:

Input factors are only determined for baseline conditions for future use activities. Based on the 'Current and Future Activities' Worksheet, the Total Potential Contact Time is: **7,488** receptor hrs/yr
Based on the table above, this corresponds to a input factor score of: **15** Score

Response Alternative No. 1:

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Total Potential Contact Time
Based on the table above, this corresponds to input factor scores of: ***Score***
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 2:

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Total Potential Contact Time
Based on the table above, this corresponds to input factor scores of: ***Score***
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 3:

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Total Potential Contact Time
Based on the table above, this corresponds to input factor scores of: ***Score***
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 4:

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Total Potential Contact Time
Based on the table above, this corresponds to input factor scores of: ***Score***
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 5:

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Total Potential Contact Time
Based on the table above, this corresponds to input factor scores of: **Score**
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 6:

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Total Potential Contact Time
Based on the table above, this corresponds to input factor scores of: **Score**
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Amount of MEC Input Factor Categories

The following table is used to determine scores associated with the Amount of MEC:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Target Area	Areas at which munitions fire was directed	180	120	30
OB/OD Area	Sites where munitions were disposed of by open burn or open detonation methods. This category refers to the core activity area of an OB/OD area. See the "Safety Buffer Areas" category for safety fans and kick-outs.	180	110	30
Function Test Range	Areas where the serviceability of stored munitions or weapons systems are tested. Testing may include components, partial functioning or complete functioning of stockpile or developmental items.	165	90	25
Burial Pit	The location of a burial of large quantities of MEC items.	140	140	10
Maneuver Areas	Areas used for conducting military exercises in a simulated conflict area or war zone	115	15	5
Firing Points	The location from which a projectile, grenade, ground signal, rocket, guided missile, or other device is to be ignited, propelled, or released.	75	10	5
Safety Buffer Areas	Areas outside of target areas, test ranges, or OB/OD areas that were designed to act as a safety zone to contain munitions that do not hit targets or to contain kick-outs from OB/OD areas.	30	10	5
Storage	Any facility used for the storage of military munitions, such as earth-covered magazines, above-ground magazines, and open-air storage areas.	25	10	5
Explosive-Related Industrial Facility	Former munitions manufacturing or demilitarization sites and TNT production plants	20	10	5

Select the category that best describes the ***most hazardous*** amount of MEC: ***Score***

OB/OD Area

	Score
Baseline Conditions:	**180**
Surface Cleanup:	**110**
Subsurface Cleanup:	**30**

Minimum MEC Depth Relative to the Maximum Intrusive Depth Input Factor Categories

Current Use Activities

The shallowest minimum MEC depth, based on the 'Cased Munitions Information' Worksheet: **0.25** ft
The deepest intrusive depth: **0** ft
The table below is used to determine scores associated with the minimum MEC depth relative to the maximum intrusive depth:

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240	150	95
Baseline Condition: MEC located surface and subsurface, After Cleanup: Intrusive depth does not overlap with subsurface MEC.	240	50	25
Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth overlaps with minimum MEC depth.	150	N/A	95
Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth does not overlap with minimum MEC depth.	50	N/A	25

Because the shallowest minimum MEC depth is greater than the deepest intrusive depth, the intrusive depth will not overlap after cleanup. MECs are located only subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth does not overlap with minimum MEC depth.' For 'Current Use Activities', only Baseline Conditions are considered. **50** ***Score***

Future Use Activities

Deepest intrusive depth: **7** ft

Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth overlaps. MECs are located only subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth overlaps with minimum MEC depth.'. For 'Future Use Activities', only Baseline Conditions are considered. **150** ***Score***

Response Alternative No. 1:

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): ft

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Maximum Intrusive Depth ft

Not enough information has been entered to calculate this input factor.

Score

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 2:

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): ft

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Maximum Intrusive Depth ft

Not enough information has been entered to calculate this input factor.

Score

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 3:

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): **4** ft

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Maximum Intrusive Depth ft

Not enough information has been entered to calculate this input factor.

Score

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 4:

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): ft

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Maximum Intrusive Depth ft

Not enough information has been entered to calculate this input factor.

Score

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 5:
Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): ft
Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Maximum Intrusive Depth ft

Not enough information has been entered to calculate this input factor.

	Score
Baseline Conditions:	
Surface Cleanup:	
Subsurface Cleanup:	

Response Alternative No. 6:
Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): ft
Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Maximum Intrusive Depth ft

Not enough information has been entered to calculate this input factor.

	Score
Baseline Conditions:	
Surface Cleanup:	
Subsurface Cleanup:	

Migration Potential Input Factor Categories

Is there any physical or historical evidence that indicates it is possible for natural physical forces in the area (e.g., frost heave, erosion) to expose subsurface MEC items, or move surface or subsurface MEC items? Yes

If "yes", describe the nature of natural forces. Indicate key areas of potential migration (e.g., overland water flow) on a map as appropriate (attach a map to the bottom of this sheet, or as a separate worksheet).

Frost heave, erosion caused by heavy rains

The following table is used to determine scores associated with the migration potential:

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Possible	30	30	10
Unlikely	10	10	10

Based on the question above, migration potential is 'Possible.'

	Score
Baseline Conditions:	**30**
Surface Cleanup:	**30**
Subsurface Cleanup:	**10**

Reference(s) for above information:

Preliminary Draft Remedial Investigation Report for RVAAP-063-R-01 Group 8 MRS, February 2013

Select Ref(s)

MEC Classification Input Factor Categories

Cased munitions information has been inputed into the 'Munitions, Bulk Explosive Info' Worksheet; therefore, bulk explosives do not comprise all MECs for this MRS.

The 'Amount of MEC' category is 'OB/OD Area'.

Has a technical assessment shown that MEC in the OB/OD Area is DMM? No

Are any of the munitions listed in the 'Munitions, Bulk Explosive Info' Worksheet: Yes

- Submunitions
- Rifle-propelled 40mm projectiles (often called 40mm grenades)
- Munitions with white phosphorus filler
- High explosive anti-tank (HEAT) rounds
- Hand grenades
- Fuzes
- Mortars

None of the items listed in the 'Munitions, Bulk Explosive Info' Worksheet were identified as 'fuzed'.

The following table is used to determine scores associated with MEC classification categories:

UXO Special Case	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
UXO Special Case	180	180	180
UXO	110	110	110
Fuzed DMM Special Case	105	105	105
Fuzed DMM	55	55	55
Unfuzed DMM	45	45	45
Bulk Explosives	45	45	45

Based on your answers above, the MEC classification is 'UXO Special Case'.

	Score
Baseline Conditions:	**180**
Surface Cleanup:	**180**
Subsurface Cleanup:	**180**

MEC Size Input Factor Categories

The following table is used to determine scores associated with MEC Size:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Small	Any munitions (from the 'Munitions, Bulk Explosive Info' Worksheet) weigh less than 90 lbs; small enough for a receptor to be able to move and initiate a detonation	40	40	40
Large	All munitions weigh more than 90 lbs; too large to move without equipment	0	0	0

Based on the definitions above and the types of munitions at the site (see 'Munitions, Bulk Explosive Info' Worksheet), the MEC Size Input Factor is: Small

	Score
Baseline Conditions:	**40**
Surface Cleanup:	**40**
Subsurface Cleanup:	**40**

Scoring Summary

Site ID:	OH5210020736, RVAAP-063-R-01	a. Scoring Summary for Current Use Activities	
Date:	8/23/2012	Response Action Cleanup:	No Response Action
Input Factor		Input Factor Category	Score
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	30
III. Site Accessibility		Full Accessibility	80
IV. Potential Contact Hours		<10,000 receptor-hrs/yr	15
V. Amount of MEC		OB/OD Area	180
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located only subsurface. Baseline condition or after cleanup: Intrusive depth does not overlap with minimum MEC depth.	50
VII. Migration Potential		Possible	30
VIII. MEC Classification		UXO Special Case	180
IX. MEC Size		Small	40
		Total Score	**705**
		Hazard Level Category	**3**

Site ID:	OH5210020736, RVAAP-063-R-01	b. Scoring Summary for Future Use Activities	
Date:	8/23/2012	Response Action Cleanup:	No Response Action
Input Factor		Input Factor Category	Score
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	30
III. Site Accessibility		Full Accessibility	80
IV. Potential Contact Hours		<10,000 receptor-hrs/yr	15
V. Amount of MEC		OB/OD Area	180
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth overlaps with minimum MEC depth	150
VII. Migration Potential		Possible	30
VIII. MEC Classification		UXO Special Case	180
IX. MEC Size		Small	40
		Total Score	**805**
		Hazard Level Category	**2**

MEC HA Hazard Level Determination		
Site ID: OH5210020736, RVAAP-063-R-01		
Date: 8/23/2012		
	Hazard Level Category	Score
a. Current Use Activities	3	705
b. Future Use Activities	2	805
c. Response Alternative 1:		
d. Response Alternative 2:		
e. Response Alternative 3:		
f. Response Alternative 4:		
g. Response Alternative 5:		
h. Response Alternative 6:		

Characteristics of the MRS	
Is critical infrastructure located within the MRS or within the ESQD arc?	No
Are cultural resources located within the MRS or within the ESQD arc?	No
Are significant ecological resources located within the MRS or within the ESQD arc?	Yes

Appendix K
Ecological Screening Values

Table K-1
Ecological Screening Values for Soil
Ravenna Army Ammunition Plant

COPEC	Log Kow	CAS Number	USEPA Eco SSL 2010[a] (mg/kg)	ORNL PRGs 1997[b] (mg/kg)	Region 5 ESLs 2003[c] (mg/kg)	LANL ESLs 2010[d] (mg/kg)	Talmage et al. 1999[e] (mg/kg)	Persistent, Bioaccumulative, and Toxic Pollutant [f]	Recommended Soil Ecological Screening Value[g] (mg/kg)	Is the ESV Protective of Food Chain Effects?
			Ecological Screening Values for Soil							
Metals										
Aluminum	NA	7429-90-5	Narrative	NA	NA	Narrative	NA	No (not USEPA IBC)	NA	NA
Antimony	NA	7440-36-0	0.27	5	0.142	0.05	NA	No (not USEPA IBC)	0.27	Yes
Arsenic	NA	7440-38-2	18	9 9	5.7	6.8	NA	**Yes (USEPA IBC)**	18	Yes
Barium	NA	7440-39-3	330	283	1.04	110	NA	No (not USEPA IBC)	330	Yes
Beryllium	NA	7440-41-7	21	10	1.06	2.5	NA	No (not USEPA IBC)	21	Yes
Cadmium	NA	7440-43-9	0.36	4	0.00222	0.27	NA	**Yes (USEPA IBC)**	0.36	Yes
Calcium	NA	7440-70-2	NA	NA	NA	NA	NA	No (not USEPA IBC)	NA	NA
Cobalt	NA	7440-48-4	13	20	0.14	13	NA	No (not USEPA IBC)	13	Yes
Copper	NA	7440-50-8	28	60	5.4	15	NA	**Yes (USEPA IBC)**	28	Yes
Chromium (as Cr^{3+})	NA	7440-47-3	26	0.4	0.4	2.3	NA	No (not USEPA IBC)	26	Yes
Chromium (as Cr^{6+})	NA	18540-29-9	130	NA	NA	0.34	NA	**Yes (USEPA IBC)**	130	Yes
Iron	NA	4739-89-6	Narrative	NA	NA	NA	NA	No (not USEPA IBC)	NA	NA
Lead	NA	7439-92-1	11	40.5	0.0537	14	NA	**Yes (USEPA IBC)**	11	Yes
Magnesium	NA	7439-95-4	NA	NA	NA	NA	NA	No (not USEPA IBC)	NA	NA
Manganese	NA	7439-96-5	220	NA	NA	220	NA	No (not USEPA IBC)	220	Yes
Mercury	NA	7439-97-6	NA	0.00051	0.1	0.013	NA	**Yes (OEPA PBT)**	0.00051	
Nickel	NA	7440-02-0	38	30	13.6	9.7	NA	**Yes (USEPA IBC)**	38	Yes
Potassium	NA	7440-09-7	NA	NA	NA	NA	NA	No (Log Kow < 3.0)	Nutrient	NA
Selenium	NA	7782-49-2	0.52	0.21	0.0276	0.52	NA	**Yes (USEPA IBC)**	0.52	Yes
Silver	NA	7440-22-4	4.2	2	4.04	2.6	NA	**Yes (USEPA IBC)**	4.2	Yes
Sodium	NA		NA	NA	NA	NA	NA	No (not USEPA IBC)	Nutrient	NA
Strontium	NA	7440-24-6	NA	NA	NA	96	NA	No (not USEPA IBC)	96	Yes
Thallium	NA	7440-28-0	NA	1	0.0569	0.032	NA	No (not USEPA IBC)	1	Yes
Vanadium	NA	7440-62-2	7.8	2	1.59	0.025	NA	No (not USEPA IBC)	7.8	Yes
Zinc	NA	7440-66-0	46	8 5	6.62	48	NA	**Yes (USEPA IBC)**	46	Yes
General Chemistry										
Cyanide, Total	NA	57-12-5	NA	NA	1.33	0.1	NA	NA	1.33	Yes
Perchlorate	NA	14797-73-0	NA	NA	NA	NA	NA	No (Log Kow < 3.0)	NA	NA
Nitrocellulose										
Nitrocellulose	-4.56	9004-70-0	NA	NA	NA	NA	NA	No (Log Kow < 3.0)	NA	NA
Pesticides										
4,4'-DDD	5.87	72-54-8	0.021	NA	0.758	0.0063	NA	**Yes (Log Kow ≥ 3.0)**	0.021	Yes
4,4'-DDE	6	72-55-9	0.021	NA	0.596	0.11	NA	**Yes (Log Kow ≥ 3.0)**	0.021	Yes
4,4'-DDT	6.79	50-29-3	0.021	NA	0.0035	0.044	NA	**Yes (Log Kow ≥ 3.0)**	0.021	Yes
gamma Chlordane	6.26	5103-74-2	NA	NA	0.224	2.2	NA	**Yes (Log Kow ≥ 3.0)**	0.224	No
Endosulfan II	3 5	33213-65-9	NA	NA	0.119	0.694	NA	**Yes (Log Kow ≥ 3.0)**	0.119	Yes
Endrin Aldehyde	4.8	7421-93-4	NA	NA	0.0105	0.0014	NA	**Yes (Log Kow ≥ 3.0)**	0.0105	Yes
Heptachlor	5.86	76-44-8	NA	NA	0.00598	0.059	NA	**Yes (Log Kow ≥ 3.0)**	0.00598	Yes
Lindane	4.26	58-89-9	NA	NA	0.005	0.0094	NA	**Yes (Log Kow ≥ 3.0)**	0.005	No
Methoxychlor	5.67	72-43-5	NA	NA	0.0199	5	NA	**Yes (Log Kow ≥ 3.0)**	0.0199	Yes

Table K-1
Ecological Screening Values for Soil
Ravenna Army Ammunition Plant

COPEC	Log Kow	CAS Number	Ecological Screening Values for Soil: USEPA Eco SSL 2010[a] (mg/kg)	ORNL PRGs 1997[b] (mg/kg)	Region 5 ESLs 2003[c] (mg/kg)	LANL ESLs 2010[d] (mg/kg)	Talmage et al. 1999[e] (mg/kg)	Persistent, Bioaccumulative, and Toxic Pollutant [f]	Recommended Soil Ecological Screening Value[g] (mg/kg)	Is the ESV Protective of Food Chain Effects?
PCBs										
Aroclor 1016	5.69	12674-11-2	NA	0.371	0.000332	1	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
Aroclor 1221	4.4	11104-28-2	NA	0.371	0.000332	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
Aroclor 1232	4.4	11141-16-5	NA	0.371	0.000332	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
Aroclor 1242	6.34	53469-21-9	NA	0.371	0.000332	0.041	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
Aroclor 1248	6.34	12672-29-6	NA	0.371	0.000332	0.0072	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
Aroclor 1254	6.98	11097-69-1	NA	0.371	0.000332	0.041	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
Aroclor 1260	8.27	11096-82-5	NA	0.371	0.000332	0.14	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
Explosives										
1,3,5-Trinitrobenzene	1.45	99-35-4	NA	NA	0.376	6.6	9.7	No (Log Kow < 3.0)	0.376	Yes
1,3-Dinitrobenzene	1.63	99-65-0	NA	NA	0.655	0.073	0.41	No (Log Kow < 3.0)	0.655	Yes
2,4,6-Trinitrotoluene	1.99	118-96-7	NA	NA	NA	6.4	5.6	No (Log Kow < 3.0)	6.4	Yes
2,4-Dinitrotoluene	2.18	121-14-2	NA	NA	1.28	0.52	NA	No (Log Kow < 3.0)	1.28	Yes
2,6-Dinitrotoluene	2.18	606-20-2	NA	NA	0.0328	0.37	NA	No (Log Kow < 3.0)	0.0328	Yes
Dinitrotoluene (2,4/2,6-) Mixture (ca)	2.18	25321-14-6	NA	NA	NA	NA	NA	No (Log Kow < 3.0)	NA	NA
2-Amino-4,6-dinitrotoluene	1.84	35572-78-2	NA	NA	NA	2.1	80	No (Log Kow < 3.0)	2.1	Yes
2-Nitrotoluene	2.36	88-72-2	NA	NA	NA	2	NA	No (Log Kow < 3.0)	2	Yes
3-Nitrotoluene	2.36	99-08-1	NA	NA	NA	2.4	NA	No (Log Kow < 3.0)	2.4	Yes
3,5-Dinitroaniline	1.29	618-87-1	NA	NA	NA	NA	NA	No (Log Kow < 3.0)	NA	NA
4-Amino-2,6-dinitrotoluene	1.84	19406-51-0	NA	NA	NA	0.73	NA	No (Log Kow < 3.0)	0.73	Yes
4-Nitrotoluene	2.36	99-99-0	NA	NA	NA	4.4	NA	No (Log Kow < 3.0)	4.4	Yes
HMX	0.82	2691-41-0	NA	NA	NA	27	5.6	No (Log Kow < 3.0)	27	Yes
Nitrobenzene	1.81	98-95-3	NA	NA	1.31	2.2	NA	No (Log Kow < 3.0)	1.31	Yes
Nitroglycerin	1.51	55-63-0	NA	NA	NA	71	NA	No (Log Kow < 3.0)	71	Yes
Nitroguanidine	-1.72	556-88-7	NA	NA	NA	NA	NA	No (Log Kow < 3.0)	NA	NA
PETN	2.38	78-11-5	NA	NA	NA	8600	NA	No (Log Kow < 3.0)	8600	Yes
RDX	0.68	121-82-4	NA	NA	NA	7.5	15	No (Log Kow < 3.0)	7.5	Yes
Tetryl	1.64	479-45-8	NA	NA	NA	0.99	4.4	No (Log Kow < 3.0)	0.99	Yes
Semivolatile Organic Compounds										
1,2,4-Trichlorobenzene	3.93	120-82-1	NA	20	11.1	0.27	NA	**Yes (Log Kow ≥ 3.0)**	20	No
1,2-Dichlorobenzene	3.28	95-50-1	NA	NA	2.96	0.92	NA	**Yes (Log Kow ≥ 3.0)**	2.96	Yes
1,3-Dichlorobenzene	3.28	541-73-1	NA	NA	37.7	0.73	NA	**Yes (Log Kow ≥ 3.0)**	37.7	Yes
1,4-Dichlorobenzene	3.28	106-46-7	NA	20	0.546	0.88	NA	**Yes (Log Kow ≥ 3.0)**	20	No
2,4,5-Trichlorophenol	3.45	95-95-4	NA	9	14.1	NA	NA	**Yes (Log Kow ≥ 3.0)**	9	No
2,4,6-Trichlorophenol	3.45	88-06-2	NA	4	9.94	NA	NA	**Yes (Log Kow ≥ 3.0)**	4	No
2,4-Dichlorophenol	2.8	120-83-2	NA	NA	87.5	NA	NA	No (Log Kow < 3.0)	87.5	Yes
2,4-Dimethylphenol	2.61	105-67-9	NA	NA	0.01	NA	NA	No (Log Kow < 3.0)	0.01	No
2,4-Dinitrophenol	1.73	51-28-5	NA	20	0.0609	NA	NA	No (Log Kow < 3.0)	20	No
2,4-Dinitrotoluene	2.18	121-14-2	NA	NA	1.28	0.52	NA	No (Log Kow < 3.0)	1.28	No
2,6-Dinitrotoluene	2.18	606-20-2	NA	NA	0.0328	0.37	NA	No (Log Kow < 3.0)	0.0328	No
2-Chloronaphthalene	3.81	91-58-7	NA	NA	0.0122	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.0122	Yes

Table K-1
Ecological Screening Values for Soil
Ravenna Army Ammunition Plant

COPEC	Log Kow	CAS Number	Ecological Screening Values for Soil: USEPA Eco SSL 2010[a] (mg/kg)	ORNL PRGs 1997[b] (mg/kg)	Region 5 ESLs 2003[c] (mg/kg)	LANL ESLs 2010[d] (mg/kg)	Talmage et al. 1999[e] (mg/kg)	Persistent, Bioaccumulative, and Toxic Pollutant [f]	Recommended Soil Ecological Screening Value[g] (mg/kg)	Is the ESV Protective of Food Chain Effects?
2-Chlorophenol	2.16	95-57-8	NA	NA	0.243	0.39	NA	No (Log Kow < 3.0)	0.243	Yes
2-Methylnaphthalene	3.72	91-57-6	NA	NA	3.24	2.5	NA	**Yes (Log Kow ≥ 3.0)**	3.24	Yes
2-Methylphenol	2.06	95-48-7	NA	NA	40.4	0.67	NA	No (Log Kow < 3.0)	40.4	Yes
2-Nitroaniline	2.02	88-74-4	NA	NA	74.1	5.4	NA	No (Log Kow < 3.0)	74.1	Yes
2-Nitrophenol	1.91	88-75-5	NA	NA	1.6	NA	NA	No (Log Kow < 3.0)	1.6	Yes
3 & 4-Methylphenol	2.06	CASID30030	NA	NA	3.49	0.69	NA	No (Log Kow < 3.0)	3.49	Yes
3,3'-Dichlorobenzidine	3.21	91-94-1	NA	NA	0.646	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.646	Yes
3-Nitroaniline	1.47	99-09-2	NA	NA	3.16	NA	NA	No (Log Kow < 3.0)	3.16	Yes
4,6-Dinitro-2-methylphenol	2.27	534-52-1	NA	NA	0.144	NA	NA	No (Log Kow < 3.0)	0.144	Yes
4-Bromophenyl-phenyl ether	4.94	101-55-3	NA	NA	NA	NA	NA	**Yes (Log Kow ≥ 3.0)**	NA	NA
4-Chloro-3-methylphenol	2.7	59-50-7	NA	NA	7.95	NA	NA	No (Log Kow < 3.0)	7.95	Yes
4-Chloroaniline	1.72	106-47-8	NA	NA	1.1	1	NA	No (Log Kow < 3.0)	1.1	Yes
4-Chlorophenyl-phenyl ether	4.69	7005-72-3	NA	NA	NA	NA	NA	**Yes (Log Kow ≥ 3.0)**	NA	NA
4-Nitroaniline	1.47	100-01-6	NA	NA	21.9	NA	NA	No (Log Kow < 3.0)	21.9	Yes
4-Nitrophenol	1.91	100-02-7	NA	7	5.12	NA	NA	No (Log Kow < 3.0)	7	No
Acenaphthene	4.15	83-32-9	29	20	682	0.25	NA	No*	29	Yes
Acenaphthylene	3.94	208-96-8	29	NA	682	120	NA	No*	29	Yes
Anthracene	4.35	120-12-7	29	NA	1480	6.8	NA	No*	29	Yes
Benzo(a)anthracene	5.52	56-55-3	1.1	NA	5.21	3	NA	No*	1.1	Yes
Benzo(a)pyrene	6.11	50-32-8	1.1	NA	1.52	53	NA	No*	1.1	Yes
Benzo(b)fluoranthene	6.11	205-99-2	1.1	NA	59.8	18	NA	No*	1.1	Yes
Benzo(g,h,i)perylene	6.7	191-24-2	1.1	NA	119	24	NA	No*	1.1	Yes
Benzo(k)fluoranthene	6.11	207-08-9	1.1	NA	148	62	NA	No*	1.1	Yes
Benzoic acid	1.87	65-85-0	NA	NA	NA	1	NA	No (Log Kow < 3.0)	1	Yes
Benzyl alcohol	1.08	100-51-6	NA	NA	65.8	120	NA	No (Log Kow < 3.0)	65.8	Yes
Bis(2-chloroethoxy)methane	1 3	111-91-1	NA	NA	0.302	NA	NA	No (Log Kow < 3.0)	0.302	Yes
Bis(2-chloroethyl)ether	1.56	111-44-4	NA	NA	23.7	NA	NA	No (Log Kow < 3.0)	23.7	Yes
Bis(2-chloroisopropyl)ether	2.39	108-60-1	NA	NA	19.9	NA	NA	No (Log Kow < 3.0)	19.9	Yes
Bis(2-ethylhexyl)phthalate	8.39	117-81-7	NA	NA	0.925	0.02	NA	**Yes (Log Kow ≥ 3.0)**	0.925	Yes
Butylbenzylphthalate	4.84	85-68-7	NA	NA	0.239	90	NA	**Yes (Log Kow ≥ 3.0)**	0.239	Yes
Carbazole	3.23	86-74-8	NA	NA	NA	0.00008	NA	No*	0.00008	Yes
Chrysene	5.52	218-01-9	1.1	NA	4.73	2.4	NA	No*	1.1	Yes
Di-n-butylphthalate	4.61	84-74-2	NA	200	0.15	0.011	NA	**Yes (Log Kow ≥ 3.0)**	200	No
Di-n-octylphthalate	8.54	117-84-0	NA	NA	709	1.1	NA	**Yes (Log Kow ≥ 3.0)**	709	No
Dibenzo(a,h)anthracene	6.7	53-70-3	1.1	NA	18.4	12	NA	No*	1.1	Yes
Dibenzofuran	3.71	132-64-9	NA	NA	NA	6.1	NA	**Yes (Log Kow ≥ 3.0)**	6.1	Yes
Diethylphthalate	2.65	84-66-2	NA	100	24.8	100	NA	No (Log Kow < 3.0)	100	No
Dimethylphthalate	1.66	131-11-3	NA	NA	734	10	NA	No (Log Kow < 3.0)	734	Yes
Fluoranthene	4.93	206-44-0	29	NA	122	10	NA	No*	29	Yes
Fluorene	4.02	86-73-7	29	NA	122	3.7	NA	No*	29	Yes
Hexachlorobenzene	5.86	118-74-1	NA	NA	0.199	0.079	NA	**Yes (Log Kow ≥ 3.0)**	0.199	Yes

Table K-1
Ecological Screening Values for Soil
Ravenna Army Ammunition Plant

COPEC	Log Kow	CAS Number	Ecological Screening Values for Soil: USEPA Eco SSL 2010[a] (mg/kg)	ORNL PRGs 1997[b] (mg/kg)	Region 5 ESLs 2003[c] (mg/kg)	LANL ESLs 2010[d] (mg/kg)	Talmage et al. 1999[e] (mg/kg)	Persistent, Bioaccumulative, and Toxic Pollutant [f]	Recommended Soil Ecological Screening Value[g] (mg/kg)	Is the ESV Protective of Food Chain Effects?
Hexachlorobutadiene	4.72	87-68-3	NA	NA	0.0398	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.0398	Yes
Hexachlorocyclopentadiene	4.63	77-47-4	NA	10	0.755	NA	NA	**Yes (Log Kow ≥ 3.0)**	10	No
Hexachloroethane	4.03	67-72-1	NA	NA	0.596	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.596	Yes
Indeno(1,2,3-cd)pyrene	6.7	193-39-5	1.1	NA	109	62	NA	No*	1.1	Yes
Isophorone	2.62	78-59-1	NA	NA	139	NA	NA	No (Log Kow < 3.0)	139	Yes
N-Nitroso-di-n-propylamine	1.33	621-64-7	NA	NA	0.544	NA	NA	No (Log Kow < 3.0)	0.544	Yes
N-Nitrosodiphenylamine & Diphn	3.16	86-30-6	NA	NA	0.545	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.545	Yes
Naphthalene	3.17	91-20-3	29	NA	0.0994	1	NA	No*	29	Yes
Nitrobenzene	1.81	98-95-3	NA	NA	1.31	2.2	NA	No (Log Kow < 3.0)	1.31	Yes
Pentachlorophenol	4.74	87-86-5	2.1	3	0.119	0.36	NA	**Yes (Log Kow ≥ 3.0)**	2.1	Yes
Phenanthrene	4.35	85-01-8	29	NA	45.7	5.5	NA	No*	29	Yes
Phenol	1.51	108-95-2	NA	30	120	0.79	NA	No (Log Kow < 3.0)	30	No
Pyrene	4.93	129-00-0	1.1	NA	78.5	10	NA	No*	1.1	Yes
Volatile Organic Compounds										
Acetone	-0.24	67-64-1	NA	NA	2.5	1.2	NA	No (Log Kow < 3.0)	2.5	Yes
Chloroethane	1.58	75-00-3	NA	NA	NA	NA	NA	No (Log Kow < 3.0)	NA	NA
Total Organic Carbon										
Total Organic Carbon	NA	TOC (mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
pH	NA	pH (Units)	NA	NA	NA	NA	NA	NA	NA	NA

[a] Ecological Soil Screening Levels (EcoSSLs), *(EPA, 2008) online updates from http //www.epa.gov/ecotox/ecossl/.*

[b] *ORNL Efroymson, R.A., Suter II, G.W., Sample, B.E. and Jones, D.S., 1997.* Preliminary Remediation Goals for Ecological Endpoints, *ES/ER/TM-162/R2.*

[c] Ecological Screening Levels (ESLs), *EPA Region V, August 2003.*

[d] *Los Alamos National Laboratory (LANL),* Eco Risk Database, *Release 2.5, October 2010.*

[e] *From* Nitroaromatic Munition Compounds: Environmental Effects and Screening Values, *Talmage et al., 1999, Rev. Environ. Contamin. Toxicol., 161 1-156.*

[f] *Analyte identified as a persistent, bioaccumulative, and toxic (PBT) compound (OEPA DERR ERA Guidance, April 2008). Polyaromatic hydrocarbons (PAH) are not considered PBTs.*

[g] *The following hierarchy (based on OEPA DERR ERA Guidance, April 2008) was used to select the soil screening values*

1. *EPA EcoSSL (plants, invertebrates, wildlife)*
2. *ORNL, 1997 (plants, invertebrates, wildlife)*
3. *EPA Region 5 ESLs (2003)*
4. *LANL, 2010 (various endpoints)*
5. *Talmage et al. (1999)*

CAS denotes Chemical Abstracts Service.
IBC denotes important bioaccumlative compound (see Table 4-2 of Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment*, February, EPA-823-R-00-001, [EPA, 2000]).*
mg/kg denotes milligrams per kilogram.
NA denotes RVAAP-specific screening level not available.
RVAAP denotes Ravenna Army Ammunition Plant.
** Polycyclic aromatic hydrocarbons (PAHs) are not considered bioaccumulative.*

Appendix L
SLERA Risk Characterization Worksheets

Table L-1
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Short-Tailed Shrew
Group 8 Munitions Response Site
Ravenna Army Ammunition Plant, Ravenna, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF
Metals														
Antimony	0 00E+00	mg/L	0 00E+00	mg/kg	2 28E+01	mg/kg	1 00E+00			9 63E-02		3 25E-02	5 00E-02	
Cadmium	0 00E+00	mg/L	0 00E+00	mg/kg	3 96E+02	mg/kg	1 00E+00			2 43E+00		4 11E-02	1 21E-02	
Copper	0 00E+00	mg/L	0 00E+00	mg/kg	7 11E+02	mg/kg	1 00E+00			4 11E-02		3 65E-02	2 80E-02	
Lead	0 00E+00	mg/L	0 00E+00	mg/kg	9 77E+02	mg/kg	1 00E+00			2 13E-01		1 29E-02	2 32E-02	
Mercury	0 00E+00	mg/L	0 00E+00	mg/kg	8 90E-01	mg/kg	1 00E+00			1 17E+00		3 88E-01	1 92E-01	
Zinc	0 00E+00	mg/L	0 00E+00	mg/kg	1 06E+03	mg/kg	1 00E+00			7 93E-01		2 16E-01	1 21E-01	
Polychlorinated Biphenyls														
Aroclor-1254	0 00E+00	mg/L	0 00E+00	mg/kg	7 40E-01	mg/kg	1 00E+00			1 64E+01		3 60E-03	1 32E-03	
Aroclor-1260	0 00E+00	mg/L	0 00E+00	mg/kg	4 10E-01	mg/kg	1 00E+00			1 73E+01		6 40E-04	1 32E-03	
Semivolatile Organics														
Bis(2-Ethylhexyl)phthalate	0 00E+00	mg/L	0 00E+00	mg/kg	2 00E+00	mg/kg	1 00E+00			1 73E+01		5 50E-04	1 32E-04	
Di-n-Butyl Phthalate	0 00E+00	mg/L	0 00E+00	mg/kg	4 60E-01	mg/kg	1 00E+00			1 50E+01		2 76E-01	1 32E-04	

Chemical	EED Surface Water (mg/kg-d)	EED Sediment (mg/kg-d)	EED Soil (mg/kg-d)	EED Fish (mg/kg-d)	EED Aq. Invert. (mg/kg-d)	EED Terr. Invert. (mg/kg-d)	EED Aq. Plants (mg/kg-d)	EED Terr. Plants (mg/kg-d)	EED Mammals (mg/kg-d)	EED Birds (mg/kg-d)	Total EED (mg/kg-d)	TRV $_{NOAEL}$ (mg/kg-d)	HQ $_{NOAEL}$	TRV $_{LOAEL}$ (mg/kg-d)	HQ $_{LOAEL}$
Metals															
Antimony	0 00E+00	0 00E+00	1 61E+00	0 00E+00	0 00E+00	1 07E+00	0 00E+00	5 39E-02	0 00E+00	0 00E+00	2 73E+00	1 25E-01	2 19E+01	1 25E+00	2 19E+00
Cadmium	0 00E+00	0 00E+00	2 80E+01	0 00E+00	0 00E+00	4 69E+02	0 00E+00	1 19E+00	0 00E+00	0 00E+00	4 98E+02	1 00E+00	4 98E+02	1 00E+01	4 98E+01
Copper	0 00E+00	0 00E+00	5 02E+01	0 00E+00	0 00E+00	1 43E+01	0 00E+00	1 89E+00	0 00E+00	0 00E+00	6 63E+01	1 17E+01	5 67E+00	1 51E+01	4 38E+00
Lead	0 00E+00	0 00E+00	6 90E+01	0 00E+00	0 00E+00	1 01E+02	0 00E+00	9 18E-01	0 00E+00	0 00E+00	1 71E+02	8 00E+00	2 14E+01	8 00E+01	2 14E+00
Mercury	0 00E+00	0 00E+00	6 28E-02	0 00E+00	0 00E+00	5 07E-01	0 00E+00	2 51E-02	0 00E+00	0 00E+00	5 95E-01	1 32E+01	4 51E-02	1 32E+02	4 51E-03
Zinc	0 00E+00	0 00E+00	7 48E+01	0 00E+00	0 00E+00	4 09E+02	0 00E+00	1 67E+01	0 00E+00	0 00E+00	5 01E+02	1 60E+02	3 13E+00	3 20E+02	1 57E+00
Polychlorinated Biphenyls															
Aroclor-1254	0 00E+00	0 00E+00	5 22E-02	0 00E+00	0 00E+00	5 91E+00	0 00E+00	1 94E-04	0 00E+00	0 00E+00	5 97E+00	6 80E-02	8 77E+01	6 80E-01	8 77E+00
Aroclor-1260	0 00E+00	0 00E+00	2 89E-02	0 00E+00	0 00E+00	3 46E+00	0 00E+00	1 91E-05	0 00E+00	0 00E+00	3 48E+00	6 80E-02	5 12E+01	6 80E-01	5 12E+00
Semivolatile Organics															
Bis(2-Ethylhexyl)phthalate	0 00E+00	0 00E+00	1 41E-01	0 00E+00	0 00E+00	1 69E+01	0 00E+00	8 01E-05	0 00E+00	0 00E+00	1 70E+01	1 83E+01	9 27E-01	1 83E+02	9 29E-02
Di-n-Butyl Phthalate	0 00E+00	0 00E+00	3 25E-02	0 00E+00	0 00E+00	3 36E+00	0 00E+00	9 24E-03	0 00E+00	0 00E+00	3 40E+00	5 50E+02	6 19E-03	1 83E+03	1 86E-03

Intake Equation:

$$Ej = \left(\frac{A}{HR}\left[\sum_{i=1}^{m}\left(\frac{IRi\,x\,Cij}{BW}\right)\right]\right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
EEQ = Ecological Effects Quotient
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
mg/kg-d = milligrams per kilogram per day
mg/L = milligrams per liter
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): See appropriate text tables for equations
LOAEL and NOAEL values from appropriate toxicity summary tables in the text
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium
Receptor diet data and home range data from appropriate text table
Exposure point concentrations (EPCs) from appropriate text tables

Species-Specific Factors

Terrestrial plant diet fraction =	0 13	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq Invert diet fraction =	0	unitless
Terr Invert diet fraction =	0 87	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0 0012	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0 00952	kg/d
Body weight =	0 017	kg
Home range =	0 96	acres
Water intake rate =	0 0038	L/d
Site Area =	2 65	acres
Area Use Factor (AUF) =	1	unitless
Exposure Frequency (EF) =	1	unitless

Table L-2
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Robin
Group 8 Munitions Response Site
Ravenna Army Ammunition Plant, Ravenna, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF
Metals														
Antimony	0 00E+00	mg/L	0 00E+00	mg/kg	2 28E+01	mg/kg	1 00E+00			9 63E-02		3 25E-02	5 00E-02	
Cadmium	0 00E+00	mg/L	0 00E+00	mg/kg	3 96E+02	mg/kg	1 00E+00			2 43E+00		4 11E-02	1 21E-02	
Copper	0 00E+00	mg/L	0 00E+00	mg/kg	7 11E+02	mg/kg	1 00E+00			4 11E-02		3 65E-02	2 80E-02	
Lead	0 00E+00	mg/L	0 00E+00	mg/kg	9 77E+02	mg/kg	1 00E+00			2 13E-01		1 29E-02	2 32E-02	
Mercury	0 00E+00	mg/L	0 00E+00	mg/kg	8 90E-01	mg/kg	1 00E+00			1 17E+00		3 88E-01	1 92E-01	
Zinc	0 00E+00	mg/L	0 00E+00	mg/kg	1 06E+03	mg/kg	1 00E+00			7 93E-01		2 16E-01	1 21E-01	
Polychlorinated Biphenyls														
Aroclor-1254	0 00E+00	mg/L	0 00E+00	mg/kg	7 40E-01	mg/kg	1 00E+00			1 64E+01		3 60E-03	1 32E-03	
Aroclor-1260	0 00E+00	mg/L	0 00E+00	mg/kg	4 10E-01	mg/kg	1 00E+00			1 73E+01		6 40E-04	1 32E-03	
Semivolatile Organics														
Bis(2-Ethylhexyl)phthalate	0 00E+00	mg/L	0 00E+00	mg/kg	2 00E+00	mg/kg	1 00E+00			1 73E+01		5 50E-04	1 32E-04	
Di-n-Butyl Phthalate	0 00E+00	mg/L	0 00E+00	mg/kg	4 60E-01	mg/kg	1 00E+00			1 50E+01		2 76E-01	1 32E-04	

Chemical	EED Surface Water (mg/kg-d)	EED Sediment (mg/kg-d)	EED Soil (mg/kg-d)	EED Fish (mg/kg-d)	EED Aq. Invert. (mg/kg-d)	EED Terr. Invert. (mg/kg-d)	EED Aq. Plants (mg/kg-d)	EED Terr. Plants (mg/kg-d)	EED Mammals (mg/kg-d)	EED Birds (mg/kg-d)	Total EED (mg/kg-d)	TRV_{NOAEL} (mg/kg-d)	HQ_{NOAEL}	TRV_{LOAEL} (mg/kg-d)	HQ_{LOAEL}
Metals															
Antimony	0 00E+00	0 00E+00	1 37E+00	0 00E+00	0 00E+00	1 32E+00	0 00E+00	4 44E-01	0 00E+00	0 00E+00	3 13E+00	NA	NA	NA	NA
Cadmium	0 00E+00	0 00E+00	2 38E+01	0 00E+00	0 00E+00	5 77E+02	0 00E+00	9 78E+00	0 00E+00	0 00E+00	6 11E+02	1 45E+00	4 21E+02	2 00E+01	3 05E+01
Copper	0 00E+00	0 00E+00	4 27E+01	0 00E+00	0 00E+00	1 76E+01	0 00E+00	1 56E+01	0 00E+00	0 00E+00	7 58E+01	4 70E+01	1 61E+00	6 17E+01	1 23E+00
Lead	0 00E+00	0 00E+00	5 86E+01	0 00E+00	0 00E+00	1 25E+02	0 00E+00	7 56E+00	0 00E+00	0 00E+00	1 91E+02	1 13E+00	1 69E+02	1 13E+01	1 69E+01
Mercury	0 00E+00	0 00E+00	5 34E-02	0 00E+00	0 00E+00	6 24E-01	0 00E+00	2 07E-01	0 00E+00	0 00E+00	8 85E-01	4 50E-01	1 97E+00	9 00E-01	9 83E-01
Zinc	0 00E+00	0 00E+00	6 36E+01	0 00E+00	0 00E+00	5 04E+02	0 00E+00	1 37E+02	0 00E+00	0 00E+00	7 05E+02	1 45E+01	4 86E+01	1 31E+02	5 38E+00
Polychlorinated Biphenyls															
Aroclor-1254	0 00E+00	0 00E+00	4 44E-02	0 00E+00	0 00E+00	7 28E+00	0 00E+00	1 60E-03	0 00E+00	0 00E+00	7 33E+00	1 80E-01	4 07E+01	1 80E+00	4 07E+00
Aroclor-1260	0 00E+00	0 00E+00	2 46E-02	0 00E+00	0 00E+00	4 26E+00	0 00E+00	1 57E-04	0 00E+00	0 00E+00	4 28E+00	1 80E-01	2 38E+01	1 80E+00	2 38E+00
Semivolatile Organics															
Bis(2-Ethylhexyl)phthalate	0 00E+00	0 00E+00	1 20E-01	0 00E+00	0 00E+00	2 08E+01	0 00E+00	6 60E-04	0 00E+00	0 00E+00	2 09E+01	1 11E+00	1 88E+01	1 11E+01	1 88E+00
Di-n-Butyl Phthalate	0 00E+00	0 00E+00	2 76E-02	0 00E+00	0 00E+00	4 14E+00	0 00E+00	7 62E-02	0 00E+00	0 00E+00	4 24E+00	1 10E-01	3 86E+01	1 10E+00	3 86E+00

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
EEQ = Ecological Effects Quotient
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
mg/L = milligrams per liter
mg/kg-d = milligams per kilogram per day
NOAEL = No Observed Adverse Effect Leve
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): See appropriate text tables for equations
LOAEL and NOAEL values from appropriate toxicity summary tables in the text
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium
Receptor diet data and home range data from appropriate text tables
Exposure point concentrations (EPCs) from appropriate text tables

Species-Specific Factors

Terrestrial plant diet fraction =	0 5	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq Invert diet fraction =	0	unitless
Terr Invert diet fraction =	0 5	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0 00486	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0 0972	kg/d
Body weight =	0 081	kg
Home range =	0 618	acres
Water intake rate =	0 011	L/d
Site Area =	2 65	acres
Area Use Factor (AUF) =	1	unitless
Exposure Frequency (EF) =	1	unitless

Table L-3
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Meadow Vole
Group 8 Munitions Response Site
Ravenna Army Ammunition Plant, Ravenna, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water (mg/kg-d)	EED Sediment (mg/kg-d)	EED Soil (mg/kg-d)	EED Fish (mg/kg-d)	EED Aq. Invert. (mg/kg-d)	EED Terr. Invert. (mg/kg-d)	EED Aq. Plants (mg/kg-d)	EED Terr. Plants (mg/kg-d)	EED Mammals (mg/kg-d)	EED Birds (mg/kg-d)	Total EED (mg/kg-d)	TRV $_{NOAEL}$ (mg/kg-d)	HQ $_{NOAEL}$	TRV $_{LOAEL}$ (mg/kg-d)	HQ $_{LOAEL}$
Metals																													
Antimony	0 00E+00	mg/L	0 00E+00	mg/kg	2 28E+01	mg/kg	1 00E+00			9 63E-02		3 25E-02	5 00E-02		0 00E+00	0 00E+00	1 52E-01	0 00E+00	0 00E+00	0 00E+00	0 00E+00	2 44E-01	0 00E+00	0 00E+00	3 96E-01	1 25E-01	3 17E+00	1 25E+00	3 17E-01
Cadmium	0 00E+00	mg/L	0 00E+00	mg/kg	3 96E+02	mg/kg	1 00E+00			2 43E+00		4 11E-02	1 21E-02		0 00E+00	0 00E+00	2 64E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	5 38E+00	0 00E+00	0 00E+00	8 02E+00	1 00E+00	8 02E+00	1 00E+01	8 02E-01
Copper	0 00E+00	mg/L	0 00E+00	mg/kg	7 11E+02	mg/kg	1 00E+00			4 11E-02		3 65E-02	2 80E-02		0 00E+00	0 00E+00	4 74E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	8 56E+00	0 00E+00	0 00E+00	1 33E+01	1 17E+01	1 14E+00	1 51E+01	8 78E-01
Lead	0 00E+00	mg/L	0 00E+00	mg/kg	9 77E+02	mg/kg	1 00E+00			2 13E-01		1 29E-02	2 32E-02		0 00E+00	0 00E+00	6 51E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	4 16E+00	0 00E+00	0 00E+00	1 07E+01	8 00E+00	1 33E+00	8 00E+01	1 33E-01
Mercury	0 00E+00	mg/L	0 00E+00	mg/kg	8 90E-01	mg/kg	1 00E+00			1 17E+00		3 88E-01	1 92E-01		0 00E+00	0 00E+00	5 93E-03	0 00E+00	0 00E+00	0 00E+00	0 00E+00	1 14E-01	0 00E+00	0 00E+00	1 20E-01	1 32E+01	9 09E-03	1 32E+02	9 09E-04
Zinc	0 00E+00	mg/L	0 00E+00	mg/kg	1 06E+03	mg/kg	1 00E+00			7 93E-01		2 16E-01	1 21E-01		0 00E+00	0 00E+00	7 07E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	7 56E+01	0 00E+00	0 00E+00	8 27E+01	1 60E+02	5 17E-01	3 20E+02	2 58E-01
Polychlorinated Biphenyls																													
Aroclor-1254	0 00E+00	mg/L	0 00E+00	mg/kg	7 40E-01	mg/kg	1 00E+00			1 64E+01		3 60E-03	1 32E-03		0 00E+00	0 00E+00	4 93E-03	0 00E+00	0 00E+00	0 00E+00	0 00E+00	8 79E-04	0 00E+00	0 00E+00	5 81E-03	6 80E-02	8 55E-02	6 80E-01	8 55E-03
Aroclor-1260	0 00E+00	mg/L	0 00E+00	mg/kg	4 10E-01	mg/kg	1 00E+00			1 73E+01		6 40E-04	1 32E-03		0 00E+00	0 00E+00	2 73E-03	0 00E+00	0 00E+00	0 00E+00	0 00E+00	8 66E-05	0 00E+00	0 00E+00	2 82E-03	6 80E-02	4 15E-02	6 80E-01	4 15E-03
Semivolatile Organics																													
Bis(2-Ethylhexyl)phthalate	0 00E+00	mg/L	0 00E+00	mg/kg	2 00E+00	mg/kg	1 00E+00			1 73E+01		5 50E-04	1 32E-04		0 00E+00	0 00E+00	1 33E-02	0 00E+00	0 00E+00	0 00E+00	0 00E+00	3 63E-04	0 00E+00	0 00E+00	1 37E-02	1 83E+01	7 47E-04	1 83E+02	7 48E-05
Di-n-Butyl Phthalate	0 00E+00	mg/L	0 00E+00	mg/kg	4 60E-01	mg/kg	1 00E+00			1 50E+01		2 76E-01	1 32E-04		0 00E+00	0 00E+00	3 07E-03	0 00E+00	0 00E+00	0 00E+00	0 00E+00	4 19E-02	0 00E+00	0 00E+00	4 50E-02	5 50E+02	8 18E-05	1 83E+03	2 45E-05

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi\,x\,Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
EEQ = Ecological Effects Quotient
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
mg/L = milligrams per liter
mg/kg-d = milligrams per kilogram per day
NOAEL = No Observed Adverse Effect Leve
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): See appropriate text tables for equations
LOAEL and NOAEL values from appropriate toxicity summary tables in the text
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium
Receptor diet data and home range data from appropriate text table
Exposure point concentrations (EPCs) from appropriate text tables

Species-Specific Factors

Terrestrial plant diet fraction =	1	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq Invert diet fraction =	0	unitless
Terr Invert diet fraction =	0	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0 00022	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0 01089	kg/d
Body weight =	0 033	kg
Home range =	0 07	acres
Water intake rate =	0 00594	L/d
Site Area =	2 65	acres
Area Use Factor (AUF) =	1	unitless
Exposure Frequency (EF) =	1	unitless

Table L-4
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Red-Tailed Hawk
Group 8 Munitions Response Site
Ravenna Army Ammunition Plant, Ravenna, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF
Metals														
Antimony	0 00E+00	mg/L	0 00E+00	mg/kg	2 28E+01	mg/kg	1 00E+00			9 63E-02		3 25E-02	5 00E-02	
Cadmium	0 00E+00	mg/L	0 00E+00	mg/kg	3 96E+02	mg/kg	1 00E+00			2 43E+00		4 11E-02	1 21E-02	
Copper	0 00E+00	mg/L	0 00E+00	mg/kg	7 11E+02	mg/kg	1 00E+00			4 11E-02		3 65E-02	2 80E-02	
Lead	0 00E+00	mg/L	0 00E+00	mg/kg	9 77E+02	mg/kg	1 00E+00			2 13E-01		1 29E-02	2 32E-02	
Mercury	0 00E+00	mg/L	0 00E+00	mg/kg	8 90E-01	mg/kg	1 00E+00			1 17E+00		3 88E-01	1 92E-01	
Zinc	0 00E+00	mg/L	0 00E+00	mg/kg	1 06E+03	mg/kg	1 00E+00			7 93E-01		2 16E-01	1 21E-01	
Polychlorinated Biphenyls														
Aroclor-1254	0 00E+00	mg/L	0 00E+00	mg/kg	7 40E-01	mg/kg	1 00E+00			1 64E+01		3 60E-03	1 32E-03	
Aroclor-1260	0 00E+00	mg/L	0 00E+00	mg/kg	4 10E-01	mg/kg	1 00E+00			1 73E+01		6 40E-04	1 32E-03	
Semivolatile Organics														
Bis(2-Ethylhexyl)phthalate	0 00E+00	mg/L	0 00E+00	mg/kg	2 00E+00	mg/kg	1 00E+00			1 73E+01		5 50E-04	1 32E-04	
Di-n-Butyl Phthalate	0 00E+00	mg/L	0 00E+00	mg/kg	4 60E-01	mg/kg	1 00E+00			1 50E+01		2 76E-01	1 32E-04	

Chemical	EED Surface Water (mg/kg-d)	EED Sediment (mg/kg-d)	EED Soil (mg/kg-d)	EED Fish (mg/kg-d)	EED Aq. Invert. (mg/kg-d)	EED Terr. Invert. (mg/kg-d)	EED Aq. Plants (mg/kg-d)	EED Terr. Plants (mg/kg-d)	EED Mammals (mg/kg-d)	EED Birds (mg/kg-d)	Total EED (mg/kg-d)	TRV $_{NOAEL}$ (mg/kg-d)	HQ $_{NOAEL}$	TRV $_{LOAEL}$ (mg/kg-d)	HQ $_{LOAEL}$
Metals															
Antimony	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	1 93E-04	0 00E+00	1 93E-04	NA	NA	NA	NA
Cadmium	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	8 12E-04	0 00E+00	8 12E-04	1 45E+00	5 60E-04	2 00E+01	4 06E-05
Copper	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	3 37E-03	0 00E+00	3 37E-03	4 70E+01	7 16E-05	6 17E+01	5 46E-05
Lead	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	3 84E-03	0 00E+00	3 84E-03	3 85E+00	9 96E-04	3 85E+01	9 96E-05
Mercury	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	2 89E-05	0 00E+00	2 89E-05	4 50E-01	6 43E-05	9 00E-01	3 21E-05
Zinc	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	2 17E-02	0 00E+00	2 17E-02	1 45E+01	1 50E-03	1 31E+02	1 66E-04
Polychlorinated Biphenyls															
Aroclor-1254	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	1 65E-07	0 00E+00	1 65E-07	1 80E-01	9 19E-07	1 80E+00	9 19E-08
Aroclor-1260	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	9 16E-08	0 00E+00	9 16E-08	1 80E-01	5 09E-07	1 80E+00	5 09E-08
Semivolatile Organics															
Bis(2-Ethylhexyl)phthalate	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	4 47E-08	0 00E+00	4 47E-08	1 11E+00	4 03E-08	1 11E+01	4 03E-09
Di-n-Butyl Phthalate	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	1 03E-08	0 00E+00	1 03E-08	1 10E-01	9 34E-08	1 10E+00	9 34E-09

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi\,x\,Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
EEQ = Ecological Effects Quotient
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
mg/L = milligrams per liter
mg/kg-d = milligrams per kilogram per day
NOAEL = No Observed Adverse Effect Leve
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): See appropriate text tables for equations
LOAEL and NOAEL values from appropriate toxicity summary tables in the text
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium
Receptor diet data and home range data from appropriate text table
Exposure point concentrations (EPCs) from appropriate text tables

Species-Specific Factors

Terrestrial plant diet fraction =	0	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq Invert diet fraction =	0	unitless
Terr Invert diet fraction =	0	unitless
Mammal diet fraction =	1	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0 1243	kg/d
Body weight =	1 13	kg
Home range =	1722	acres
Water intake rate =	0 06441	L/d
Site Area =	2 65	acres
Area Use Factor (AUF) =	0 00153891	unitless
Exposure Frequency (EF) =	1	unitless

Table L-5
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Barn Owl
Group 8 Munitions Response Site
Ravenna Army Ammunition Plant, Ravenna, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water (mg/kg-d)	EED Sediment (mg/kg-d)	EED Soil (mg/kg-d)	EED Fish (mg/kg-d)	EED Aq. Invert. (mg/kg-d)	EED Terr. Invert. (mg/kg-d)	EED Aq. Plants (mg/kg-d)	EED Terr. Plants (mg/kg-d)	EED Mammals (mg/kg-d)	EED Birds (mg/kg-d)	Total EED mg/kg-d	TRV_{NOAEL} (mg/kg-d)	HQ_{NOAEL}	TRV_{LOAEL} (mg/kg-d)	HQ_{LOAEL}
Metals																													
Antimony	0 00E+00	mg/L	0 00E+00	mg/kg	2 28E+01	mg/kg	1 00E+00			9 63E-02		3 25E-02	5 00E-02		0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	6 11E-04	0 00E+00	6 11E-04	NA	NA	NA	NA
Cadmium	0 00E+00	mg/L	0 00E+00	mg/kg	3 96E+02	mg/kg	1 00E+00			2 43E+00		4 11E-02	1 21E-02		0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	2 57E-03	0 00E+00	2 57E-03	1 45E+00	1 77E-03	NA	NA
Copper	0 00E+00	mg/L	0 00E+00	mg/kg	7 11E+02	mg/kg	1 00E+00			4 11E-02		3 65E-02	2 80E-02		0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	1 07E-02	0 00E+00	1 07E-02	4 70E+01	2 27E-04	NA	NA
Lead	0 00E+00	mg/L	0 00E+00	mg/kg	9 77E+02	mg/kg	1 00E+00			2 13E-01		1 29E-02	2 32E-02		0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	1 21E-02	0 00E+00	1 21E-02	3 85E+00	3 16E-03	NA	NA
Mercury	0 00E+00	mg/L	0 00E+00	mg/kg	8 90E-01	mg/kg	1 00E+00			1 17E+00		3 88E-01	1 92E-01		0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	9 16E-05	0 00E+00	9 16E-05	4 50E-01	2 04E-04	NA	NA
Zinc	0 00E+00	mg/L	0 00E+00	mg/kg	1 06E+03	mg/kg	1 00E+00			7 93E-01		2 16E-01	1 21E-01		0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	6 88E-02	0 00E+00	6 88E-02	1 45E+01	4 75E-03	NA	NA
Polychlorinated Biphenyls																													
Aroclor-1254	0 00E+00	mg/L	0 00E+00	mg/kg	7 40E-01	mg/kg	1 00E+00			1 64E+01		3 60E-03	1 32E-03		0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	5 24E-07	0 00E+00	5 24E-07	1 80E-01	2 91E-06	NA	NA
Aroclor-1260	0 00E+00	mg/L	0 00E+00	mg/kg	4 10E-01	mg/kg	1 00E+00			1 73E+01		6 40E-04	1 32E-03		0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	2 90E-07	0 00E+00	2 90E-07	1 80E-01	1 61E-06	NA	NA
Semivolatile Organics																													
Bis(2-Ethylhexyl)phthalate	0 00E+00	mg/L	0 00E+00	mg/kg	2 00E+00	mg/kg	1 00E+00			1 73E+01		5 50E-04	1 32E-04		0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	1 42E-07	0 00E+00	1 42E-07	1 11E+00	1 28E-07	NA	NA
Di-n-Butyl Phthalate	0 00E+00	mg/L	0 00E+00	mg/kg	4 60E-01	mg/kg	1 00E+00			1 50E+01		2 76E-01	1 32E-04		0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	0 00E+00	3 26E-08	0 00E+00	3 26E-08	1 10E-01	2 96E-07	NA	NA

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi\,x\,Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
EEQ = Ecological Effects Quotient
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
mg/L = milligrams per liter
mg/kg-d = milligrams per kilogram per day
NOAEL = No Observed Adverse Effect Leve
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box See appropriate text tables for equations
LOAEL and NOAEL values from appropriate toxicity summary tables in the text
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium
Receptor diet data and home range data from appropriate text table
Exposure point concentrations (EPCs) from appropriate text tables

Species-Specific Factors

Terrestrial plant diet fraction =	0	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq Invert diet fraction =	0	unitless
Terr Invert diet fraction =	0	unitless
Mammal diet fraction =	1	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0 05825	kg/d
Body weight =	0 466	kg
Home range =	617 8	acres
Water intake rate =	0 0163	L/d
Site Area =	2 65	acres
Area Use Factor (AUF) =	0 00428941	unitless
Exposure Frequency (EF) =	1	unitless

Table L-6
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Red Fox
Group 8 Munitions Response Site
Ravenna Army Ammunition Plant, Ravenna, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF
Metals														
Antimony	0 00E+00	mg/L	0 00E+00	mg/kg	2 28E+01	mg/kg	1 00E+00			9 63E-02		3 25E-02	5 00E-02	
Cadmium	0 00E+00	mg/L	0 00E+00	mg/kg	3 96E+02	mg/kg	1 00E+00			2 43E+00		4 11E-02	1 21E-02	
Copper	0 00E+00	mg/L	0 00E+00	mg/kg	7 11E+02	mg/kg	1 00E+00			4 11E-02		3 65E-02	2 80E-02	
Lead	0 00E+00	mg/L	0 00E+00	mg/kg	9 77E+02	mg/kg	1 00E+00			2 13E-01		1 29E-02	2 32E-02	
Mercury	0 00E+00	mg/L	0 00E+00	mg/kg	8 90E-01	mg/kg	1 00E+00			1 17E+00		3 88E-01	1 92E-01	
Zinc	0 00E+00	mg/L	0 00E+00	mg/kg	1 06E+03	mg/kg	1 00E+00			7 93E-01		2 16E-01	1 21E-01	
Polychlorinated Biphenyls														
Aroclor-1254	0 00E+00	mg/L	0 00E+00	mg/kg	7 40E-01	mg/kg	1 00E+00			1 64E+01		3 60E-03	1 32E-03	
Aroclor-1260	0 00E+00	mg/L	0 00E+00	mg/kg	4 10E-01	mg/kg	1 00E+00			1 73E+01		6 40E-04	1 32E-03	
Semivolatile Organics														
Bis(2-Ethylhexyl)phthalate	0 00E+00	mg/L	0 00E+00	mg/kg	2 00E+00	mg/kg	1 00E+00			1 73E+01		5 50E-04	1 32E-04	
Di-n-Butyl Phthalate	0 00E+00	mg/L	0 00E+00	mg/kg	4 60E-01	mg/kg	1 00E+00			1 50E+01		2 76E-01	1 32E-04	

Chemical	EED Surface Water (mg/kg-d)	EED Sediment (mg/kg-d)	EED Soil (mg/kg-d)	EED Fish (mg/kg-d)	EED Aq. Invert. (mg/kg-d)	EED Terr. Invert. (mg/kg-d)	EED Aq. Plants (mg/kg-d)	EED Terr. Plants (mg/kg-d)	EED Mammals (mg/kg-d)	EED Birds (mg/kg-d)	Total EED (mg/kg-d)	TRV_{NOAEL} (mg/kg-d)	HQ_{NOAEL}	TRV_{LOAEL} (mg/kg-d)	HQ_{LOAEL}
Metals															
Antimony	0 00E+00	0 00E+00	7 87E-05	0 00E+00	0 00E+00	0 00E+00	0 00E+00	4 24E-06	1 35E-04	0 00E+00	2 18E-04	1 25E-01	1 75E-03	1 25E+00	1 75E-04
Cadmium	0 00E+00	0 00E+00	1 37E-03	0 00E+00	0 00E+00	0 00E+00	0 00E+00	9 32E-05	5 69E-04	0 00E+00	2 03E-03	1 00E+00	2 03E-03	1 00E+01	2 03E-04
Copper	0 00E+00	0 00E+00	2 46E-03	0 00E+00	0 00E+00	0 00E+00	0 00E+00	1 48E-04	2 36E-03	0 00E+00	4 96E-03	1 17E+01	4 24E-04	1 51E+01	3 28E-04
Lead	0 00E+00	0 00E+00	3 37E-03	0 00E+00	0 00E+00	0 00E+00	0 00E+00	7 21E-05	2 69E-03	0 00E+00	6 13E-03	8 00E+00	7 67E-04	8 00E+01	7 67E-05
Mercury	0 00E+00	0 00E+00	3 07E-06	0 00E+00	0 00E+00	0 00E+00	0 00E+00	1 98E-06	2 03E-05	0 00E+00	2 53E-05	1 00E+00	2 53E-05	5 00E+00	5 06E-06
Zinc	0 00E+00	0 00E+00	3 66E-03	0 00E+00	0 00E+00	0 00E+00	0 00E+00	1 31E-03	1 52E-02	0 00E+00	2 02E-02	1 60E+02	1 26E-04	3 20E+02	6 31E-05
Polychlorinated Biphenyls															
Aroclor-1254	0 00E+00	0 00E+00	2 56E-06	0 00E+00	0 00E+00	0 00E+00	0 00E+00	1 52E-08	1 16E-07	0 00E+00	2 69E-06	1 40E-01	1 92E-05	6 90E-01	3 89E-06
Aroclor-1260	0 00E+00	0 00E+00	1 42E-06	0 00E+00	0 00E+00	0 00E+00	0 00E+00	1 50E-09	6 42E-08	0 00E+00	1 48E-06	1 40E-01	1 06E-05	6 90E-01	2 15E-06
Semivolatile Organics															
Bis(2-Ethylhexyl)phthalate	0 00E+00	0 00E+00	6 91E-06	0 00E+00	0 00E+00	0 00E+00	0 00E+00	6 29E-09	3 13E-08	0 00E+00	6 94E-06	1 83E+01	3 79E-07	1 83E+02	3 79E-08
Di-n-Butyl Phthalate	0 00E+00	0 00E+00	1 59E-06	0 00E+00	0 00E+00	0 00E+00	0 00E+00	7 26E-07	7 20E-09	0 00E+00	2 32E-06	5 50E+02	4 22E-09	1 83E+03	1 27E-09

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi\,x\,Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
EEQ = Ecological Effects Quotient
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
mg/kg-day = milligrams per kilogram per day
mg/L = milligrams per liter
NOAEL = No Observed Adverse Effect Leve
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): See appropriate text tables for equations
LOAEL and NOAEL values from appropriate toxicity summary tables in the text
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium
Receptor diet data and home range data from appropriate text tables
Exposure point concentrations (EPCs) from appropriate text tables

Species-Specific Factors

Terrestrial plant diet fraction =	0 046	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq Invert diet fraction =	0	unitless
Terr Invert diet fraction =	0	unitless
Mammal diet fraction =	0 954	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0 009	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0 324	kg/d
Body weight =	4 69	kg
Home range =	1472 7	acres
Water intake rate =	0 399	L/d
Site Area =	2 65	acres
Area Use Factor (AUF) =	0 00179942	unitless
Exposure Frequency (EF) =	1	unitless

Appendix M
Munitions Response Site Prioritization Protocol
Worksheets

1

Table A

MRS Background Information

DIRECTIONS: Record the background information below for the MRS to be evaluated. Much of this information is available from DoD databases, such as RMIS. If the MRS is located on a FUDS property, the suitable FUDS property information should be substituted. In the MRS summary, briefly describe the UXO, DMM, or MC that are known or suspected to be present, the exposure setting (the MRS's physical environment), any other incidental non-munitions related contaminants found at the MRS (e.g., benzene, trichloroethylene), and any potentially exposed human and ecological receptors. Include a map of the MRS, if one is available.

Munitions Response Site (MRS) Name:	**Group 8 MRS**
Component:	US Army
Installation/Property Name:	**Ravenna Army Ammunition Plant**
Location (City, County, State):	Newton Falls, Portage and Trumbull Counties, Ohio
UTM Coordinates (NAD83):	X = 496687.252403 Y = 4559101.976339
Site Name (RMIS ID):	OH213820736
Project Name (Project No.):	Ravenna Army Ammunition Plant Group 8 MRS (RVAAP-063-R-01) Remedial Investigation
Date Information Entered/Updated:	13-Dec-2012
Point of Contact (Name/Phone):	Eeda Wallbank (202.261.1954)

Project Phase ("X" only one):										
		PA		**SI**	X	**RI**		**FS**		**RD**
		RA-C		**RIP**		**RA-O**		**RC**		**LTM**

Media Evaluated ("X" all that apply):				
		Groundwater (human receptor)		**Sediment (human receptor)**
	X	**Surface soil (human receptor)**		**Surface water (ecological receptor)**
		Sediment (ecological receptor)		**Surface water (human receptor)**

MRS Summary

MRS Description: Describe the munitions-related activities that occurred at the installation, the dates of operation, and the UXO, DMM (by type of munition, if known) or munitions constituents (by type, if known) known or suspected to be present):

The Group 8 MRS is a 2.65-acre MRS and is located between Buildings 846 and 849. The MRS was used for an undetermined amount of time to burn construction debris and rubbish. Although it has not been documented, previous discoveries of MEC and MD indicate that the area also received various munitions items which may also have been burned at the MRS. After burning activities ceased, the area was used as an staging area for military vehicles. The MRS is currently vacant with no improvements. In 1996, one anti-personnel fragmentation bomb with high-explosives and a demilitarized (i e., cut in half) 175mm projectile were both found on the ground surface within the MRS boundary. The 1996 fragmentation bomb was removed from the MRS and detonated at the Open Demolition Area #2. The demilitarized 175mm projectile was removed and taken to Building 1501 (RI Report, Section 1.4). No MEC was identified during the RI intrusive activities; however, 359 individual MD items that weighed 1,418 pounds were recovered at depths ranging from 1 inch to 4 feet bgs (RI Report, Section 4.2). MC sampling activities were conducted durin the RI field work. Site-related chemicals identified in for the media sampled at the MRS included 2 explosives, 10 inorganics, 21 SVOCs, and 2 PCBs in surface soil (0 to 0.5-foot bgs) and 8 inorganics, 14 SVOCs, and 2 PCBs in surface soil (4 to 4.5 feet bgs) (RI Report Section 4.3). Subsequent human health and ecological risk assessments determined that there were potential risks associated with MC to receptors (RI Report, Section 7.0 and 8.0).

Description of Pathways for Human and Ecological Receptors:

Although a MEC explosive hazard was not identified at the MRS during the RI, the distribution of the MD items throughout the MRS, and the reported potential MEC that was identified during previous investigations is taken into consideration. Therefore, a MEC explosive hazard may remain at the MRS and potentially complete pathways are identified for all receptors accessing surface or subsurface soils (RI Report, Section 9.1). Although no MEC was found during the RI, various MD items were encountered and detected SRCs were evaluated as MC. The SRCs for surface soils were considered to be present at concentrations great enough to pose risks to the unrestricted and military land use human and environmental receptors. The National Guard Trainee is considered as the most sensitive of the identified current and future human receptors that have the potential to be exposed to MC at the Group 8 MRS and the SRCs for subsurface soil (4 to 4.5 feet bgs) were not considered to be present at concentrations great enough to pose a risk. Therefore, the MC CSM for the National Guard Trainee has been updated to reflect a complete pathway for surface soil and incomplete pathway for subsurface soil. Various SRCs in surface soil were determined to present potential threats to likely ecological receptors; therefore the MC exposure pathways for ecological receptors in surface soil are considered complete. The MC exposure pathways for ecological receptors at the MRS to the aquatic environments, including surface water and sediment, the plant/game/fish/prey exposure media, and groundwter are considered incomplete (RI Report, Section 9.2).

Description of Receptors (Human and Ecological):

Human receptors identified for the Group 8 MRS include both current and anticipated future land users. Human receptors associated with the current land uses at the MRS include facility personnel and contractors. The National Guard Trainee has been identified as a future land use receptor. The National Guard Trainee is the most sensitive of the identified current and future human receptors that has the potential to be exposed to MEC and MC (RI Report, Section 9.1.4). Ecological receptors (biota) have been identified to include terrestrial invertebrates (earthworms), voles, shrews, robins, foxes, barn owls, and hawks. The biota consist of mammals and birds known to be present at the RVAAP and based on the MRS physical setting are reasonably anticipated to be present on either a permanent or transient basis at the terrestrial habitats at the Group 8 MRS (RI Report, Section 9.1.4).

Table 1
EHE Module: Munitions Type Data Element Table

Directions: Below are eleven classifications of munitions and their descriptions. Annotate the score(s) that correspond with **all** munitions types known or suspected to be present at the MRS.

Note: The terms *practice munitions*, *small arms*, *physical evidence*, and *historical evidence* are defined in Appendix C of the MRSPP Primer (Draft, Dec 2005).

Classification	Description	Possible Score	Score
Sensitive	All UXO that are considered likely to function upon any interaction with exposed persons [e.g., submunitions, 40mm high-explosive (HE) grenades, white phosphorous (WP) munitions, high-explosive antitank (HEAT) munitions, and practice munitions with sensitive fuzes, but excluding all other practice munitions].	30	30
	All hand grenades containing energetic filler.		
	Bulk primary explosives, or mixtures of these with environmental media, such that the mixture poses an explosive hazard.		
High explosive (used or damaged)	All UXO containing a high-explosive filler (e.g., RDX, Composition B), that are not considered "sensitive."	25	
	All DMM containing a high-explosive filler that have been damaged by burning or detonation, or deteriorated to the point of instability.		
Pyrotechnic (used or damaged)	All UXO containing pyrotechnic fillers other than white phosphorous (e.g., flares, signals, simulators, smoke grenades).	20	
	All DMM containing pyrotechnic fillers other than white phosphorous (e.g., flares, signals, simulators, smoke grenades) that have been damaged by burning or detonation, or deteriorated to the point of instability.		
High explosive (unused)	All DMM containing a high-explosive filler that have not been damaged by burning or detonation, or are not deteriorated to the point of instability.	15	
Propellant	All UXO containing mostly single-, double-, or triple-based propellant, or composite propellants (e.g., a rocket motor).	15	
	All DMM containing mostly single-, double-, or triple-based propellant, or composite propellants (e.g., a rocket motor) that are damaged by burning or detonation, or deteriorated to the point of instability.		
Bulk secondary high explosives, pyrotechnics, or propellant	All DMM containing mostly single-, double-, or triple-based propellant, or composite propellants (e.g., a rocket motor), that are deteriorated.	10	
	Bulk secondary high explosives, pyrotechnic compositions, or propellant (not contained in a munition), or mixtures of these with environmental media such that the mixture poses an explosive hazard.		
Pyrotechnic (not used or damaged)	All DMM containing a pyrotechnic filler (i.e. red phosphorous), other than white phosphorous filler, that have not been damaged by burning or detonation, or are not deteriorated to the point of instability.	10	
Practice	All UXO that are practice munitions that are not associated with a sensitive fuze.	5	
	All DMM that are practice munitions that are not associated with a sensitive fuze and that have not been damaged by burning or detonation, or are not deteriorated to the point of instability.		
Riot control	All UXO or DMM containing a riot control agent filler (e.g., tear gas).	3	
Small arms	All used munitions or DMM that are categorized as small arms ammunition [Physical evidence or historical evidence that no other types of munitions (e.g., grenades, subcaliber training rockets, demolition charges) were used or are present on the MRS is required for selection of this category.].	2	
Evidence of no munitions	Following investigation of the MRS, there is physical evidence that there are no UXO or DMM present, or there is historical evidence indicating that no UXO or DMM are present.	0	
MUNITIONS TYPE	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 30).		**30**

DIRECTIONS: Document any MRS-specific data used in selecting the ***Munitions Type*** classifications in the space below.

No MEC was identified at the MRS during the RI intrusive investigation activities; however, MD items of various types, including M397 series 40 millimeter (mm) high explosive (HE) grenades, M49 series 60mm mortars, M72 series 75mm projectile, M557 series fuzes, 175mm projectiles, HE anti-tank warheads, and assorted fuzes, were encountered at depths ranging from 1 inch to 4 feet bgs (RI Report, Section 4.1.3.1 and 4.1.3.2).

Table 2

EHE Module: Source of Hazard Data Element Table

Directions: Below are eleven classifications describing sources of explosive hazards. Annotate the score(s) that correspond with **all** sources of explosive hazards known or suspected to be present at the MRS.

Note: The terms *former range* , *practice munitions* , *small arms* , *physical evidence* , and *historical evidence* are defined in Appendix C of the MRSPP Primer (Draft, Dec 2005).

Classification	Description	Possible Score	Score
Former range	The MRS is a former military range where munitions (including practice munitions with sensitive fuzes) have been used. Such areas include: impact or target areas, associated buffer and safety zones, firing points, and live-fire maneuver areas.	10	
Former munitions treatment (i.e. OB/OD) unit	The MRS is a location where UXO or DMM (e.g., munitions, bulk explosives, bulk pyrotechnic, or bulk propellants) were burned or detonated for the purpose of treatment prior to disposal.	8	8
Former practice munitions range	The MRS is a former military range on which only practice munitions without sensitive fuzes were used.	6	
Former maneuver area	The MRS is a former maneuver area where no munitions other than flares, simulators, smokes, and blanks were used. There must be evidence that no other munitions were used at the location to place an MRS into this category.	5	
Former burial pit or other disposal area	The MRS is a location where DMM were buried or disposed of (e.g., disposed of into a water body) without prior thermal treatment.	5	
Former industrial operating facilities	The MRS is a location that is a former munitions maintenance, manufacturing, or demilitarization facility.	4	
Former firing points	The MRS is a firing point, where the firing point is delineated as an MRS separate from the rest of a former military range.	4	
Former missile or air defense artillery emplacements	The MRS is a former missile defense or air defense artillery (ADA) emplacement not associated with a military range.	2	
Former storage or transfer points	The MRS is a location where munitions were stored or handled for transfer between different modes of transportation (e.g., rail to truck, truck to weapon system).	2	
Former small arms range	The MRS is a former military range where only small arms ammunition was used [There must be evidence that no other types of munitions (e.g., grenades) were used or are present to place an MRS iinto this category.].	1	
Evidence of no munitions	Following investigation of the MRS, there is physical evidence that no UXO or DMM are present, or there is historical evidence indicating that no UXO or DMM are present.	0	
SOURCE OF HAZARD	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 10).		**8**

DIRECTIONS: Document any MRS-specific data used in selecting the **Source of Hazard** classifications in the space below.

Based on historical information, the category used for this input was determined to be former muntitions treatment (OB/OD) (RI Report, Section 1.4).

Table 3
EHE Module: Location of Munitions Data Element Table

Directions: Below are eight classifications of munitions locations and their descriptions. Annotate the score(s) that correspond with **all** locations where munitions are located or suspected of being found at the MRS.

Note: The terms *surface*, *subsurface*, *physical evidence*, and *historical evidence* are defined in Appendix C of the MRSPP Primer (Draft, Dec 2005).

Classification	Description	Possible Score	Score
Confirmed surface	Physical evidence indicates that there are UXO or DMM on the surface of the MRS. Historical evidence (e.g., a confirmed incident report or accident report) indicates there are UXO or DMM on the surface of the MRS.	25	
Confirmed subsurface, active	Physical evidence indicates the presence of UXO or DMM in the subsurface of the MRS, and the geological conditions at the MRS are likely to cause UXO or DMM to be exposed, in the future, by naturally occurring phenomena (e.g., drought, flooding, erosion, frost, heat heave, tidal action), or intrusive activities (e.g., plowing, construction, dredging) at the MRS are likely to expose UXO or DMM. Historical evidence indicates that UXO or DMM are located in the subsurface of the MRS and the geological conditions at the MRS are likely to cause UXO or DMM to be exposed, in the future, by naturally occurring phenomena (e.g., drought, flooding, erosion, frost, heat heave, tidal action), or intrusive activities (e.g., plowing, construction, dredging) at the MRS are likely to expose UXO or DMM.	20	
Confirmed subsurface, stable	Physical evidence indicates the presence of UXO or DMM in the subsurface of the MRS, and the geological conditions at the MRS are not likely to cause UXO or DMM to be exposed, in the future, by naturally occurring phenomena, or intrusive activities at the MRS are not likely to cause UXO or DMM to be exposed. Historical evidence indicates that UXO or DMM are located in the subsurface of the MRS, and the geological conditions at the MRS are not likely to cause UXO or DMM to be exposed, in the future, by naturally occurring phenomena, or intrusive activities at the MRS are not likely to cause UXO or DMM to be exposed.	15	
Suspected (physical evidence)	There is physical evidence (e.g., munitions debris, such fragments, penetrators, projectiles, shell casings, links, fins), other than the documented presence of UXO or DMM, indicating that UXO or DMM may be present at the MRS.	10	10
Suspected (historical evidence)	There is historical evidence indicating that UXO or DMM may be present at the MRS.	5	
Subsurface, physical constraint	There is physical or historical evidence indicating that UXO or DMM may be present in the subsurface, but there is a physical constraint (e.g., pavement, water depth over 120 feet) preventing direct access to the UXO or DMM.	2	
Small arms (regardless of location)	The presence of small arms ammunition is confirmed or suspected, regardless of other factors such as geological stability [There must be evidence that no other types of munitions (e.g., grenades) were used or are present at the MRS to place an MRS into this category.]	1	
Evidence of no munitions	Following investigation of the MRS, there is physical evidence that there are no UXO or DMM present, or there is historical evidence indicating that no UXO or DMM are present.	0	
LOCATION OF MUNITIONS	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 25).		**10**

DIRECTIONS: Document any MRS-specific data used in selecting the ***Location of Munitions*** classifications in the space below.

No MEC was identified at the MRS during the RI intrusive investigation activities; however, MD items of various types, including M397 series 40mm HE grenades, M49 series 60mm mortars, M72 series 75mm projectile, M557 series fuzes, 175mm projectiles, HE anti-tank warheads, and assorted fuzes, were encountered at depths ranging from 1 inch to 4 feet bgs (RI Report, Section 4.1.3.1 and 4.1.3.2).

Table 4
EHE Module: Ease of Access Data Element Table

Directions: Below are four classifications of barrier types that can surround an MRS and their descriptions. The barrier type is directly related to the ease of public access to any explosive materiel. Annotate the score that corresponds with the ease of access to the MRS.

Note: The term *barrier* is defined in Appendix C of the MRSPP Primer (Draft, Dec 2005).

Classification	Description	Possible Score	Score
No barrier	There is no barrier preventing access to any part of the MRS (i.e. all parts of the MRS are accessible).	10	10
Barrier to MRS access is incomplete	There is a barrier preventing access to parts of the MRS, but not the entire MRS.	8	
Barrier to MRS access is complete but not monitored	There is a barrier preventing access to all parts of the MRS, but there is no surveillance (e.g., by a guard) to ensure that the barrier is effectively preventing access to all parts of the MRS.	5	
Barrier to MRS access is complete and monitored	There is a barrier preventing access to all parts of the MRS, and there is active, continual surveillance (e.g., by a guard, video monitoring) to ensure that the barrier is effectively preventing access to all parts of the MRS.	0	
EASE OF ACCESS	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 10).		**10**

DIRECTIONS: Document any MRS-specific data used in selecting the ***Ease of Access*** classification in the space below.

There is a perimeter fence that helps prevent unauthorized access into the installation. The MRS boundary is marked with siebert stakes and signage warning receptors about the MRS to help deter access (RI Report, Section 9.1.3).

Table 5
EHE Module: Status of Property Data Element Table

Directions: Below are three classifications of the status of a property within the Department of Defense (DoD) and their descriptions. Annotate the score that corresponds with the status of property at the MRS.

Note: N/A

Classification	Description	Possible Score	Score
Non-DoD control	The MRS is at a location that is no longer owned by, leased to, or otherwise possessed or used by DoD. Examples are privately owned land or water bodies; land or water bodies owned or controlled by state, tribal, or local governments; and land or water bodies managed by other federal agencies.	5	
Scheduled for transfer from DoD control	The MRS is on land or is a water body that is owned, leased, or otherwise possessed by DoD, and DoD plans to transfer that land or water body to the control of another entity (e.g., a state, tribal, or local government; a private party; another federal agency) within 3 years from the date the rule is applied.	3	
DoD control	The MRS is on land or is a water body that is owned, leased, or otherwise possessed by DoD. With respect to property that is leased or otherwise possessed, DoD must control access to the MRS 24 hours per day, every day of the calendar year.	0	0
STATUS OF PROPERTY	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 5).		**0**

DIRECTIONS: Document any MRS-specific data used in selecting the ***Status of Property*** classification in the space below.

The Group 8 MRS is under the adminstrative control of the Army National Guard (RI Report, Section 1.3.1)

Table 6
EHE Module: Population Density Data Element Table

Directions: Below are three classifications of population density and their descriptions. Determine the population density per square mile in the vicinity of the MRS and annotate the score that corresponds with the associated population density.

Note: If an MRS is located in more than one county, use the largest population density value among the counties. If the MRS is within or borders a city or town, use the population density for the city or town, rather than that of the county.

Classification	Description	Possible Score	Score
> 500 persons per square mile	There are more than 500 persons per square mile in the county in which the MRS is located, based on US Census Bureau data.	5	
100 - 500 persons per square mile	There are 100 to 500 persons per square mile in the county in which the MRS is located, based on US Census Bureau data.	3	3
< 100 persons per square mile	There are fewer than 100 persons per square mile in the county in which the MRS is located, based on US Census Bureau data.	1	
POPULATION DENSITY	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 5).		**3**

DIRECTIONS: Document any MRS-specific data used in selecting the ***Population Density*** classification in the space below.

The population density for Portage County is 331.2 people per square mile (U.S. Census Bureau, 2010)

Table 7
EHE Module: Population Near Hazard Data Element Table

Directions: Below are six classifications describing the number of inhabited structures near the MRS. The number of inhabited buildings relates to the population near the hazard. Determine the number of inhabited structures within two miles of the MRS boundary and annotate the score that corresponds with the associated population near the known or suspected hazard.

Note: The term *inhabited structures* is defined in Appendix C of the MRSPP Primer (Draft, Dec 2005).

Classification	Description	Possible Score	Score
26 or more inhabited structures	There are 26 or more inhabited structures located up to 2 miles from the boundary of the MRS, within the boundary of the MRS, or both.	5	5
16 to 25 inhabited structures	There are 16 to 25 inhabited structures located up to 2 miles from the boundary of the MRS, within the boundary of the MRS, or both.	4	
11 to 15 inhabited structures	There are 11 to 15 inhabited structures located up to 2 miles from the boundary of the MRS, within the boundary of the MRS, or both.	3	
6 to 10 inhabited structures	There are 6 to 10 inhabited structures located up to 2 miles from the boundary of the MRS, within the boundary of the MRS, or both.	2	
1 to 5 inhabited structures	There are 1 to 5 inhabited structures located up to 2 miles from the boundary of the MRS, within the boundary of the MRS, or both.	1	
0 inhabited structures	There are no inhabited structures located up to 2 miles from the boundary of the MRS, within the boundary of the MRS, or both.	0	
POPULATION NEAR HAZARI	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 5).		**5**

DIRECTIONS: Document any MRS-specific data used in selecting the ***Population Near Hazard*** classification in the space below.

There are over 200 residences located within a 2-mile radius of the MRS. These residences primarily are located to the south in Newton Falls, Ohio (National Agriculture Imagery Program, 2011).

Table 8

EHE Module: Types of Activities/Structures Data Element Table

Directions: Below are five classifications of activities and/or inhabited structures near the hazard and their descriptions. Review the types of activities that occur and/or structures that are present within two miles of the MRS and annotate the score(s) that correspond with **all** the activities/structure classifications at the MRS.

Note: The term *inhabited structures* is defined in Appendix C of the MRSPP Primer (Draft, Dec 2005).

Classification	Description	Possible Score	Score
Residential, educational, commercial, or subsistence	Activities are conducted, or inhabited structures are located up to two miles from the MRS's boundary or within the MRS's boundary, that are associated with any of the following purposes: residential, educational, child care, critical assets (e.g., hospitals, fire and rescue, police stations, dams), hotels, commercial, shopping centers, playgrounds, community gathering areas, religious sites, or sites used for subsistence hunting, fishing, and gathering.	5	5
Parks and recreational areas	Activities are conducted, or inhabited structures are located up to two miles from the MRS's boundary or within the MRS's boundary, that are associated with parks, nature preserves, or other recreational uses.	4	
Agricultural, forestry	Activities are conducted, or inhabited structures are located up to two miles from the MRS's boundary or within the MRS's boundary, that are associated with agriculture or forestry.	3	
Industrial or warehousing	Activities are conducted, or inhabited structures are located up to two miles from the MRS's boundary or within the MRS's boundary, that are associated with industrial activities or warehousing.	2	
No known or recurring activities	There are no known or recurring activities occurring up to two miles from the MRS's boundary or within the MRS's boundary.	1	
TYPES OF ACTIVITIES/STRUCTURES	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 5).		**5**

DIRECTIONS: Document any MRS-specific data used in selecting the ***Types of Activities/Structures*** classifications in the space below.

There are over 200 residences located within a 2-mile radius of the MRS. The residences are located primarily to the south in Newton Falls, Ohio (National Agriculture Imagery Program, 2011).

Table 9

EHE Module: Ecological and/or Cultural Resources Data Element Table

Directions: Below are four classifications of ecological and/or cultural resources and their descriptions. Review the types of resources present and annotate the score that corresponds with the ecological and/or cultural resource classifications at the MRS.

Note: The terms *ecological resources* and *cultural resources* are defined in Appendix C of the MRSPP Primer (Draft, Dec 2005).

Classification	Description	Possible Score	Score
Ecological and cultural resources present	There are both ecological and cultural resources present on the MRS.	5	
Ecological resources present	There are ecological resources present on the MRS.	3	3
Cultural resources present	There are cultural resources present on the MRS.	3	
No ecological or cultural resources present	There are no ecological resources or cultural resources present on the MRS.	0	
ECOLOGICAL AND/OR CULTURAL RESOURCES	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 5).		**3**

DIRECTIONS: Document any MRS-specific data used in selecting the ***Ecological and/or Cultural Resources*** classification in the space below.

Biological inventories have not occurred within the MRS boundary and no confirmed sightings of state-listed species have been reported; however, there is the potential for state listed or rare species to be within the MRS boundary (RI Report, Section 1.3.8). A number of archeological surveys have been conducted at the RVAAP. Cultural and archeological resources have been identified at the RVAAP during past surveys. The Group 8 MRS has not been previously surveyed for cultural or archaeological resources; however, due to the disturbed nature of the ground from former activities, it is unlikely that cultural/archaeological resources exist at the MRS (RI Report, Section 1.3.9).

Table 10

Determining the EHE Module Rating

DIRECTIONS:		Source	Score	Value
	Explosive Hazard Factor Data Elements			
1. From Tables 01 - 09, record the data element scores in the **Score** boxes to the right.	Munitions Type	Table 01	30	38
	Source of Hazard	Table 02	8	
	Accessibility Factor Data Elements			
	Location of Munitions	Table 03	10	20
	Ease of Access	Table 04	10	
2. Add the **Score** boxes for each of the three factors and record this number in the **Value** boxes to the right.	Status of Property	Table 05	0	
	Receptor Factor Data Elements			
	Population Density	Table 06	3	16
	Population Near Hazard	Table 07	5	
3. Add the three **Value** boxes and record this number in the **EHE Module Total** box below.	Types of Activities/Structures	Table 08	5	
	Ecological and/or Cultural Resources	Table 09	3	
	EHE MODULE TOTAL			**74**

	EHE Module Total	EHE Module Rating
4. Identify the appropriate range for the **EHE Module Total** at right.	92 to 100	A
	82 to 91	B
	71 to 81	C
	60 to 70	D
5. Identify the **EHE Module Rating** that corresponds to the range selected and record this rating in the **EHE Module Rating** box at the lower right corner of this table.	48 to 59	E
	38 to 47	F
	less than 38	G
NOTE: An alternative module rating may be assigned when a module letter rating is inappropriate. An alternative module rating is used when more information is needed to score one or more data elements, contamination at an MRS was previously addressed, or there is no reason to suspect contamination was ever present at an MRS.	Alternative Module Ratings	Evaluation Pending
		No Longer Required
		No Known or Suspected Explosive Hazard
	EHE MODULE RATING	**C**

Table 11

CHE Module: CWM Configuration Data Element Table

Directions: Below are seven classifications of CWM configuration and their descriptions. Annotate the score(s) that correspond to **all** CWM configurations known or suspected to be present at the MRS.

Note: The terms *CWM/UXO*, *CWM/DMM*, *physical evidence*, and *historical evidence* are defined in Appendix C of the MRSPP Primer (Draft, Dec 2005).

Classification	Description	Possible Score	Score
CWM, explosive configuration either UXO or damaged DMM	The CWM known or suspected of being present at the MRS is (a) explosively configured CWM that are UXO (i.e. CWM/UXO), or (b) explosively configured CWM that are DMM (i.e. CWM/DMM) that have been damaged.	30	
CWM mixed with UXO	The CWM known or suspected of being present at the MRS are explosively configured CWM/DMM that have not been damaged, or nonexplosively configured CWM/DMM, or CWM not configured as a munition, that are commingled with conventional munitions that are UXO.	25	
CWM, explosive configuration that are undamaged DMM	The CWM known or suspected of being present at the MRS are explosively configured CWM/DMM that have not been damaged.	20	
CWM, not explosively configured or CWM, bulk container	The CWM known or suspected of being present at the MRS is (a) nonexplosively configured CWM/DMM, or (b) bulk CWM/DMM (e.g., ton container).	15	
CAIS K941 and CAIS K942	The CWM/DMM known or suspected of being present at the MRS is CAIS K941(toxic gas set M-1) or CAIS K942 (toxic gas set M-2/E11).	12	
CAIS (chemical agent identification sets)	Only CAIS, other than CAIS K941 and K942, are known or suspected of being present at the MRS.	10	
Evidence of no CWM	Following investigation, the physical evidence indicates that CWM are not present at the MRS, or the historical evidence indicates that CWM are not present at the MRS.	0	0
CWM CONFIGURATION	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 30).		**0**

DIRECTIONS: Document any MRS-specific data used in selecting the ***CWM Configuration*** classifications in the space below.

The RVAAP is listed on the Non-Stockpile CWM List as a site with known or possible buried CWM; however, there is no known historical or physical evidence of CWM being produced, stored, or used at the MRS. As such, Tables 12-19 are not applicable and have intentionally been omitted according to active Army guidance.

Tables 12 through 19 intentionally omitted according to Army Guidance

Table 20

Determining the CHE Module Rating

DIRECTIONS:		Source	Score	Value
	CWM Hazard Factor Data Elements			
1. From Tables 11 - 19, record the data element scores in the **Score** boxes to the right.	CWM Configuration	Table 11	0	0
	Sources of CWM	Table 12	0	
	Accessibility Factor Data Elements			
	Location of CWM	Table 13	0	0
2. Add the **Score** boxes for each of the three factors and record this number in the **Value** boxes to the right.	Ease of Access	Table 14	0	
	Status of Property	Table 15	0	
	Receptor Factor Data Elements			
	Population Density	Table 16	0	0
	Population Near Hazard	Table 17	0	
3. Add the three **Value** boxes and record this number in the **CHE Module Total** box below.	Types of Activities/Structures	Table 18	0	
	Ecological and/or Cultural Resources	Table 19	0	
	CHE MODULE TOTAL			**No Known or Suspected CWM Hazard**

	CHE Module Total	**CHE Module Rating**
4. Identify the appropriate range for the **CHE Module Total** at right.	92 to 100	A
	82 to 91	B
	71 to 81	C
	60 to 70	D
5. Identify the **CHE Module Rating** that corresponds to the range selected and record this rating in the **CHE Module Rating** box at the lower right corner of this table.	48 to 59	E
	38 to 47	F
	less than 38	G
NOTE: An alternative module rating may be assigned when a module letter rating is inappropriate. An alternative module rating is used when more information is needed to score one or more data elements, contamination at an MRS was previously addressed, or there is no reason to suspect contamination was ever present at an MRS.	Alternative Module Ratings	Evaluation Pending
		No Longer Required
		No Known or Suspected CWM Hazard
	CHE MODULE RATING	**No Known or Suspected CWM Hazard**

Table 21

HHE Module: Groundwater Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's groundwater and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard present in the groundwater, select the box at the bottom of the table.

Note: Use dissolved, rather than total, metals analyses when both are available.

Contaminant [CAS No.]	Maximum Concentration (µg/L)	Comparison Value (µg/L)	Ratios
No samples have been collected from the MRS (RI Report, Section 3.0)			
		Total from Table 27	
		Sum the Ratios	

CHF Scale	CHF Value
CHF > 100	H (High)
100 > CHF >2	M (Medium)
2 > CHF	L (Low)

CHF = $\sum$ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])

CONTAMINANT HAZARD FACTOR — Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the groundwater migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the groundwater is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in groundwater has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the groundwater to a potential point of exposure (possibly due to geological structures or physical controls).	L

MIGRATORY PATHWAY FACTOR — Directions: Record **the single highest value** from above in the box to the right (maximum value = H).

Receptor Factor

Directions: Annotate the value that corresponds most closely to the groundwater receptors at the MRS.

Classification	Description	Value
Identified	There is a threatened water supply well downgradient of the source and the groundwater is a current source of drinking water or source of water for other beneficial uses such as irrigation/agriculture (equivalent to Class I or IIA aquifer).	H
Potential	There is no threatened water supply well downgradient of the source and the groundwater is currently or potentially usable for drinking water, irrigation, or agriculture (equivalent to Class I, IIA, or IIB aquifer).	M
Limited	There is no potentially threatened water supply well downgradient of the source and the groundwater is not considered a potential source of drinking water and is of limited beneficial use (equivalent to Class IIIA or IIIB aquifer, or where perched aquifer exists only).	L

RECEPTOR FACTOR — Directions: Record **the single highest value** from above in the box to the right (maximum value = H).

Place an "X" in the box to the right if there is no known or suspected Groundwater MC Hazard

Table 22

HHE Module: Surface Water - Human Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's surface water and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard present in the surface water, select the box at the bottom of the table.

Note: Use dissolved, rather than total, metals analyses when both are available.

Contaminant [CAS No.]	Maximum Concentration (µg/L)	Comparison Value (µg/L)	Ratios
No samples have been collected a the MRS (RI Report, Section 3.0)			
		Total from Table 27	
CHF Scale	**CHF Value**	**Sum the Ratios**	
CHF > 100	**H (High)**		
100 > CHF >2	**M (Medium)**	CHF = ∑ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])	
2 > CHF	**L (Low)**		

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface water migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the surface water is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in surface water has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the surface water to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L
MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface water receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to surface water to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to surface water to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to surface water to which contamination has moved or can move.	L
RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Place an "X" in the box to the right if there is no known or suspected Surface Water (Human Endpoint) MC Hazard	

Table 23

HHE Module: Sediment - Human Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the site's sediment and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard for human endpoints present in the sediment, select the box at the bottom of the table.

Note: N/A

Contaminant [CAS No.]	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
No samples have been collected at the MRS (RI Report, Section 3.0)			
		Total from Table 27	
CHF Scale	**CHF Value**	**Sum the Ratios**	
CHF > 100	**H (High)**		
100 > CHF >2	**M (Medium)**	CHF = $\sum$ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])	
2 > CHF	**L (Low)**		

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface water migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the sediment is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in sediment has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the sediment to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L
MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface water receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to sediment to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to sediment to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to sediment to which contamination has moved or can move.	L
RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Place an "X" in the box to the right if there is no known or suspected Sediment (Human Endpoint) MC Hazard	

Table 24

HHE Module: Surface Water - Ecological Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's surface water and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard for ecological endpoints present in the surface water, select the box at the bottom of the table.

Note: Use either dissolved or total metals analyses.

Contaminant [CAS No.]	Maximum Concentration (µg/L)	Comparison Value (µg/L)	Ratios
No samples have been collected at the MRS (RI Report, Section 3.0)			
		Total from Table 27	
CHF Scale	**CHF Value**	**Sum the Ratios**	
CHF > 100	**H (High)**	CHF = $\sum$ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])	
100 > CHF >2	**M (Medium)**		
2 > CHF	**L (Low)**		

CONTAMINANT HAZARD FACTOR — Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface water migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the surface water is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in surface water has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the surface water to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L

MIGRATORY PATHWAY FACTOR — Directions: Record **the single highest value** from above in the box to the right (maximum value = H).

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface water receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to surface water to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to surface water to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to surface water to which contamination has moved or can move.	L

RECEPTOR FACTOR — Directions: Record **the single highest value** from above in the box to the right (maximum value = H).

Place an "X" in the box to the right if there is no known or suspected Surface Water (Ecological Endpoint) MC Hazard

Table 25

HHE Module: Sediment - Ecological Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's sediment and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard for ecological endpoints present in the sediment, select the box at the bottom of the table.

Note: N/A

Contaminant [CAS No.]	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
No samples have been collected at the MRS (RI Report, Section 3.0)			
		Total from Table 27	
CHF Scale	**CHF Value**	**Sum the Ratios**	
CHF > 100	**H (High)**		
100 > CHF >2	**M (Medium)**	$CHF = \sum$ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])	
2 > CHF	**L (Low)**		

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface water migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the sediment is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in sediment has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the sediment to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L
MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface water receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to sediment to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to sediment to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to sediment to which contamination has moved or can move.	L
RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Place an "X" in the box to the right if there is no known or suspected Sediment (Ecological Endpoint) MC Hazard	

Table 26

HHE Module: Surface Soil - Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's surface soil and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard present in the surface soil, select the box at the bottom of the table.

Note: N/A

Contaminant [CAS No.]	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
Cadmium [7440-43-9]	396.00	39.00	10
Iron [7439-89-6]	50,300.00	2,300.00	22
Lead [7439-92-1]	977.00	400.00	2
Benzo(a)anthracene [56-55-3]	0.41	62.00	0
Benzo(a)pyrene [50-32-8]	0.27	6.20	0
		Total from Table 27	1
CHF Scale	**CHF Value**	**Sum the Ratios**	35
CHF > 100	**H (High)**	**CHF = ∑ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])**	
100 > CHF >2	**M (Medium)**		
2 > CHF	**L (Low)**		

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	**M**

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface soil migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the surface soil is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in surface soil has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the surface soil to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L
MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	**M**

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface soil receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to surface soil to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to surface soil to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to surface soil to which contamination has moved or can move.	L
RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	**M**

Place an "X" in the box to the right if there is no known or suspected Surface Soil MC Hazard	

Table 27

HHE Module: Supplemental Contaminant Hazard Factor Table

Contaminant Hazard Factor (CHF)

Directions: **Only use this table if there are more than five contaminants present at the MRS.** This is a supplemental table designed to hold information about contaminants that do not fit in the previous tables Indicate the **media** in which these contaminants are present Then record all **contaminants**, their **maximum concentrations** and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below Calculate and record the **ratio** for each contaminant by dividing the **maximum concentration** by the **comparison value** Determine the **CHF** for each medium on the appropriate media-specific tables

Note: For human exposures to groundwater and surface water, use dissolved, rather than total, metals analyses when both are available Remember not to add ratios from different media

Media	Contaminant [CAS No.]	Maximum Concentration	Units	Comparison Value	Units	Ratios
Surface soil	Benzo(b)fluoranthene [205-99-2]	0 46	mg/kg	62 00	mg/kg	0
Surface soil	Dibenzo(a,h)anthracene [53-70-3]	0 06	mg/kg	6 20	mg/kg	0
Surface soil	Acrolor-1254 [11097-69-1]	0 74	mg/kg	1 10	mg/kg	1
Surface soil	Acrolor-1260 [11096-82-5]	0 41	mg/kg	22 00	mg/kg	0
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
					SUBTOTAL FOR SURFACE SOIL	**1**
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
					SUBTOTAL FOR SEDIMENT	**0**
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
					SUBTOTAL FOR SURFACE WATER	**0**
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
					SUBTOTAL FOR GROUNDWATER	**0**

Table 28

Determining the HHE Module Rating

DIRECTIONS:

1 Record the letter values (H, M, L) for the **Contaminant Hazard**, **Migration Pathway**, and **Receptor Factors** for the media (from Tables 21 - 26) in the corresponding boxes below

2 Record the media's three-letter combinations in the **Three-Letter-Combination** boxes below (three-letter combinations are arranged from Hs to Ms to Ls)

3 Using the reference provided below, determine each medium's rating (A - G) and record the letter in the corresponding **Media Rating** box below

Medium (Source)	Contaminant Hazard Factor Value	Migratory Pathway Factor Value	Receptor Factor Value	Three-Letter Combination (Hs-Ms-Ls)	Media Rating (A - G)
Table 21 - Groundwater					
Table 22 - Surface Water (Human Endpoint)					
Table 23 - Sediment (Human Endpoint)					
Table 24 - Surface Water (Ecological Endpoint)					
Table 25 - Sediment (Ecological Endpoint)					
Table 26 - Surface Soil	M	M	M	MMM	D
			HHE MODULE RATING		**D**

DIRECTIONS (Continued):

4 Select the single highest **Media Rating** (A is the highest; G is the lowest) and enter the letter in the **HHE Module Rating** box below

HHE Ratings (for reference only)

HHH	A
HHM	B
HHL	C
HMM	C
HML	D
MMM	D
HLL	E
MML	E
MLL	F
LLL	G
Alternative Module Ratings	Evaluation Pending
	No Longer Required
	No Known or Suspected MC Hazard

NOTE: An alternative module rating may be assigned when a module letter rating is used when more information is needed to score one or more media, contamination at an MRS was previously addressed, or there is no reason to suspect contamination was ever present at an MRS

Table 29

MRS Priority

DIRECTIONS: In the chart below, enter the letter **rating** for each module recorded in Table 10 (EHE), Table 20 (CHE), and Table 28 (HHE). Enter the corresponding numerical **priority** for each module. If information to determine the module rating is not available, choose the appropriate alternative module rating. The MRS priority is the single highest priority; record this number in the **MRS or Alternative Priority** box at the bottom of the table.

NOTE: An MRS assigned Priority 1 has the highest relative priority; an MRS assigned Priority 8 has the lowest relative priority. Only an MRS with CWM known or suspected to be present can be assigned Priority 1; an MRS that has CWM known or suspected to be present cannot be assigned Priority 8.

EHE Rating	Priority	CHE Rating	Priority	HHE Rating	Priority
		A	1		
A	2	B	2	A	2
B	3	C	3	B	3
C	4	D	4	C	4
D	5	E	5	D	5
E	6	F	6	E	6
F	7	G	7	F	7
G	8			G	8
Evaluation Pending		Evaluation Pending		Evaluation Pending	
No Longer Required		No Longer Required		No Longer Required	
No Known or Suspected Explosive Hazard		No Known or Suspected CWM Hazard		No Known or Suspected MC Hazard	

Reference Table 10:		Reference Table 20:		Reference Table 28:	
EHE Module Rating	**Priority**	**CHE Module Rating**	**Priority**	**HHE Module Rating**	**Priority**
C	4	No Known or Suspected CWM Hazard	No Known or Suspected CWM Hazard	D	5

MRS or Alternative Priority	4

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