4.0 CHARACTERIZATION OF MEC AND MC

4.1 INTRODUCTION

4.1.0.1 HGL performed RI field activities at MRS-R01, MRS-R02, MRS-R03, and MRS-R09 from August 24, 2015, through May 13, 2016. The RI field activities were conducted IAW the approved Work Plan (HGL, 2015a) and FWVs. To meet the established project DQOs, the HGL RI field team completed the RI activities summarized below. A detailed description of the methods used for completion of the field activities is included in the approved Work Plan (HGL, 2015a).

Site Planning- ROE:

- HGL compiled county parcel ownership information within the former Conway BGR and coordinated with USACE to send and track ROE requests to landowners.

Site Preparation:

- HGL conducted surface sweeps by visual inspection of surface locations for MEC or MD in transects and grids. MEC/MPPEH avoidance procedures were utilized IAW the approved work plan.
- UXO-trained personnel cleared undergrowth using Bobcat Tracked Loaders with a 50-inch forestry cutter attachment, chainsaws, weed trimmers, and hand tools in the planned transects and grids on properties with approved ROE.
- Global positioning system (GPS) units were employed to track transect locations for approximately 28 miles of transects during brush clearing operations. An additional 11.7 miles of brush clearance of transects was required as access paths to allow teams to access remote areas.
- Teams defined grid boundaries, conducted brush clearance, and set up 158 grids.

Geophysical Surveying:

- HGL teams conducted DGM surveys of 49 miles along transects, and 24 miles of analog surveys of two types (both intrusive and non-intrusive) which included 17.7 miles of mag and dig transects and 6.1 miles of non-intrusive analog transects (mag and count).
- HGL conducted 100 percent DGM over a total of 152 variously sized grids.
- HGL processed geophysical data collected using Geosoft Oasis Montaj, generated anomaly density maps, and prioritized target lists.

Anomaly Reacquisition and Investigation:

- UXO-trained personnel intrusively investigated 1,210 targets and polygons within 143 DGM grids. Not all of the grids with DGM surveys completed could be intrusively investigated, for various reasons. An additional twelve anomalies were detected and investigated using analog mag and dig methods in four grids.

- During the completion of the mag and dig transects, teams intrusively investigated 123 total anomalies. Within MRS-R01, 8.9 miles of mag and dig transects included 98 anomalies (15 were MD, 83 were other items or cultural debris); within MRS-R02, 4.5 miles of mag and dig transects did not identify any anomalies; and within MRS-R03, 4.38 miles of mag and dig transects were completed which included 25 anomalies (one was MD, and 24 were cultural debris).
- Under the direct supervision of the SUXOS, MEC teams resolved identified anomalies and containerized MD for off-site disposal. (All UXO personnel on this project met the minimum qualifications outlined in the Department of Defense Explosives Safety Board Technical Paper-18.)

MC Sampling:

- Based on existing site conditions, historical site activities, and previous investigation data and results, the PDT determined that a combination of a biased ISM and discrete sampling strategy was appropriate for characterizing MC at the former Conway BGR. HGL collected 10 ISM and 10 discrete soil samples within each MRS. Each 100- by 100-ft ISM sampling unit (SU) was composed of 32 increments. Soil sample locations were biased toward areas of MEC/MD presence, based on historical information, the confirmed presence of MEC, or high concentrations of MD during RI field activities.
- A total of 10 discrete background soil samples were collected from outside the investigation boundaries for each MRS. Background samples were analyzed for metals, including Pb and Zn (Method 6020A).
- Based on the analytical results from the Phase 1 sampling, sampling of additional media such as sediment, surface water, and subsurface soil was not required.

4.1.0.2 Table 4.1 provides a summary of completed field activities broken down by MRS. Additional detail of field activities in each MRS is included in the following subchapters. Figures 4.1 through 4.4 show the ROE permissions received for each MRS. Figures 4.5 through 4.8 show the DGM transect paths that were completed. Figure 4.9 through 4.12 show the background surface soil locations and the surface soil and ISM SU sampling locations sampled within the MRS during the RI field activities. Figure 4.13 provides anomaly densities developed from DGM transect data for MRS-R01.

Table 4.1
Summary of Field Activities Completed by MRS

Item Description	Unit	MRS-R01	MRS-R02	MRS-R03	MRS-R09
Brush Clearance (all Transect types)	Miles	7.74	13.33	3.31	4.03
Overland Mag and Count Transects	Miles	0.64	0.36	0.61	0.28
Wetland Mag and Count Transects	Miles	1.89	1.33	0.51	0.24
Residential Mag and Count Transects	Miles	0.25	0	0	0
Overland DGM Transects	Miles	8.71	7.41	0.31	3.38
Wetland DGM Transects	Miles	5.82	2.19	0.16	0.35
Golf Course DGM Transects	Miles	16.2	0	0	4.82
Characterization DGM Grids	Grids	50	36	28	10
	Equivalent Acres	2.48	2.07	1.61	0.57
Characterization DGM Grids Intrusively Investigated	Grids	47	30	28	10
	Equivalent Acres	2.31	1.72	1.61	0.57
DGM Grids in Background Areas Intrusively Investigated	Grids	38	30	26	10
	Equivalent Acres	1.79	1.72	1.49	0.57
Background Mag and Dig Transects (4.5-ft)	Miles	7.34	4.5	4.17	0
	Acres	4.00	2.45	2.28	0.00
QC Transects	Miles	0.94	0.26	0.63	0
Background DGM Grids	Grids	12	4	3	8
	Equivalent Acres	2.54	0.75	0.52	1.84
Background Grids Intrusively Investigated*	Grids	12	6	5	8
	Equivalent Acres	2.54	1.08	0.96	1.84
EE/CA DGM Grids Intrusively Investigated in Background Areas*	Grids	9	32	59	0
	Equivalent Acres	0.52	1.84	3.39	0.00
Intrusively Investigated Anomalies (within Grids)	Each	688	202	227	162
Incremental Samples / with co-located Discrete Surface Soil Sample	Each	9	10	10	10
Background Sample, for metals	Each	10	10	10	10

**The required acreage to meet residential use (< 0.1 UXO per acre) considering all MRSs is 22.9 acres at 90% confidence. The required acreage to meet low use (< 0.5 UXO per acre) considering all MRSs is 4.6 acres at 90% confidence.*

4.1.1 Obtaining Right of Entry

4.1.1.1 HGL attempted to obtain ROE for the properties within MRS-R01, MRS-R02, MRS-R03, and MRS-R09 where investigation activities were planned. ROE was granted for a sufficient number of parcels within the MRSs to complete field activities. HGL mailed ROE requests to landowners. HGL and USACE Wilmington District representatives also conducted in person requests to negotiate additional obtain ROE. ROE was tracked using a web-based map so that the PDT could follow the ROE progress. Figure 4.1 through Figure 4.4 present the parcels where ROE was granted and where ROE was not granted. Of the 450 separate parcels identified for field activities, ROE was granted for 221 parcels. ROE was solicited for all parcels where the work plan proposed field effort, and 221 landowners granted permission for work to be performed.

4.1.1.3 HGL completed the following activities to obtain ROE:

- Built a GIS database with the real estate data and developed the parcel legal descriptions.
- Conducted ROE support including updating property records in the project GIS for all landowners within the project boundaries.
- Assisted the USACE Savannah District, Real Estate Division by mailing and tracking mailed and executed ROEs.
- Supported mailings to landowners, conducted a public meeting, and traveled to the site to attempt to obtain ROEs by personally contacting landowners.

4.1.2 Field Activities

4.1.2.1 HGL gathered data using a combination of DGM and analog geophysical techniques, equipment, and methods to investigate MEC. In general, DGM and analog transects and grids were used to identify potential subsurface anomalies/MEC associated with former activities and to determine the distribution density and extent of MEC.

4.1.2.2 Vegetation clearance was required before field activities were conducted, if the landowner granted permission. Mature trees of 4 inches or more in diameter were left in place and some dense stands of vegetation were not cleared. The geophysical investigations for MRS-R01, MRS-R02, MRS-R03, and MRS-R09 were conducted with EM61-MK2A detectors on a wheeled platform and in litter carry mode in combination with a GPS. The DGM characterization was conducted by a two-person team consisting of a geophysicist and a UXO technician (or two experienced UXO technicians) along transects that varied in spacing that were 3 ft in width. Grids were placed in areas of high, medium, and low anomaly density IAW the Work Plan, transect data, and past investigative results. The HGL team processed the digital geophysical data from the grids to produce maps showing the distribution and magnitude of identified anomalies that most likely represented MEC or MPPEH. Anomalies were selected based on size and amplitude results from the IVS. A target list was developed from this data and was intrusively investigated by HGL to determine the nature of the selected target anomalies.

4.1.2.3 HGL conducted soil characterization for MC using the ISM IAW USACE guidance, *The Implementation of Incremental Sampling of Soil for the Military Munitions Response Program (MMRP)* (USACE, 2009). Soil characterization sampling was conducted at ten 100-ft by 100-ft SUs and ten co-located discrete soil sample locations in high anomaly density areas, areas with identified MD or historical investigation MEC, and at 10 background locations for each MRS.

4.2 MEC CHARACTERIZATION

4.2.0.1 The MEC characterization tasks performed during this RI, described in Chapter 4.1 included the field activities summarized above. The characterization methods performed at the project site are described in the following subchapters. For project support, portable toilets were mobilized to the project site. An office and a storage area were set up at a warehouse near MRS-R02. The office area was equipped with laptop computers and a printer, copier, scanner, and other supplies and was used for overnight storage of equipment and field gear. On-site communication was maintained using two-way handheld radios/repeater and cell phones. On-site conditions and findings were documented using personal digital assistants (PDAs), handheld GPS, and digital cameras. All field vehicles and the office trailer were equipped with first aid kits and fire extinguishers.

4.2.0.2 Equipment and sensor technology used for the MEC characterization included WAAS-enabled GPS, White's All Metals detectors, Schonstedt GA-52Cx magnetic locators, and the Geonics EM61-MK2A.

4.2.1 Identification of MEC Contamination

4.2.1.0.1 The RI fieldwork focused on areas where MEC contamination needed further delineation, based on historical investigations and historical MEC and MD finds, and areas where no MEC was expected. The overall approach was: (1) conduct DGM surveys along transects of varying spacing to identify the potential distribution of anomalies, and (2) incorporate DGM investigations of grids in areas of high, medium, and low anomaly density. For implementing this strategy at MRS-R02 and MRS-R03, the extensive historical investigation data was also used to recommend grid locations. Once the established background area was determined, DGM grid investigations were conducted based on UXO Estimator acreage requirements to achieve 90 percent confidence that non-MEC contaminated areas have fewer than 0.1 MEC item per acre for residential use or fewer than 0.5 MEC item for low use areas. DGM grids were placed throughout each MRS in background areas. The required acreage to meet residential use ($<$ 0.1 UXO per acre) is 22.9 acres at 90 percent confidence. The required acreage to meet low use ($<$ 0.5 UXO per acre) is 4.6 acres at 90 percent confidence. Results of the MEC contamination delineation are provided in Chapter 5.

4.2.1.1 <u>Archeological and Paleontological Surveys</u>

4.2.1.1.1 There are no sites listed on the National Register of Historic Places or with the American Battlefield Protection Program within the investigation areas or MRS boundaries (NPS, 2014a; NPS, 2014b). HGL searched the websites of the South Carolina State Historic Preservation Office and the South Carolina Department of Archives and History (SCDAH) and identified no significant historic structures or areas within the investigation areas or MRS boundaries (SCDAH, 2014).

4.2.2 Geophysical Investigation

4.2.2.1 <u>Site Preparation: Vegetation Clearance and Surface Clearance</u>

4.2.2.1.1 The HGL team removed vegetation, as needed, in the areas of transects and grids that were surveyed during RI activities. Flags and survey stakes were placed or GPS coordinates were collected to mark transect paths and obstacles to collection of DGM data. No trees greater than 4-inches in diameter were removed. While conducting vegetation clearance, MPPEH avoidance procedures were used to identify potential surface hazards. A visual inspection was performed by a qualified UXO technician to identify potential MPPEH. If possible, surface metallic debris encountered was removed from the survey area; otherwise, any targets or obstacles were clearly marked with flags. The location of these target features or obstacles were mapped with a GPS and incorporated into the GIS for data evaluation. No MEC items were located during surface clearance or brush cutting; however, an MD item was removed during preparation for transect brush cutting (MD from a 2.25 inch MK4 MOD 0 Subcaliber Practice Rocket) found along transect T10110.

4.2.2.2 Location Surveys and Transect / Grid System Development

4.2.2.2.1 A Professional Land Surveyor established three control points at MRS-R01, MRS-R02, and MRS-R03. The HGL Site Geophysicist utilized a Trimble RTK GPS to verify the accuracy of the existing site control points and monuments and establish the IVS. Wide area augmentation system (WAAS)-capable handheld GPS units were uploaded with the start and end points of each proposed transect and the data collection field teams used the GPS to navigate along the transects and digitally record the tracks.

4.2.2.2.2 The WAAS-capable GPS systems were also used to scout the general area for each proposed full coverage grid and provide the approximate coordinates of the grid corners. Fiberglass measuring tapes were used to construct each grid to specified dimensions (e.g., 50-ft by 50-ft or 100-ft by 100-ft or an equivalent size for the intended acreage) and metallic survey nails were placed at all grid corners. Real-Time Kinematic (RTK) GPS was used to establish the corners for two grids in MRS-R01. Some grids were rectangular instead of square as a result of localized site characteristics. The UXOQCS placed a blind seed in each grid as required prior to DGM or analog data collection.

4.2.2.3 DGM and Analog Geophysics

4.2.2.3.0.1 A combination of historical removal action and investigation data, DGM transects and full coverage grids, analog intrusive transect segments and grids were utilized to characterize the nature and extent of MEC and MD in all four MRSs. The actual transect paths and grid locations completed during the RI are shown on Figure 4.5 through Figure 4.8.

4.2.2.3.0.2 DGM data were collected for 49 miles of transects and 152 grids from September 2015 through April of 2016. DGM data were collected within the grids using wheel mode or line-and-fiducial positioning. The RTK GPS was used in conjunction with the EM61 in several grids at the beginning of the project. Four grids were investigated using analog intrusive investigation (“mag and dig”) due to the extensive number of obstacles present. Grids were assigned alphanumeric IDs and all production tracking was tied to grid IDs.

4.2.2.3.0.3 The extent of the bombing target in MRS-R01 was not well defined by past investigations. To adequately characterize MRS-R01 target selections from the DGM transect data were transferred to the Visual Sampling Plan (VSP) software and a color-coded image of the anomaly density was generated. The anomaly density information was used in conjunction with previous investigation data to select the optimum locations for placement of the full coverage DGM grids in high, medium, and low anomaly density regions. An email summarizing the grid selection process for each MRS and recommended grid locations was delivered to the USACE technical team for review and acceptance during the field work activities. Based on feedback from USACE, locations were modified, if requested.

4.2.2.3.0.4 The extent of the bombing target in MRS-R01 was estimated after analysis of the initial intrusive results and additional DGM grids were distributed throughout the MRS in presumptively clean areas based on UXO Estimator guidelines. A portion of MRS-R01 is occupied by an operational golf course, and golf course management requested the RI activities be performed with minimal disturbance to operations. To comply, HGL substituted mag and dig transects for the DGM grids on the golf course properties.

4.2.2.3.0.5 Within MRS-R02 and MRS-R03, extensive historical investigation and removal action data exists that defines the central region of the bombing targets, and the primary RI objective was to better define the target boundary in these MRSs. A limited amount of DGM and analog "mag and count" transects were initially performed in MRS-R02 to define the target area boundary. A VSP evaluation and creation of anomaly density maps were not appropriate for MRS-R02 and MRS-R03. The main target areas for MRS R02 and R03 were defined during previous characterization efforts. Additional analysis of anomaly density was not practical based on insufficient ROE and extensive vegetation that prevented adequate transect coverage in large regions of MRS R02 and R03. Based on analysis of transect data, HGL placed DGM grids throughout the remainder MRS-R02 in accessible areas and analyzed the initial intrusive data. Additional DGM grids were placed in accessible areas based on UXO Estimator guidelines. Mag and dig transects replaced DGM grids where site conditions were not suitable for DGM in MRS-R02. The expansive wetlands and very dense vegetation in most areas surrounding MRS-R03 limited the number of DGM and analog grids that could be completed. The primary method used to refine the historical bombing target boundary was mag and dig transects.

4.2.2.3.0.6 A region of the firing point, in the southwestern portion of MRS-R09 was accessible for the RI, based on ROE granted. A VSP evaluation and creation of anomaly density map was not appropriate for MRS-R09 based on low density and lack of ROE. Sampling grids were evenly distributed in MRS R09 based on the small percentage of ROE and very limited number of DGM transect targets. The characterization methodology was similar to that performed for MRS-R01. A golf course landowner granted ROE in the central area of the MRS; however, no intrusive activities were permitted on the golf course property, though the landowner allowed DGM transect data to be collected. The anomaly density along the DGM transects was evaluated and DGM grids were placed in areas where ROE were granted. The intrusive information was analyzed, and additional grids were placed based on UXO Estimator guidelines.

4.2.2.3.0.7 The DGM QC program consisted of the geophysical system verification (GSV) approach, which included an IVS and blind seeding of the full coverage DGM and analog grids. Additional elements of the QC program included a battery of instrument functional tests performed in the morning prior to production DGM and at the end of each day, as well as implementation of the geophysical feedback process and acceptance sampling.

4.2.2.3.0.8 The DGM data deliverable is included in Appendix F and includes the IVS report, Microsoft Access database, and digital versions of the geophysical data (Oasis Montaj. GDB, .MAP, and .XYZ files) for all four MRSs. Specific tables within the Microsoft Access database document the results of the DGM and analog QC program performed during production activities and during the anomaly reacquire and intrusive phases of the project.

4.2.2.3.1 GSV

4.2.2.3.1.1 The IVS was used at the start of the project to ensure functionality of the DGM systems and is the basis for the IVS Report. The initial IVS was located near the Saint Mark Coptic Orthodox Church in MRS-R02. A second "satellite" IVS was established in MRS-R01 due to the travel time between the two MRSs. The satellite IVS was destroyed by landfill operations and was not used after November 2015. IVS items used to verify the operation of the EM61-MK2A consisted of several small industry standard objects (ISOs) at multiple orientations and depths.

4.2.2.3.1.2 Throughout the project the DGM teams used the IVS locations to perform the daily QC test regimen, which included a minimum of one pass along the IVS centerline and noise lines. The data collected at the IVSs throughout the duration of the project are summarized in the appropriate tables in the Microsoft Access database.

4.2.2.3.1.3 As part of the GSV process, HGL placed 152 blind seeds (1 per grid) to verify performance of the DGM equipment and provide verifiable target detection and positioning capabilities over the course of the DGM survey. The blind seeds were also used as a tool for evaluating specific data collection, processing, and anomaly selection procedures and intrusive investigation performance criteria.

4.2.2.3.1.4 Blind seed items consisted of small ISOs placed within the upper 0.25 meter (m) of soil. The position of each blind seed item within the full coverage grids was measured with a fiberglass measuring tape by the UXOQCS from the southwest grid corner. The DGM survey team and data processor/analyst did not have prior knowledge of placement locations of the blind seeds. DGM transects were not seeded.

4.2.2.3.2 Analog Verification

4.2.2.3.2.1 Multiple test pits were established for the project and used on a daily basis to validate the personnel and detectors used for analog geophysics. The test pit design consisted of a small ISO buried horizontally at 10-centimeter (cm) depth. The UXOQCS also placed coverage and blind seeds in the four grids where analog investigation ("mag and dig") of the grid was performed. A minimum of one blind seed item was used per instrument operator. The Access database table "*Analog_Instrument_QC_Results*" contains the documentation for the instrument QC test results.

4.2.2.3.3 Data Collection

4.2.2.3.3.1 DGM data were collected along characterization transects and within full coverage grids using two unique instrument configurations and modes of data acquisition. For transect data collection, a WAAS GPS system was used to provide positioning data for the geophysical measurements. EM61-MK2A data were acquired using a wheeled platform (or litter carry) at a minimum rate of 10 hertz (Hz). The National Marine Electronics Association (NMEA) positioning string from the WAAS GPS was updated at 1 Hz and integrated with the EM61-MK2A measurements in real-time in the ruggedized data logger.

4.2.2.3.2.2 The acquisition system for the full coverage grids consisted of an EM61-MK2A on a wheeled platform. Wheel mode or automatic mode (line and fiducial positioning) were used to locate the geophysical measurements within each full coverage grid along acquisition lines spaced 2.5 ft apart. Prior to data collection plastic tent stakes were positioned at regular intervals within each grid using fiberglass measuring tapes to assist the field team with navigation. Wheel mode utilized the wheel counter on the EM61 to trigger measurements at 20 cm (8 inch) intervals along each line. For the line and fiducial method data were automatically recorded at a minimum rate of 10 Hz along each line and fiducial marks were placed in the digital data at regular intervals and used during data processing to determine the coordinates for the geophysical measurements.

4.2.2.3.2.3 Mag and dig transects were performed in MRS-R01, MRS-R02, and MRS-R03. The analog transect team used the virtual transects displayed on the WAAS GPS screen to navigate along each transect and investigate “hits” detected with the Schonstedt or White’s handheld detectors. The GPS track path was recorded in conjunction with each intrusive location and the data were transferred to the HGL GIS department.

4.2.2.4 Data Transfer

4.2.2.4.0.1 The DGM data, field notes, sketches, and README files for each day were transmitted by field personnel through a secure HGL network site on a daily basis for retrieval by the HGL data processor / analyst. The data processor / analyst evaluated the data on a daily basis and a data package was transmitted to USACE on a weekly basis.

4.2.2.4.1 Data Conversion and Initial Processing

4.2.2.4.1.1 The EM61-MK2A data collected over the characterization transects and full coverage grids were converted from binary to ASCII format using the Geonics DAT61MK2 software. EM61-MK2A measurements for the transects were positioned in Universal Transverse Mercator Zone 17 North coordinates using the position information in the GPS NMEA data string and the sensor measurements and positions were output to an XYZ file for direct upload into Oasis Montaj. EM61-MK2A data collected with wheel or fiducial mode required additional processing in DAT61MK2 prior to transfer to Oasis Montaj for final data processing.

4.2.2.4.2 Review of Daily Instrument Functional Tests

4.2.2.4.2.1 The daily QC tests were analyzed using the UX-Process suite of applications in Oasis Montaj and the results documented in the Microsoft Access database.

4.2.2.4.2.2 For the static background and spike test, the data processor used the static test tool in the UX-Process module to assess the background level, instrument drift, and the response to the standard test item. For the cable shake and personnel tests, the data processor reviewed the data for data spikes and other deviations that exceeded the metrics specified in the Work Plan.

4.2.2.4.2.3 Evaluation of the IVS dynamic repeatability test included manual selection of target locations corresponding to each IVS item utilizing the data profiles. The position and signal intensity for each IVS item were compared to baseline values, which were established at the start of each instrument's use on the project.

4.2.2.4.3 Final Data Processing – Characterization Transects

4.2.2.4.3.1 The UX-Process module of Oasis Montaj was used to perform the final data processing. The general processing sequence consisted of corrections for latency and drift, and editing of overlapping and repeat data acquisition lines in some areas. As part of the final data processing sequence spatial sampling statistics that included along line measurement spacing, dynamic noise, and platform speed were calculated using UX-Process tools and documented in the Microsoft Access database.

4.2.2.4.3.2 Individual Oasis Montaj geophysical databases (GDBs) for the DGM data and target selections were merged into a master GDB for the entire site to facilitate evaluation of the survey progress and assessment of the data. The final processed data and Microsoft Access database were transferred to USACE on a weekly basis during project execution.

4.2.2.4.3.3 Targets were selected along the characterization transects using a Channel 2 signal intensity of 4 millivolt (mV). The instrument path along transects and the coordinates for each target selected were transferred to the VSP software and the information was used to generate a color-coded anomaly density image for MRS-R01. The anomaly density map for MRS-R01 (Figure 4.13) was used in conjunction with historical data to select locations for the full coverage DGM grids. Anomaly density maps were not appropriate for MRSs R02, R03, and R09. Sampling grids were evenly distributed in MRS R09 based on the small percentage of ROE and very limited number of DGM transect targets. The main target areas for MRS R02 and R03 were defined during previous characterization efforts. Additional analysis of anomaly density was not practical based on insufficient ROE and extensive vegetation that prevented adequate transect coverage in large regions of MRS R02 and R03.An email with technical descriptions of the proposed grid locations was developed for each MRS and distributed to USACE for review and acceptance.

4.2.2.4.4 Final Data Processing - Full Coverage Grids

4.2.2.4.4.1 Upon receiving the data, the data processor reviewed the field notes, field sketches, and the digital EM61-MK2A data files. If any issues were identified, such as an incorrect wheel increment value or incorrect direction of a survey line, the data processor corrected the *.m61 file.

4.2.2.4.4.2 The corrected *.m61 file was uploaded into the DAT61MK2 software and the processing tools were used to define the correct start and stop coordinates of each acquisition line based on the field sketch map created by the DGM field team. The data processor checked the start and end coordinates of each obstacle in the *.m61 file and compared the coordinates with those documented in the field notes and grid sketch maps. The final procedure involved adjusting the coordinates based on the locations of the plastic tent stakes placed at regular intervals within the survey area. After the correct relative coordinates along each line or line segment were determined, the file was exported in XYZ format for direct upload into Oasis Montaj.

4.2.2.4.4.3 The UX-Process module of Oasis Montaj was used to perform the final data processing. The general processing sequence consisted of corrections for lag and drift. The parameters used for these corrections were dependent on the data characteristics for each dataset and the parameters are documented in the Microsoft Access database. Statistics for sample measurement (along-line) spacing, grid coverage, dynamic noise, and platform speed were calculated using UX-Process tools and documented in the Microsoft Access database.

4.2.2.4.4.4 DGM data were interpolated (gridded) to generate color-coded images of the EM61-MK2A data for each grid using the minimum curvature gridding routine at a 15-cm cell size and 50 cm blanking distance. The Blakely routine in UX Process module was used to select targets using channel 2 at a minimum signal intensity of 4 mV. A representative color scale was selected to exhibit responses from small, isolated anomalies as well as responses from more significant features such as potential large-scale burial areas.

4.2.2.4.4.5 The final processed data and Microsoft Access database were transferred to USACE on a weekly basis during project execution.

4.2.2.5 Target Selection

4.2.2.5.1 A total of 1,172 targets were selected along the characterization transects in MRS-R01, MRS-R02, and MRS-R09. Six hundred twenty-four (624) viable targets were selected in 152 DGM grids in all four MRSs. An additional 711 target selections represent the nails placed by HGL at grid corners and blind seeds. Two (2) areas with saturated EM61 signal intensity were identified in Grids 1004 and 1046, and the data processor / analyst used a polygon in each grid to define the area for mag and dig operations. Section 5.1 documents the results of the intrusive investigations performed for each MRS.

4.2.2.6 Geophysics Quality Control Results

4.2.2.6.1 The results of the geophysical QC program are documented in the Microsoft Access database, including the results for the blind seeds and geophysical feedback process. During the project, there were no significant issues identified with the daily QC tests and blind seed results that would alter the overall characterization results presented in this report.

4.2.2.6.2 The geophysical feedback process was used to ensure the representativeness of the intrusive information. Five (5) anomaly locations were revisited by the dig teams prior to releasing the respective grids to the UXOQCS for acceptance sampling. The results for the feedback process are presented in the Microsoft Access database.

4.2.2.6.3 The results of the DGM QC results are summarized below. The digital results are presented in the Microsoft Access database in Appendix F.

4.2.2.6.4 ***Project Metric: Static Response Repeatability –*** The static response of each EM61 system channel to a standard test object must be within 10 percent of the reference value established either at the start of the project or when the instrument is placed into use for the first time. Throughout the project 334 tests were performed during production DGM (transects and grids) and during anomaly reacquire, intrusive, and QC activities at the beginning and end of each day. Additional static tests were performed throughout the project when the field team assessed ambient interference from power lines or other sources of electromagnetic interference and when they switched batteries. All 334 static spike tests (100 percent) used to validate the production DGM data achieved the metric.

4.2.2.6.5 ***Project Metric: Along Line Spacing –*** At least 98 percent of the samples along each line must be within 25 cm. For DGM transects and full coverage grids, 192 of the 200 datasets achieved the metric (96.0 percent). The eight datasets that did not achieve the metric are full coverage grids in MRS-R01 that were collected in wheel-mode. The latency correction applied to data collected at variable speeds artificially increased the sample spacing.

4.2.2.6.6 ***Project Metric: Survey Speed –*** At least 95 percent of the data must be collected at speeds of less than 1.6 meters per second. For DGM transects and full coverage grids, 191 of the 200 datasets achieved the metric (95.5 percent). The nine datasets that did not achieve the metric were collected along transects, and one of the transect segments was recollected. The along line spacing metric was achieved for these datasets and the noise was not elevated.

4.2.2.6.7 ***Project Metric: Spatial Coverage of Grids –*** DGM data collected in each grid are required to exceed 90 percent coverage at a 0.75-meter line spacing for all accessible areas. All 152 final datasets (100 percent) for the full coverage DGM grids achieved the metric.

4.2.2.6.8 ***Project Metric: Dynamic Response and Position Repeatability –*** Dynamic response repeatability of each EM61 data channel for the three IVS items is required to exceed 75 percent of the reference values established at the start of the project, and the offset will not exceed 0.90 m (dynamic positioning repeatability). One hundred fifty-three (153) tests were performed over the three ISOs at the IVSs located in MRS R01 and R02:

- Four hundred forty-eight (448) of the 459 response packets (153 tests encountered 3 ISOs during each test) achieved the dynamic repeatability signal metric when all data channels were evaluated (97.6 percent). Five (5) response packets that did not achieve the metric occurred when using the litter carry platform for the 9/28 and 12/1 AM tests. The remaining six response packets occurred over ISO 2, which is oriented parallel to the direction of travel of the EM61 coil. The signal trough is selected for this ISO, and the response is diminished when the speed of the platform is slow. Eight (8) of the 9 response packets that did not achieve the metric occurred during transect DGM. For any test where an ISO failed to meet the metric, the other test performed that day by the same team had all three of the ISOs achieving the metric (100 percent).
- Dynamic position repeatability was only evaluated when RTK GPS, wheel mode or line and fiducial was used at the IVS. Three hundred thirty (330) of the 330 response packets achieved the dynamic positioning metric (100 percent).

4.2.2.6.9 ***Project Metric: Blind Seeds –*** All blind seeds are required to achieve the dynamic response and positioning repeatability metrics (blind seeds will have a signal intensity greater than 75 percent of the reference value established at the start of the project and the offset will be within 0.90 m of the known position). All blind seeds (100 percent) achieved the dynamic response and positioning repeatability metrics. The QC geophysicist identified the following minor issues related to blind seed items based on weekly reviews during project execution:

- Dynamic positioning metric not achieved for Grid 1026 (metric exceeded by approximately 0.1 m). The field team used the middle and front of the coil to reference the position of the EM61 near obstacles which resulted in inaccurate position data in some portions of the grid. The data processor / analyst reprocessed the data using the center of the coil as the reference and the reprocessed data achieved the metric.
- Dynamic positioning metric not achieved for seven grids based on processed DGM data. The UXOQCS revisited the seven grids and re-measured the location of the blind seed items and all seven grids achieved the metric.

4.2.2.6.10 ***Project Metric: Geodetic Equipment Functionality –*** Position offset of known control point within 5 m for WAAS-enabled GPS in "open" areas. When WAAS capable GPS was used for characterization transects the control point was either statically occupied or mapped using a cross pattern. The maximum offset between the interpreted and known location for the control points was 4.47 m, which achieves the performance metric of 5 meters. When RTK GPS was used for grid DGM or anomaly reacquire, static position offsets were within 0.08 m, which achieves the performance metric of 0.15 m.

4.2.2.6.11 ***Project Metric: Anomaly Resolution –*** 100 percent of intrusive locations will be assessed with the EM61-MK2 post-intrusive. Residual signals greater than 4 mV (Channel 2) will require additional verification**.** The UXOQCS checked 1,141 target locations and one polygon with the EM61, including the targets selected at the grid corner nails that were investigated by the dig teams. One thousand-one hundred-thirteen (1,113) of the hole checks resulted in "no contact"; 27 resulted in miscellaneous findings including a utility, hot soils caused by residual small pieces of disintegrated metal, existing metal that could not be removed by the original dig teams, and 2 checks were not completed because the anomaly source was under a golf cart path; and 2 checks resulted in SAA.

4.2.2.6.12 The UXOQCS observed the dig team investigate the polygon in grid 1004, which was determined through intrusive findings and an interview with a landfill employee to be the remnants of an old concrete ramp. The polygon is considered characterized and was not checked by the UXOQCS with an EM61 post-intrusive.

4.2.2.6.13 ***Project Metric: Analog Test Pit*** – All items in test area detected when used for subsurface characterization (mag and dig or mag and count - trains ear daily to items of interest. Test item used at local area at least once per day prior to performing anomaly avoidance and intrusive activities. Three hundred sixty-two (362) independent tests were performed during the project for the Schonstedt and White's detectors. All of the tests (100 percent) achieved the metric.

4.2.2.6.14 ***Project Metric: Mag and dig coverage and blind seeds*** – Blind coverage seeds and blind detection seeds recovered (75 percent if MEC and 90 percent if no MEC). Mag and dig was performed over four full coverage grids, and all coverage and blind seeds (100 percent) were detected and recovered by the dig team.

4.2.2.6.15 ***Project Metric: Analog Transect Dynamic Repeatability (transects used for density estimates and transects with digging)*** – Repeat a segment of transect and show extra flags/digs not greater than the greater of 20 percent or 8 flags/digs, or w/in range of adjacent segments. The UXOQCS checked 1,244 linear meters of the 9,876 meters of mag and count transects (12.6 percent). On one transect segment in R01 the QC counts were 8 versus 18 by the production team, however, the counts were within the range of adjacent transect segments. The UXOQCS checked 1,389 linear meters of the 28,559 linear meters of mag and dig transects (4.9 percent) and no significant metal was detected other than the metal identified during the initial digging that was left in place.

4.2.2.6.16 ***Project Metric: Analog Transect Hole Checks***– Second party checks open holes to determine:

- If MEC: 70 percent confidence < 10 percent anomalies unresolved (lot size of 100; check 11)

4.2.2.6.17 The UXOQCS checked 18 out of 123 intrusive locations along the mag and dig transects and no significant metal was identified.

4.2.2.7 Dig Sheet Development

4.2.2.7.1 Dig sheets and color-coded images of each grid with the target selections superimposed were sent to the SUXOS at the site from the HGL processing center. The number of targets within each MRS selected for investigation during the investigation is provided in Table 4.2.

Table 4.2
Number of Anomalies Identified for Investigation in Grids

MRS	# of DGM Grids	DGM Targets Identified*	Mag and Dig Polygons	# of Analog Grids	Analog Anomalies Identified
MRS-R01	63	703	2	0	0
MRS-R02	40	245	0	2	10
MRS-R03	31	225	0	2	2
MRS-R09	18	162	0	0	0
TOTAL	152	1335	2	4	12

**The total will not equal targets intrusively investigated due to refusals to evacuate or other access issues.*

4.2.3 Intrusive Investigation

4.2.3.0.1 The intrusive investigation was conducted by certified UXO technicians IAW the approved Work Plan and under the approved Explosives Site Plan (ESP) (including all Amendments); except as noted in Chapter 4.4.2, Work Plan Variances. The results of the intrusive investigation are summarized in Chapter 5.1 of this report and the findings of the intrusive investigations are presented in Appendix F.

4.2.3.1 Anomaly Reacquisition and Resolution

4.2.3.1.1 Before beginning intrusive activities, field teams navigated to the location of each target on the dig sheet. The field team then intrusively investigated by starting at the location of the highest mV reading and extending to within a 1-meter search radius for excavation. Intrusive operations at each target location were conducted by hand. Excavation teams dug at the location of the highest mV reading within the search radius until the target was resolved. The dig teams used an EM61 in real-time mode to check each excavation and the residual EM61 signal intensity was documented on the dig sheet.

4.2.3.1.2 After all targets within each grid were resolved to the satisfaction of the dig team and the HGL geophysical team the grid was released to the HGL UXOQCS for acceptance sampling (final hole checks). The UXOQCS checked 100 percent of the intrusive locations with an EM61 and documented the residual EM61 signal intensity.

4.2.3.1.3 During the project the HGL geophysical team identified 5 targets through the feedback process that were required to be reinvestigated by the dig teams. The dig teams reinvestigated the targets prior to releasing the respective grids to the UXOQCS for acceptance sampling.

4.2.3.2 Munitions with the Greatest Fragmentation Distance

4.2.3.2.1 The munition with greatest fragmentation distance (MGFD) for the area is the item that has the greatest fragmentation distance of any or all MEC items that are reasonably expected to be found within that area, based on research or site characterization. As presented in the approved ESP in the Work Plan (HGL, 2015a), the MGFD applicable to MRS-R01, MRS-R02, and MRS-R03 were based on historical documents and previous investigations. HGL maintained the applicable MGFD during the investigations. No MEC was located during the RI field activities that required a change to the MGFD.

4.2.3.3 Minimum Separation Distance

4.2.3.3.1 The minimum separation distance is the protective distance based on the characteristics of the selected MGFD. A minimum separation distance of for both intentional and unintentional detonations was established for nonessential personnel based on the hazardous fragment distance of the MGFD. Minimum separation distances for intentional detonations were also established for disposal operations and these were based on the appropriate MGFD. HGL maintained the applicable minimum separation distance during RI field activities.

4.2.3.4 Exclusion Zones

4.2.3.4.1 Exclusion zones (EZs) were established during the RI to protect the public and non-essential personnel from both intentional and unintentional detonations. The boundary of the EZ was established as the distance of the applicable minimum separation distance for each MRS for unintentional detonations, and this EZ distance was enforced throughout the intrusive operations at the project site.

4.2.4 MPPEH Management

4.2.4.1 MPPEH Identification and Removal

4.2.4.1.1 Intrusive investigations were conducted by teams of varying size (minimum three-person teams) consisting of one UXO Technician III (team leader) and up to four qualified UXO Technician IIs or UXO Technician Is. The team conducted reacquisition and marking and conducted intrusive investigation of reacquired and marked anomalies. Excavation procedures at each anomaly location were conducted IAW the Work Plan. Intrusive investigation conducted along transects and within grids (DGM and analog) included 1,290 targets that were intrusively investigated. Some targets contained multiple pieces of MPPEH. None of the MPPEH inspected was confirmed to be MDEH. Of the MPPEH inspected, 169 pieces were assessed and documented as not presenting an explosive hazard and determined to be MDAS. The 169 pieces of MDAS consisted of 104 pieces from 100-lb M38A2 Practice bombs, 28 pieces from 2.25-inch SCAR, 2 pieces from 20-lb M41 Fragmentation Bomb, 2 unidentifiable fragments and 33 pieces of Small Arms Ammunition (either casings or projectiles).

4.2.4.2 Explosives Storage Magazine

4.2.4.2.1 A Bureau of Alcohol, Tobacco, and Firearms (ATF) Type II magazine was established for storage of donor explosives, IAW the approved ESP (HGL, 2015b). A double-lock system secured the magazine; one key was controlled by the SUXOS and the other was controlled by the UXOQCS. In addition to the locks, the magazine was enclosed in chain link fence, which was also secured with a heavy-duty lock. The key for this lock was also controlled by the UXOQCS. The magazine was located west of MRS-R02 and south of MRS-R01. As the field activities began to be closer to completion, and no demolition operations were required, HGL chose not to store any explosives in the magazine. On-call delivery of explosives was always available as an option for the HGL team. The magazine was removed from the site without storing any explosives.

4.2.4.3 MDEH Disposal

4.2.4.3.1 Documentation of recovered MPPEH items was maintained during the RI. Each piece of recovered MPPEH was tracked from its identification through its final disposition. No MDEH was encountered, so no items were required to be blown-in-place or relocated for demolition. The SUXOS was responsible for the tracking and maintenance of all MPPEH recovered during the project.

4.2.4.4 Inspection of MPPEH

4.2.4.4.1 Potential MPPEH items identified during intrusive operations were evaluated by the SUXOS and the UXOSO/UXOQCS. No MDEH was located during the field activities.

4.2.4.4.2 MDAS was certified after a 100% inspection and an independent 100% re-inspection to determine that no explosives hazards existed. The SUXOS and UXOSO/UXOQCS both verified and signed the DD Form 13481A to certify the material as material documented as safe (MDAS). After inspection and certification, recovered MDAS items were containerized and stored in the secure storage area until appropriate disposition was arranged. The Records of MDAS inspection and certification, transportation, and smelting of the 10,230 lbs of MDAS are provided in Appendix A.

4.2.4.5 Intrusive Investigation QC

4.2.4.5.1 Following intrusive investigations, QC efforts included the UXOQCS revisiting all anomalies classified as "no contacts" to verify the results at each investigation location. Anomalies 4 mV or above were also independently checked by the UXOQCS/QC Team. The Project Geophysicist also reviewed the reacquisition and dig results for all anomalies in the intrusive results database. Documentation for each of these QC elements is provided in the intrusive results tables in Appendix F.

4.3 MC CHARACTERIZATION

4.3.0.1 The MC characterization at the former Conway BGR was based on surface soil sampling and analysis. RI soil sample analytical results were compared to preliminary screening values to evaluate the presence of MC contamination. The characterization methods performed at the project site are described in the following subchapters.

4.3.1 Purpose of MC Sampling Activities

4.3.1.1 The objective of the RI for potential MC contamination was to first determine if there was evidence of a release of MC to the environment and then to characterize the nature and extent of the release. The data obtained during the investigation is used to assess whether the MC present poses a potential risk to human health and the environment and, therefore, should be considered to be COCs. Soil characterization was conducted to determine if a remedial response to MC-related contamination is required and, if so, to provide the required information for the development and evaluation of any necessary response alternatives. To achieve these objectives, soil samples were collected from locations that were selected based on historical information, the confirmed presence of MEC, or high concentrations of MD during RI field activities.

4.3.2 Field Sampling Activities Summary

4.3.2.0.1 The MC sampling and analysis was performed at MRS-R01, MRS-R02, MRS-R03, and MRS-R09 within the former Conway BGR where MEC investigation activities were conducted and ROE had been granted. Because only limited previous sampling had been conducted, the objective of sampling was to determine if a MC release has occurred at the project site as a result of munitions-related activities, resulting in the confirmed presence of MC contamination. The samples collected were biased to areas where MEC and/or large quantities of MD were found during previous investigations or during the MEC investigation at each MRS.

4.3.2.1 Surface Soil Sampling

4.3.2.1.1 Ten ISM soil samples and 10 discrete soil samples were collected from MRS-R01, MRS-R02, MRS-R03, and MRS-R09 at biased locations to determine the potential presence or absence of MC contamination. Locations were selected based on an evaluation of the anomaly density data and the intrusive results, where MEC and/or large quantities of MD were found during previous investigations, and in areas with accepted ROE. Discrete surface soil samples were collected within each of the SUs in areas that were judged most likely to have MC contamination based on MEC/MD presence.

4.3.2.1.2 Prior to the collection of samples, the sampling personnel prepared the sample kit. Samples were placed into either a polyethylene bag (ISM samples) or an 8-ounce sample jar (discrete samples). Sample containers were marked with pre-printed sample labels which were filled out in the field with a unique sample identifier and adhered to the container with waterproof tape. Samples were logged into a field log book (Appendix H-5), which included sample identification numbers, times, samplers, and location data. Sample locations were recorded and incorporated into the GIS database.

4.3.2.1.3 All ISM grids were 100-ft by 100-ft in size, and consisted of 32 increments which yielded sample weights between the 1 or 2 kilograms. The sampling was conducted IAW the approved work plan, including the QAPP, the guidance document titled *Implementation of Incremental Sampling (IS) of Soil for the MMRP* (USACE, 2009) and SOP-002 *Multi-Incremental Sampling Method* (April, 2014).

4.3.2.1.4 Discrete soil samples were also collected from the ground surface to 0.5 ft bgs using decontaminated stainless-steel equipment. These samples were collected IAW the approved work plan, including the QAPP (worksheet #27) and SOP-2.13 *Surface and Shallow Depth Soil Sampling* (December, 2010).

4.3.2.1.5 Information regarding background metals concentrations present in the surface soils at the Former Conway BGR does not exist; therefore, an additional ten discrete soil samples per MRS were collected to be representative of background soil conditions. The background soil samples were collected at depths of 0 to 0.5 ft bgs from outside suspected MEC contaminated portions of the MRSs, and in areas of low anomaly density or where no MEC/MD was known to be located.

4.3.2.1.6 Based on ordnance found at the site and contents of these munitions, the primary MC potentially associated with the former Conway BGR were identified as explosives, Pb, and Zn. These constituents were established by the Final Work Plan (HGL, 2015a) as the analyses planned for soil samples collected during the RI. The soil samples were analyzed for the following metals using USEPA Method SW6020A:

- Pb
- Zn

4.3.2.1.7 Soil samples were also analyzed for the following explosives using USEPA Method SW8330B:

- 1,3,5-Trinitrobenzene (TNB)
- 2,4,6-Trinitrotoluene (TNT)
- 2,4- dinitrotoluene (DNT)
- 4-Amino-2,6-DNT
- HMX
- Nitrobenzene
- Tetryl
- m-Dinitrobenzene
- m-Nitrotoluene

- 2,6-DNT
- 2-Amino-4,6-DNT
- Nitroglycerin
- PETN
- RDX
- o-Nitrotoluene
- p-Nitrotoluene

4.3.2.1.8 The sample identification and the rationale for the specific location selected for each sample are listed in Table 4.3, Table 4.4, Table 4.5, and Table 4.6 below. The sample locations are illustrated on Figure 4.9 through Figure 4.12. The results of the ISM, discrete, and background sampling are summarized in Appendix B-1.

Table 4.3
Sampling Locations and Rationale - MRS-R01

Sample Identification (ID)	Collocated Discrete Sample ID	Sample Date	Rationale for sample location
MRS01-IS-01	MRS01-SS-01	5/9/2016	Collected near grid 1002, which had high concentrations of MD and SAA, representative of the central portion of the MRS.
MRS01-IS-03	MRS01-SS-03	5/10/2016	Collected near grid 1008, where MD was found.
MRS01-IS-04	MRS01-SS-04	5/10/2016	Collected from grid 1011, which had high concentrations of MD.
MRS01-IS-05	MRS01-SS-05	5/10/2016	Collected near grid 1025, where SAA was found. Representative of the northwestern portion of the expanded investigation area.
MRS01-IS-06	MRS01-SS-06	5/10/2016	Collected near grid 1032, where MD was found. Representative of the western portion of the expanded investigation area.
MRS01-IS-07	MRS01-SS-07	5/9/2016	Collected near grid 1049, where SAA was found, representative of the central portion of the MRS.
MRS01-IS-08	MRS01-SS-08	5/9/2016	Collected from grid 1050, which had high concentrations of SAA, representative of the central portion of the MRS.
MRS01-IS-09	MRS01-SS-09	5/9/2016	Collected from grid 1003, which had high concentrations of MD and SAA, representative of the central portion of the MRS.
MRS01-IS-10	MRS01-SS-10	5/10/2016	Near a possible historical impact area, within an accessible sample location, representative of the northeast portion of the expanded investigation area.

Table 4.4
Sampling Locations and Rationale - MRS-R02

Sample ID	Collocated Discrete Sample ID	Sample Date	Rationale for sample location:
MRS02-IS-01	MRS02-SS-01	5/11/2016	High concentrations of historical MD, representative of the central portion of the MRS.
MRS02-IS-02	MRS02-SS-02	5/11/2016	Near high concentrations of historical MD and MEC items found during previous investigations, representative of the central portion of the MRS.
MRS02-IS-03	MRS02-SS-03	5/11/2016	Near a high concentration of historical MD, within an accessible sample location.
MRS02-IS-04	MRS02-SS-04	5/11/2016	Near a high concentration of historical MD, on the edge of the ROE boundary.
MRS02-IS-05	MRS02-SS-05	5/11/2016	Near a historical small arms MD, within accessible sample location.
MRS02-IS-06	MRS02-SS-06	5/11/2016	Representative of the western portion of the MRS, within an accessible sample location.
MRS02-IS-07	MRS02-SS-07	5/11/2016	Near a high concentration of historical MD, on the edge of the ROE boundary, and within an accessible sample location.
MRS02-IS-08	MRS02-SS-08	5/11/2016	Near MEC items found during previous investigations, on the edge of the ROE boundary, and within an accessible sample location.
MRS02-IS-09	MRS02-SS-09	5/11/2016	Near MEC items found during previous investigations, on the edge of the ROE boundary, and within an accessible sample location.
MRS02-IS-10	MRS02-SS-10	5/11/2016	Near MEC items found during previous investigations, on the edge of the ROE boundary, and within an accessible sample location.

Table 4.5
Sampling Locations and Rationale - MRS-R03

Sample ID	Collocated Discrete Sample ID	Sample Date	Rationale for ISM location:
MRS03-IS-01	MRS03-SS-01	5/11/2016	Near locations of historical MD, on the edge of the ROE boundary, and within an accessible sample location.
MRS03-IS-02	MRS03-SS-02	5/12/2016	Collected near grid 3015, where MD was found.
MRS03-IS-03	MRS03-SS-03	5/12/2016	Near locations of historical MD, on the edge of the ROE boundary, and within an accessible sample location.
MRS03-IS-04	MRS03-SS-04	5/12/2016	Near a location of historical MD, and within an accessible sample location.
MRS03-IS-05	MRS03-SS-05	5/12/2016	Near locations of historical MD, on the edge of the ROE boundary, and within an accessible sample location.
MRS03-IS-06	MRS03-SS-06	5/12/2016	Near locations of historical MD, near a possible historical crater location, on the edge of the ROE boundary, and within an accessible sample location.
MRS03-IS-07	MRS03-SS-07	5/12/2016	Near locations of historical MD, on the edge of the ROE boundary, and within an accessible sample location.
MRS03-IS-08	MRS03-SS-08	5/12/2016	Near locations of historical MD, on the edge of the ROE boundary, and within an accessible sample location.
MRS03-IS-09	MRS03-SS-09	5/11/2016	Near locations of historical MD, on the edge of the ROE boundary, and within an accessible sample location.
MRS03-IS-10	MRS03-SS-10	5/12/2016	Near locations of historical MD, on the edge of the ROE boundary, and within an accessible sample location.

Table 4.6
Sampling Locations and Rationale - MRS-R09

Sample ID	Collocated Discrete Sample ID	Sample Date	Rationale for ISM location:
MRS09-IS-01	MRS09-SS-01	5/12/2016	Representative of the western portion of the MRS near potential firing points, within an accessible sample location.
MRS09-IS-02	MRS09-SS-02	5/12/2016	Collected near grid 9503, where SAA was found.
MRS09-IS-03	MRS09-SS-03	5/12/2016	Representative of the western portion of the MRS, within an accessible sample location.
MRS09-IS-04	MRS09-SS-04	5/12/2016	Representative of the western portion of the MRS, within an accessible sample location.
MRS09-IS-05	MRS09-SS-05	5/12/2016	Representative of the western portion of the MRS near potential firing points or target areas, within an accessible sample location.
MRS09-IS-06	MRS09-SS-06	5/12/2016	Representative of the western portion of the MRS near potential firing points or target areas, within an accessible sample location.
MRS09-IS-07	MRS09-SS-07	5/12/2016	Collected near grid 9002, where SAA was found. Representative of the western portion of the MRS near potential firing points or target areas.
MRS09-IS-08	MRS09-SS-08	5/12/2016	Collected near grid 9001, where SAA was found. Representative of the western portion of the MRS near potential firing points or target areas.
MRS09-IS-09	MRS09-SS-09	5/12/2016	Collected near grid 9501, where SAA was found. Representative of the western portion of the MRS near potential firing points or target areas.
MRS09-IS-10	MRS09-SS-10	5/12/2016	Collected near grid 9002, where SAA was found. Representative of the western portion of the MRS near potential firing points or target areas.

4.3.2.2 Sample Handling and Packaging

4.3.2.2.1 Soil sampling, handling, packaging, and shipping, were conducted IAW the approved Work Plan (HGL, 2015a). Immediately after collection, samples were packaged with ice IAW the Quality Assurance Project Plan (QAPP) worksheet #27 and shipped to the contracted laboratory. Chains-of-custody were created for each sample shipment/cooler; copies of the chains-of-custody are included in the laboratory data package in Appendix B.

4.3.2.3 QC and QA

4.3.2.3.1 The soil sampling activities were conducted IAW the approved QAPP (Appendix E of the Work Plan). The QAPP submitted with the Work Plan addressed the DQOs, analytical methods, specific QA and QC activities, laboratory requirements, and data assessment activities designed to achieve the data quality goals of the project.

4.3.2.3.2 The sampling team collected QC (field triplicates) and QA samples. For ISM samples, triplicate QC sampling was conducted at a rate of one per MRS at three of the MRSs. One ISM SU collected in triplicate equated to three field samples. Discrete QC samples were collected at a rate of one per ten (duplicates) and one per 20 (matrix spike [MS]/matrix spike duplicates

[MSD]), and QA samples collected at a rate of one per ten. QA samples were shipped to GEL Laboratories.

4.3.3 Analytical Laboratory and Analyses

4.3.3.1 All samples were shipped to TestAmerica Denver for analysis. All coolers—except for two—were delivered to the laboratory the next day and processed in within the correct temperature range, as noted in the laboratory reports (Appendix B). Two coolers containing ISM samples on 12 May 2016 were inadvertently routed to a laboratory at another location and once received, all ice was melted and the samples were at an ambient temperature. These coolers were immediately repacked on ice and received at the TestAmerica-Denver laboratory on 18 May 2016. These coolers contained ISM samples only and data validation was completed without any rejected results (see Appendix B).

4.3.3.2 Laboratory extraction, analysis methods, and target analytes were conducted IAW the approved Work Plan (HGL, 2015a). TestAmerica Denver is accredited by the DoD Environmental Laboratory Accreditation Program for all analyses performed in support of this project. Analytical Data Reports are provided in Appendix B.

4.3.4 Analytical Data Validation

4.3.4.1 Analytical data generated during the sampling effort were validated by the HGL project chemist IAW the requirements identified in the Sampling and Analysis Plan included in the Work Plan. The validation included requirements in DoD Quality Systems Manual for Environmental Laboratories, (latest version) for USEPA Method 8330B, and USEPA Method 6020A.

4.3.4.2 Data validation reviews for laboratory data were performed by the HGL's data validator subcontractor, Laboratory Data Consultants, Inc. (LDC) for all sample results IAW the requirements contained in the QAPP. Laboratory results were assessed for compliance with required precision, accuracy, completeness, and representativeness. Field QC results were evaluated for compliance with required precision, accuracy, and representativeness. Data validation reports generated by the project chemist and the data validator subcontractor are provided in Appendix B. The validation reports note there were discrepancies with some sample labels, which were corrected after shipment of samples; however, all data are acceptable and usable as reported.

4.4 DEPARTURES FROM PLANNING DOCUMENTS

4.4.1 ROE Limitations

4.4.1.1 Areas where landowners refused to grant ROE to their property could not be investigated as proposed in the Work Plan. Certain landowners granted ROE; however, when contacted by HGL to schedule work on their property, landowners refused to cooperate with certain aspects of the field activities (limited brush clearance or limited intrusive investigation).

4.4.2 Expanded Investigation Areas

4.4.2.1 Based on historical information, previous investigations conducted at each MRS, and PDT input, the investigation areas associated with three of the four MRSs (R01, R02, and R03) were expanded from those originally proposed and described in the Final Work Plan, section 1.9 (HGL, 2015). The investigation areas were expanded from the historical MRS boundaries as an effort to include potential source areas located outside of the original MRS boundaries. Investigation boundaries were also modified to exclude areas characterized during previous investigations.

4.4.2.2 Based on the preliminary evaluation of findings from data collected during the RI field activities, and in consultation with the PDT, the investigation boundaries identified in the work plan were expanded further. Early RI investigations near the MRS boundaries did not identify MEC, even though MEC were found in these areas during previous investigations by privately-funded contractors (EODT, 2012). Additional acreage was needed to adequately delineate these areas, however the presence of extended wetlands (which remained flooded) and large tracts of land where ROE were refused required the PDT to expand these investigation areas out further to obtain the acreage needed to delineate potential MEC and MC hazards and to statistically support a background area characterization to meet PWS requirements. The background area characterization data collected supports the conclusions of this RI for each MRS. The MRS acreage, expanded investigation acreage as recorded in the Work Plan, and RI-field expanded investigation acreage are presented in Table 4.7. The Work Plan Variances are documented in the Section 4.4.3.

Table 4.7
MRS vs. Expanded Investigation Acreage

MRS	MRS Acreage	RI Work Plan Expanded Investigation Acreage	RI – Field Expanded Investigation Acreage
MRS-R01, Range II	649	1,561	2,629
MRS-R02, Range III	1,961	4,153	5,823
MRS-R03, Range IV	888	1,170	2,812
MRS-R09, MG/RR	2,056	1,755	2,366
Total	5,554	8,639	13,630

4.4.3 Work Plan Variances

4.4.3.1 MRS-R01, MRS-R02, MRS-R03, and MRS-R09 at the former Conway BGR were investigated IAW the final RI Work Plan (HGL, 2015a) with the following deviations, documented in the following FWV:

- FWV-001 – This variance proposed a change from the proposed method for geophysical investigation previously planned in golf course and residential areas. Data collection in these areas was performed by person-portable single sensor methods rather than multi-sensor towed-array methods.
- FWV-002 – Wetlands were added to the investigation area after SCDHEC approval was received on November 2, 2015. The investigation under this variance included minimal vegetation clearance and intrusive investigation to collect sufficient characterization data.

- FWV-003 – Due to a lack of ROE and inaccessibility of transect distances sufficient to support an overall density analysis HGL requested a variance on "completion of DGM density transects". An alternate approach to DGM grid placement was proposed based on historical removal action and RI data to accomplish the MEC characterization.
- FWV-004 – This variance impacted DGM locations affected by nearby electrical utilities, allowing for mag and dig where DGM data collection was impacted by the utilities.

4.4.3.2 The documentation of FWVs are included in Appendix G.

FIGURES

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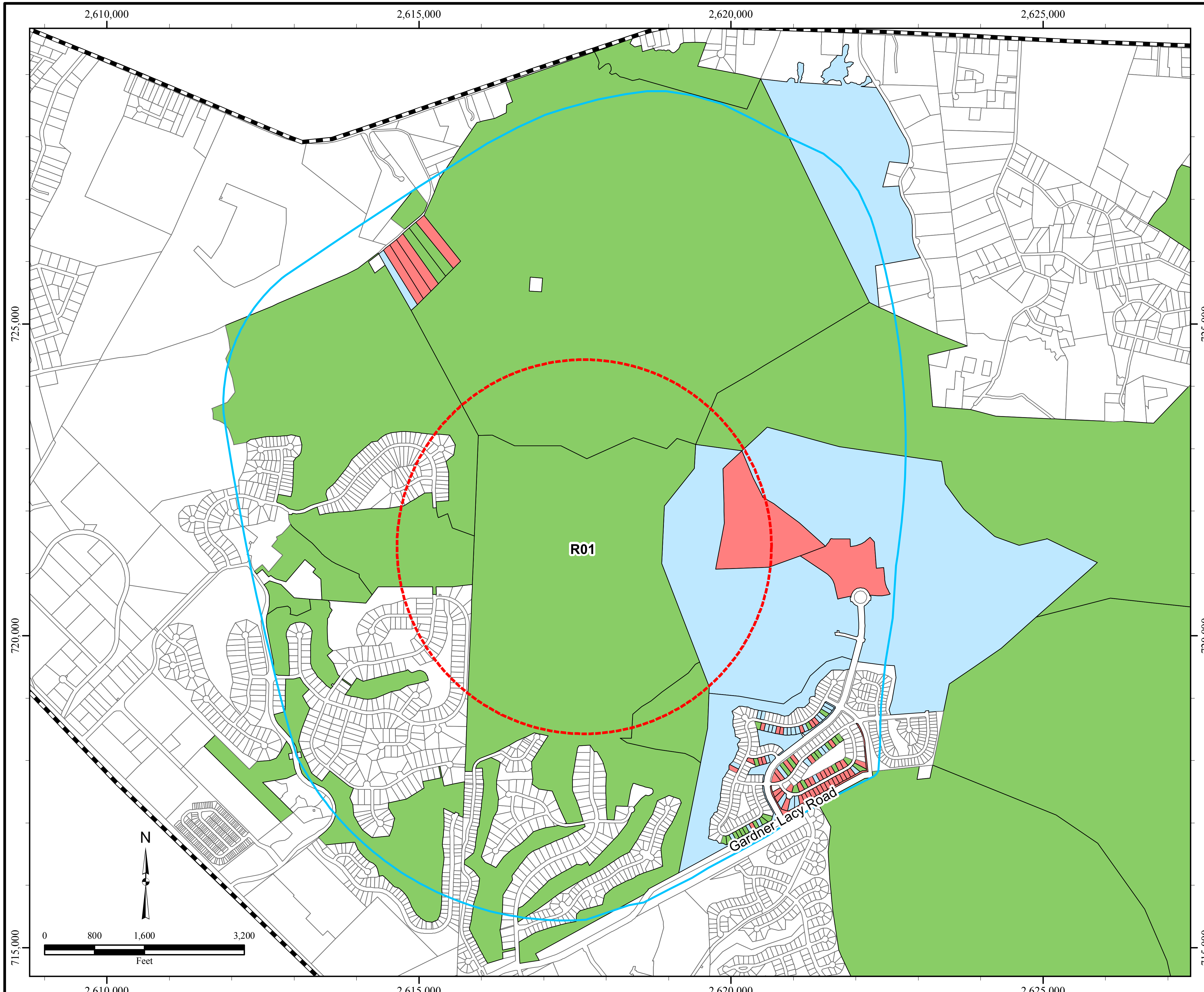
Figure 4.1
MRS-R01
ROE Status by Parcel



Legend

Former Conway Bombing and Gunnery Range Boundary

Munitions Response Site (649.2 acres)

Expanded Investigation Area (2,629 acres)

ROE Status

Accepted

Refused

Mailed

Not Mailed

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

MRS=munitions response site
RI=Remedial Investigation

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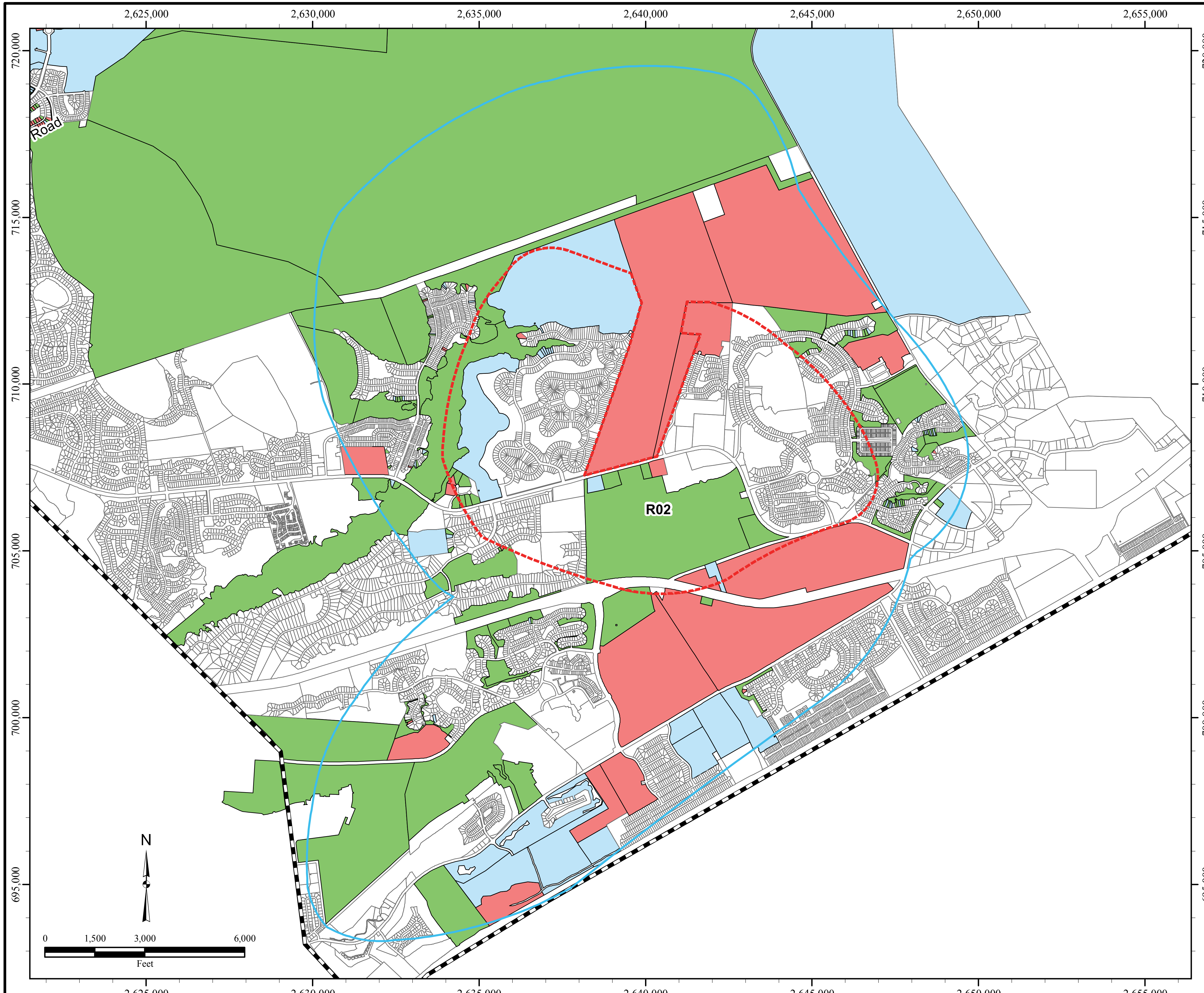

Figure 4.2
MRS-R02
ROE Status by Parcel

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961 acres)
- Expanded Investigation Area (8,189 acres)

ROE Status

- Accepted
- Refused
- Mailed
- Not Mailed

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.
The U.S. Government has been relieved of liability through multiple federal settlement agreements with private landowners. (see Figure 1.3)

MRS=munitions response site
RI=Remedial Investigation

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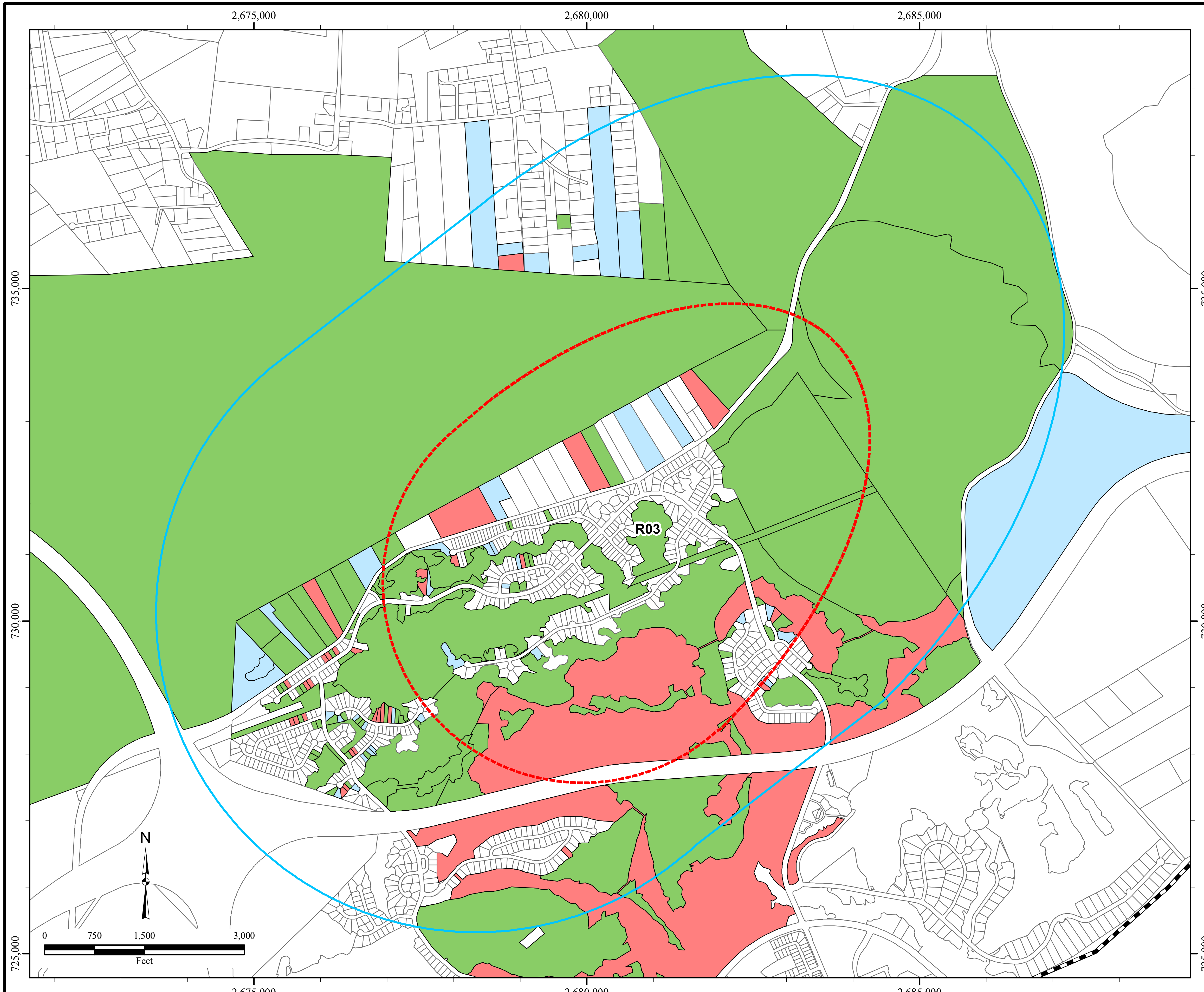
Figure 4.3
MRS-R03
ROE Status by Parcel



Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886 acres)
- Expanded Investigation Area (2,812 acres)

ROE Status

- Accepted
- Refused
- Mailed
- Not Mailed

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

MRS=munitions response site
RI=Remedial Investigation

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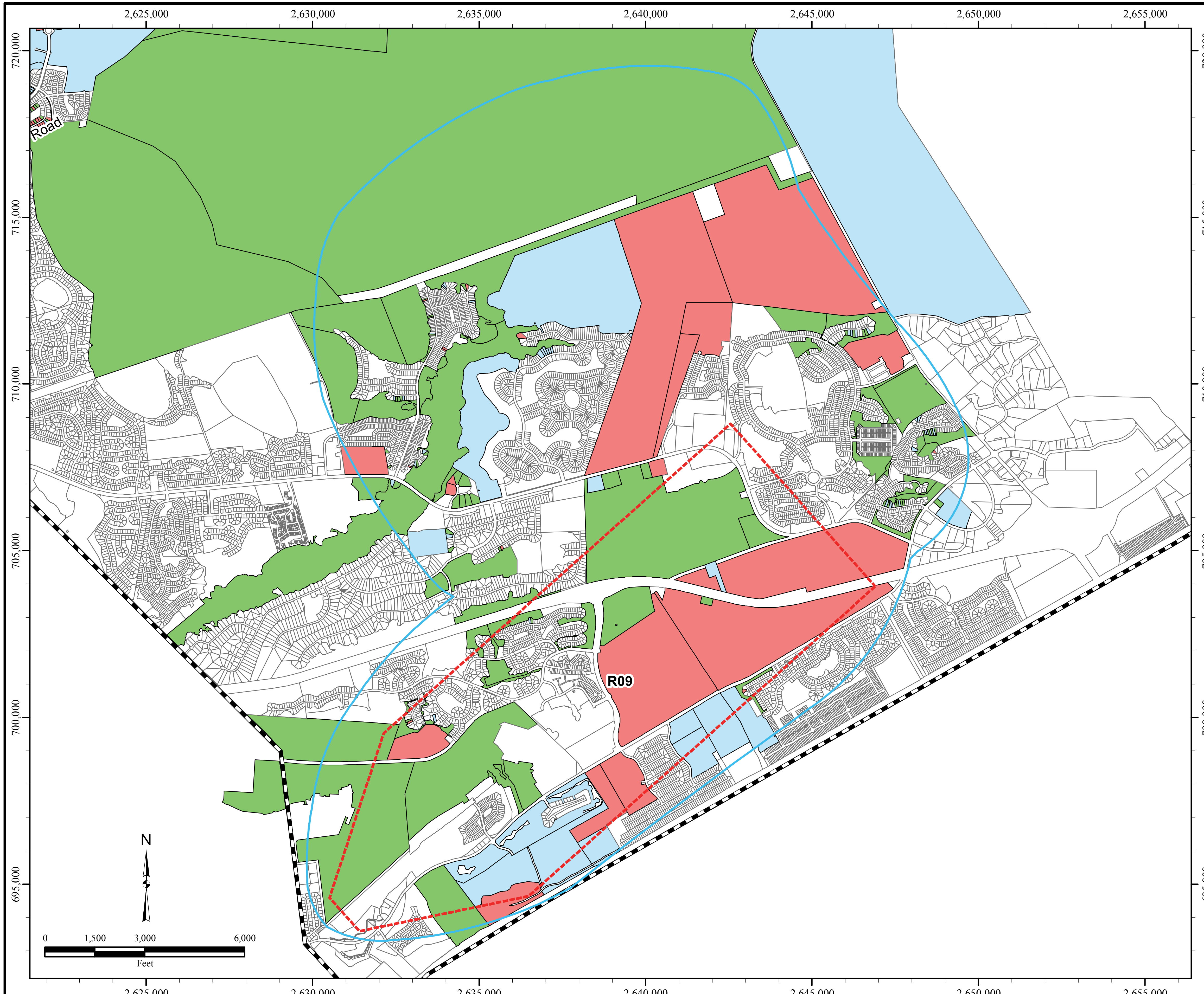
HGL—RI Report
Former Conway Bombing and Gunnery Range, SC

Figure 4.4
MRS-R09
ROE Status by Parcel



Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (2,503 acres)
- Expanded Investigation Area (8,189 acres)

ROE Status

- Accepted
- Refused
- Mailed
- Not Mailed

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

MRS=munitions response site
RI=Remedial Investigation

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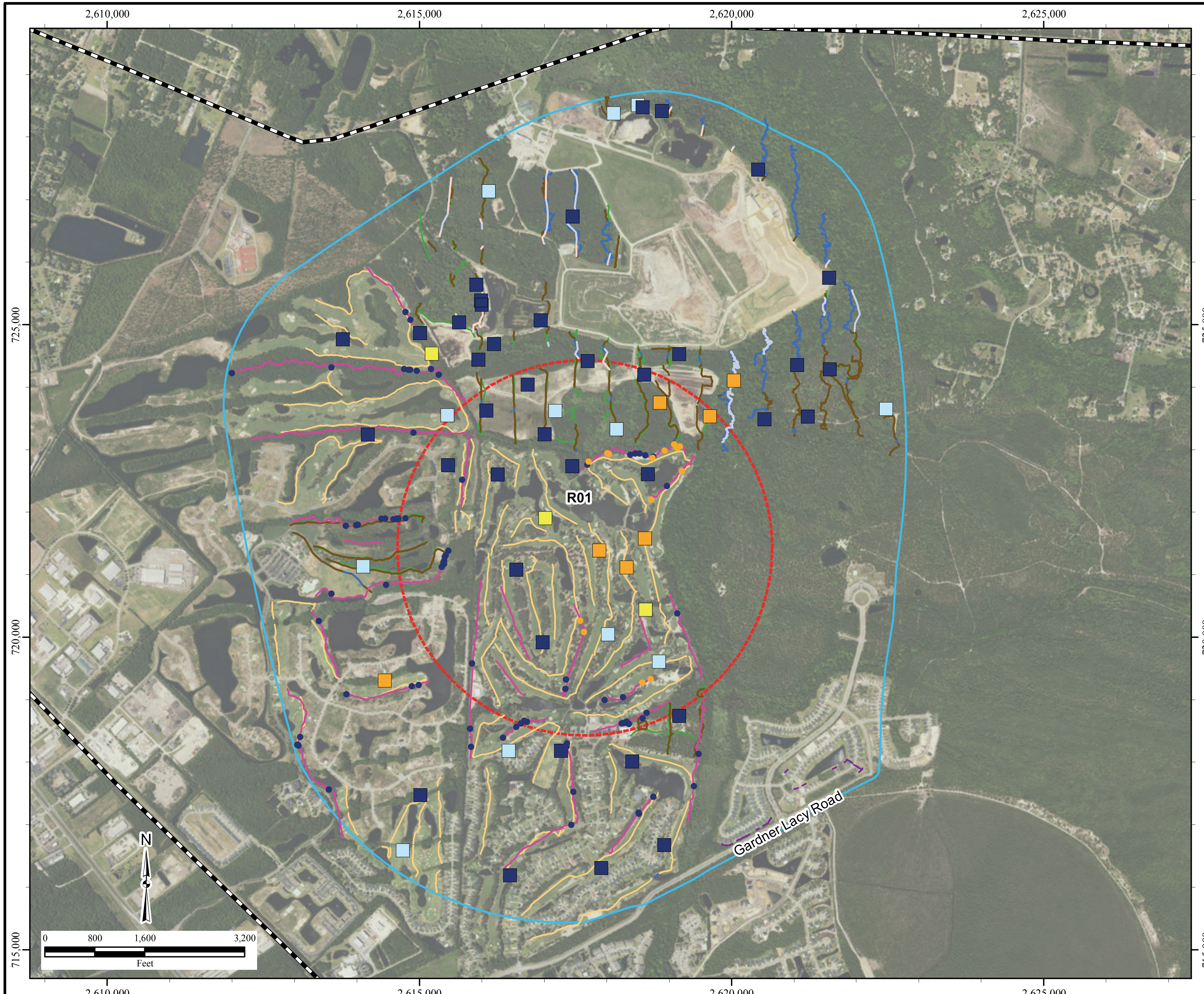

Figure 4.5
MRS-R01
Actual Transect Paths
and Grid Locations

Legend

- MD Anomaly
- CD Anomaly
- DGM Golf Transect
- DGM Overland Transect
- DGM Wetland Transect
- Mag & Dig Transect
- Overland Mag & Count Transect
- Residental Transect
- Vegetation Removal Transect
- Wetland Mag & Count Transect
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area

Instrusively Investigated Grids

- Grid Containing MD
- Grid Containing SAA
- Grid Containing CD
- Grid- Corner Nail or No Contact

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

CD=cultural debris
DGM=Digital Geophysical Mapping
MD=munitions debris
MRS=munitions response site
RI=Remedial Investigation
SAA=small arms ammunition

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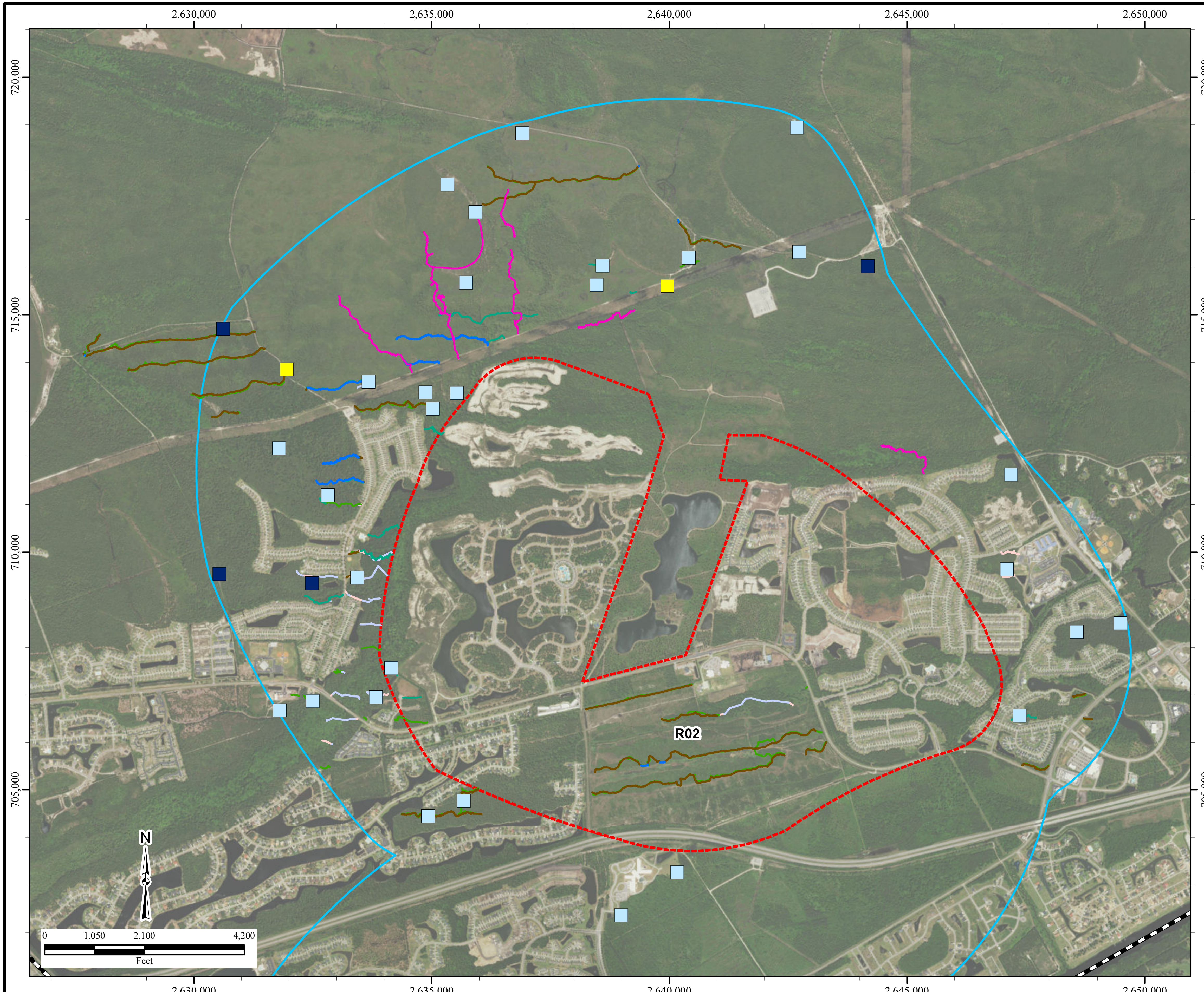
Figure 4.6
MRS-R02
Actual Transect Paths and Grid Locations



Legend

- DGM Overland Transect
- DGM Wetland Transect
- Mag & Dig Transect
- Overland Mag & Count Transect
- Vegetation Removal Transect
- Wetland Mag & Count Transect
- Wetland Vegetation Removal Transect
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area

Instrusively Investigated Grids

- Grid Containing SAA
- Grid Containing CD
- Grid- Corner Nail or No Contact

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

CD=cultural debris
DGM=Digital Geophysical Mapping
MRS=munitions response site
RI=Remedial Investigation
SAA=small arms ammunition

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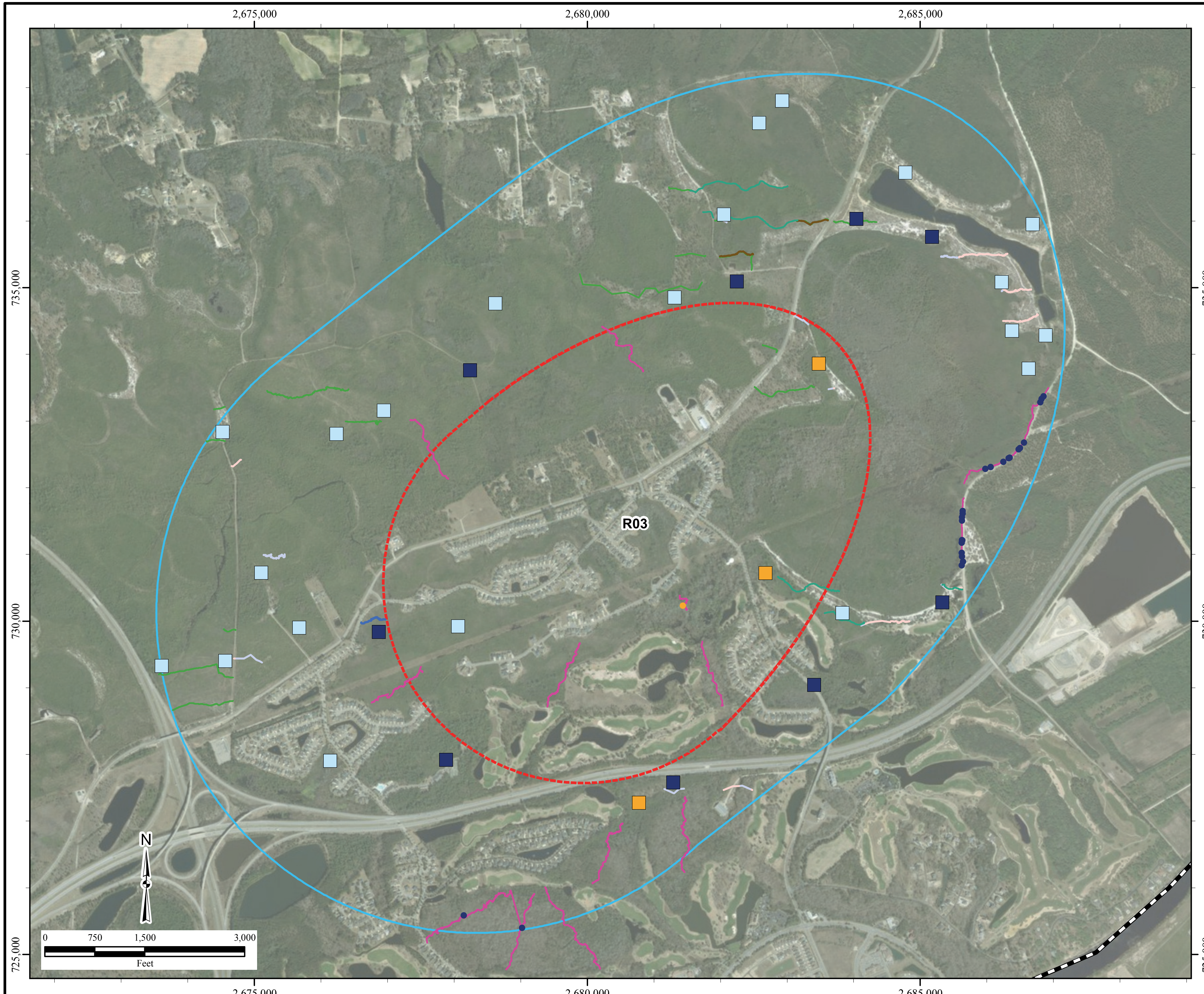
Figure 4.7
MRS-R03
Actual Transect Paths and Grid Locations



Legend

- MD Anomaly
- CD Anomaly
- DGM Overland Transect
- DGM Wetland Transect
- Mag & Dig Transect
- Overland Mag & Count Transect
- Vegetation Removal Transect
- Wetland Mag & Count Transect
- Wetland Vegetation Removal Transect
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area

Instrusively Investigated Grids

- Grid Containing MD
- Grid Containing CD
- Grid- Corner Nail or No Contact

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

CD=cultural debris
DGM=Digital Geophysical Mapping
MD=munitions debris
MRS=munitions response site
RI=Remedial Investigation

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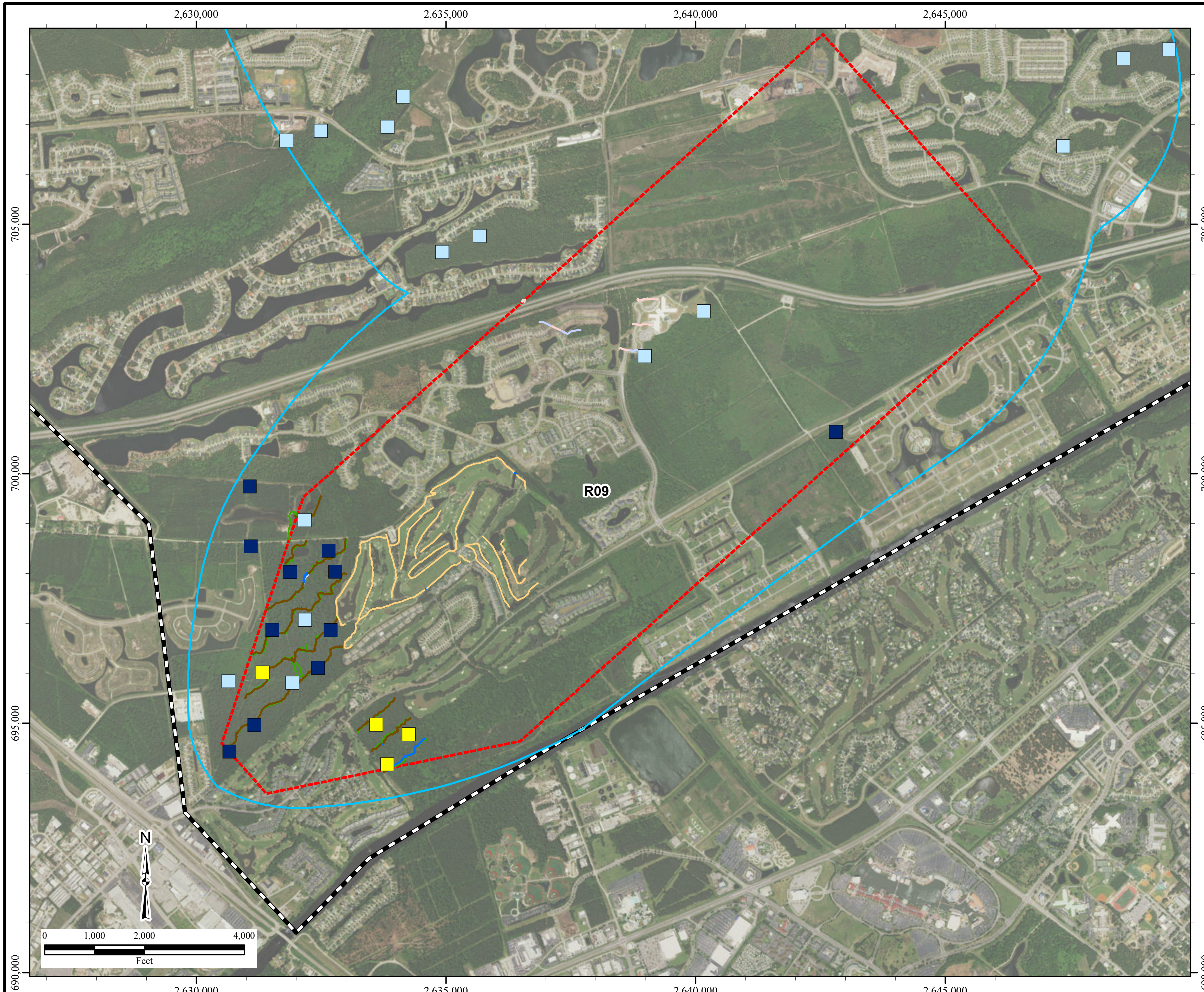
Figure 4.8
MRS-R09
Actual Transect Paths and Grid Locations



Legend

- DGM Golf Transect
- DGM Overland Transect
- DGM Wetland Transect
- Overland Mag & Count Transect
- Vegetation Removal Transect
- Wetland Mag & Count Transect
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area

Instrusively Investigated Grids

- Grid Containing SAA
- Grid Containing CD
- Grid- Corner Nail or No Contact

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

CD=cultural debris
DGM=Digital Geophysical Mapping
MRS=munitions response site
RI=Remedial Investigation
SAA=small arms ammunitions

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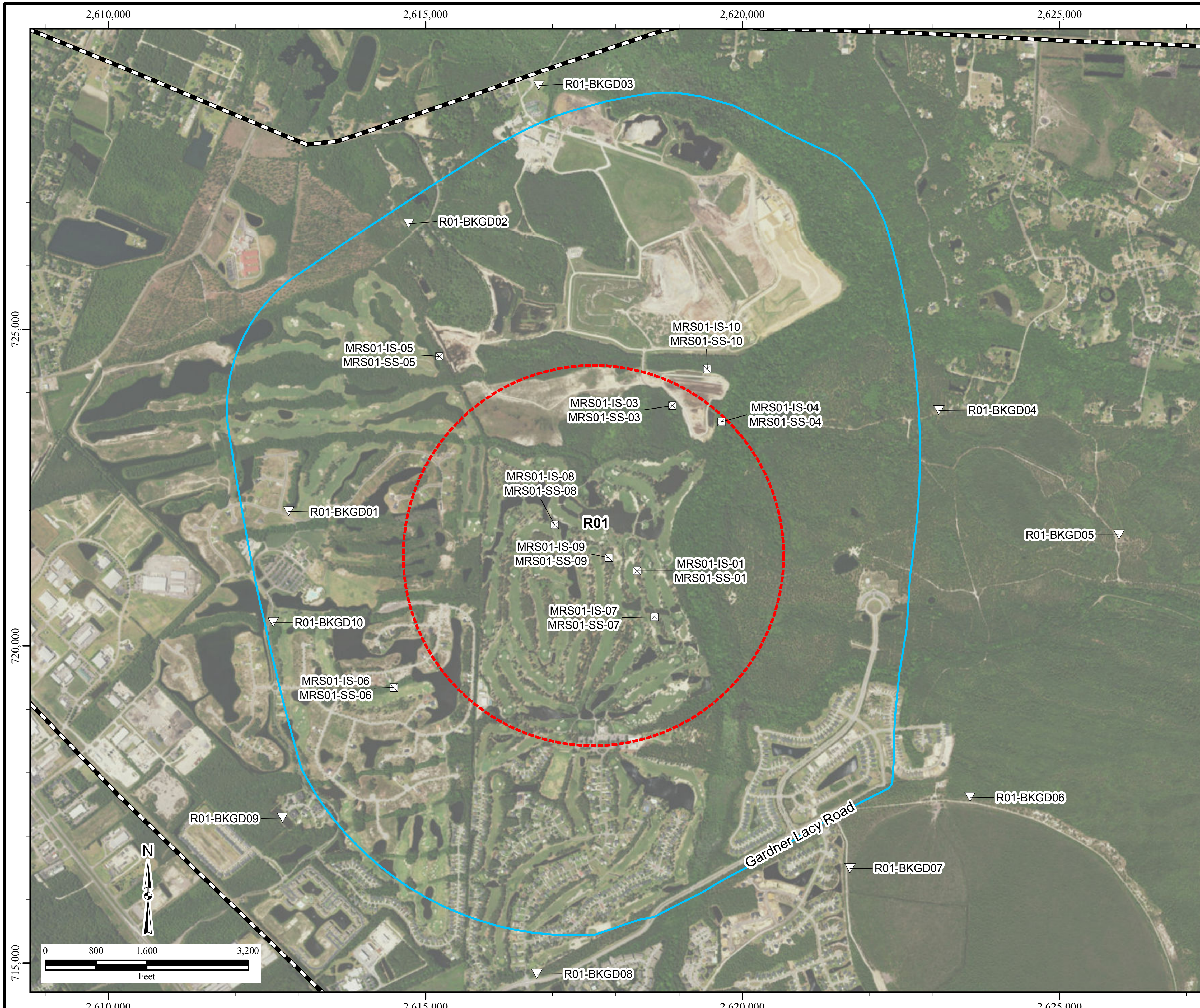
Figure 4.9
MRS-R01
Sample Locations



Legend

- Background Sample
- Soil Sample*
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

*=Discrete surface soil samples were collected at the center of the incremental sample.
MRS=munitions response site
RI=Remedial Investigation

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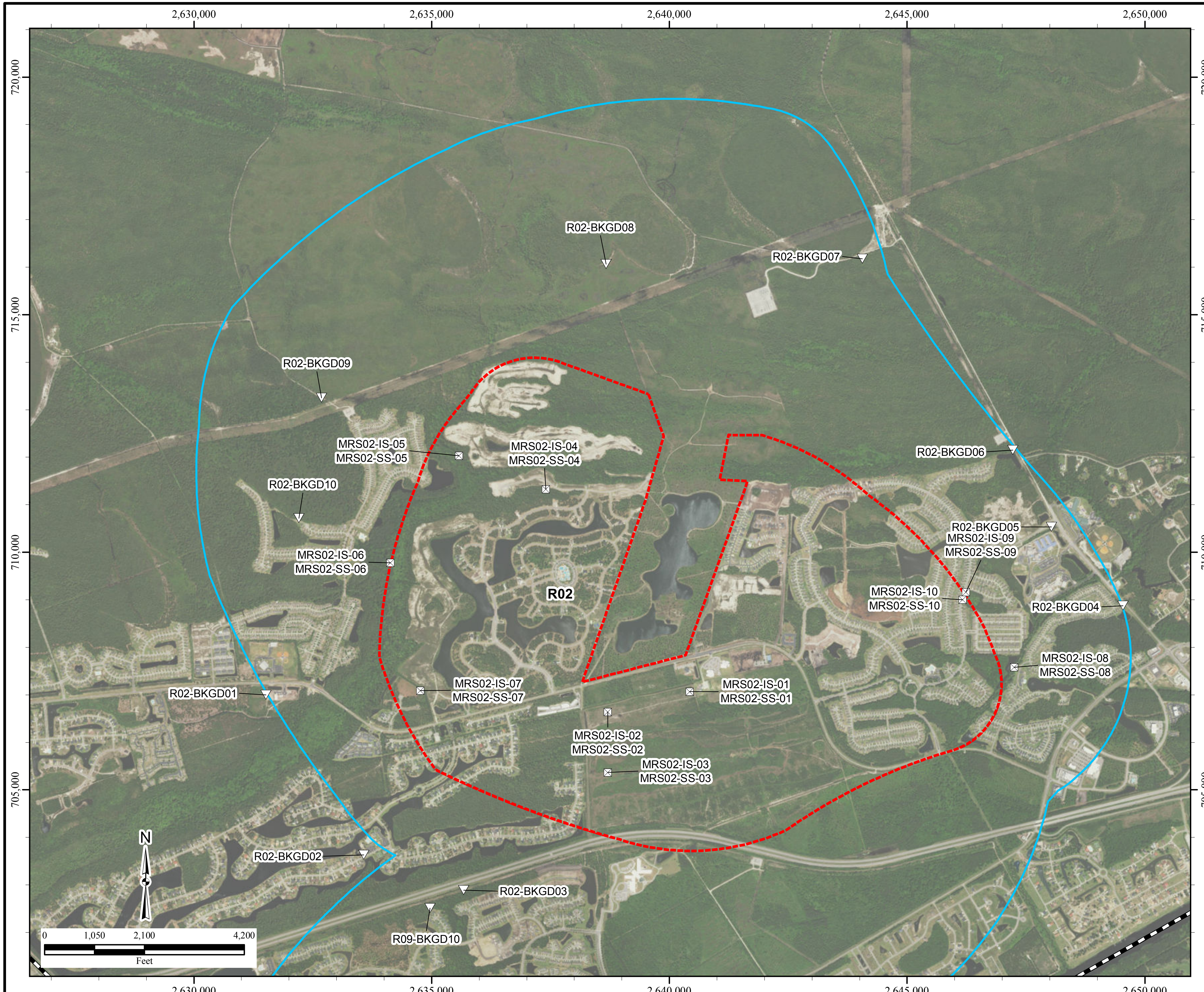
Figure 4.10
MRS-R02
Sample Locations



Legend

- ▽ Background Sample
- ⊠ Soil Sample*
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

*=Discrete surface soil samples were collected at the center of the incremental sample.
MRS=munitions response site
RI=Remedial Investigation

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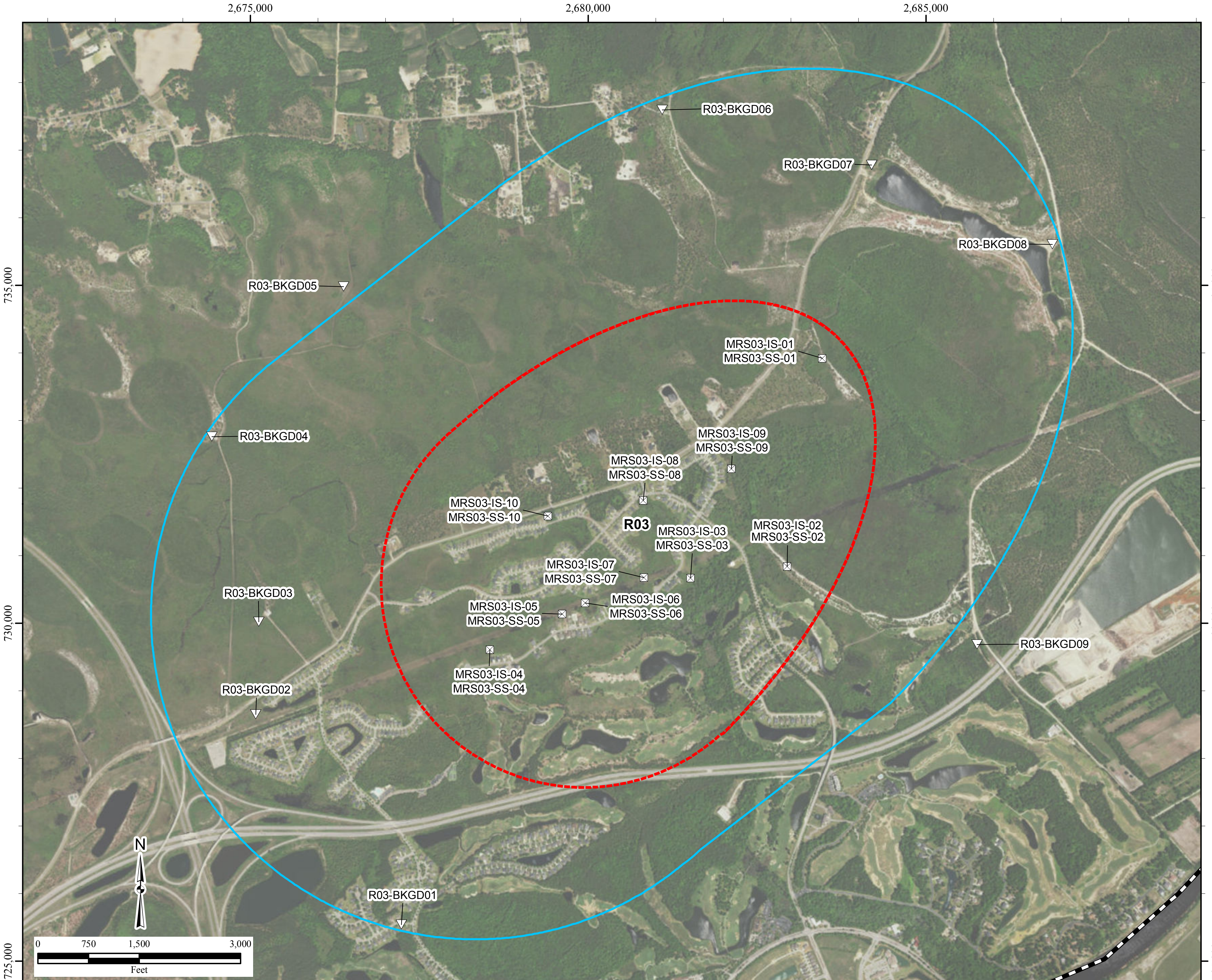
Figure 4.11
MRS-R03
Sample Locations



Legend

- Background Sample
- Soil Sample*
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

*=Discrete surface soil samples were collected at the center of the incremental sample.
MRS=munitions response site
RI=Remedial Investigation

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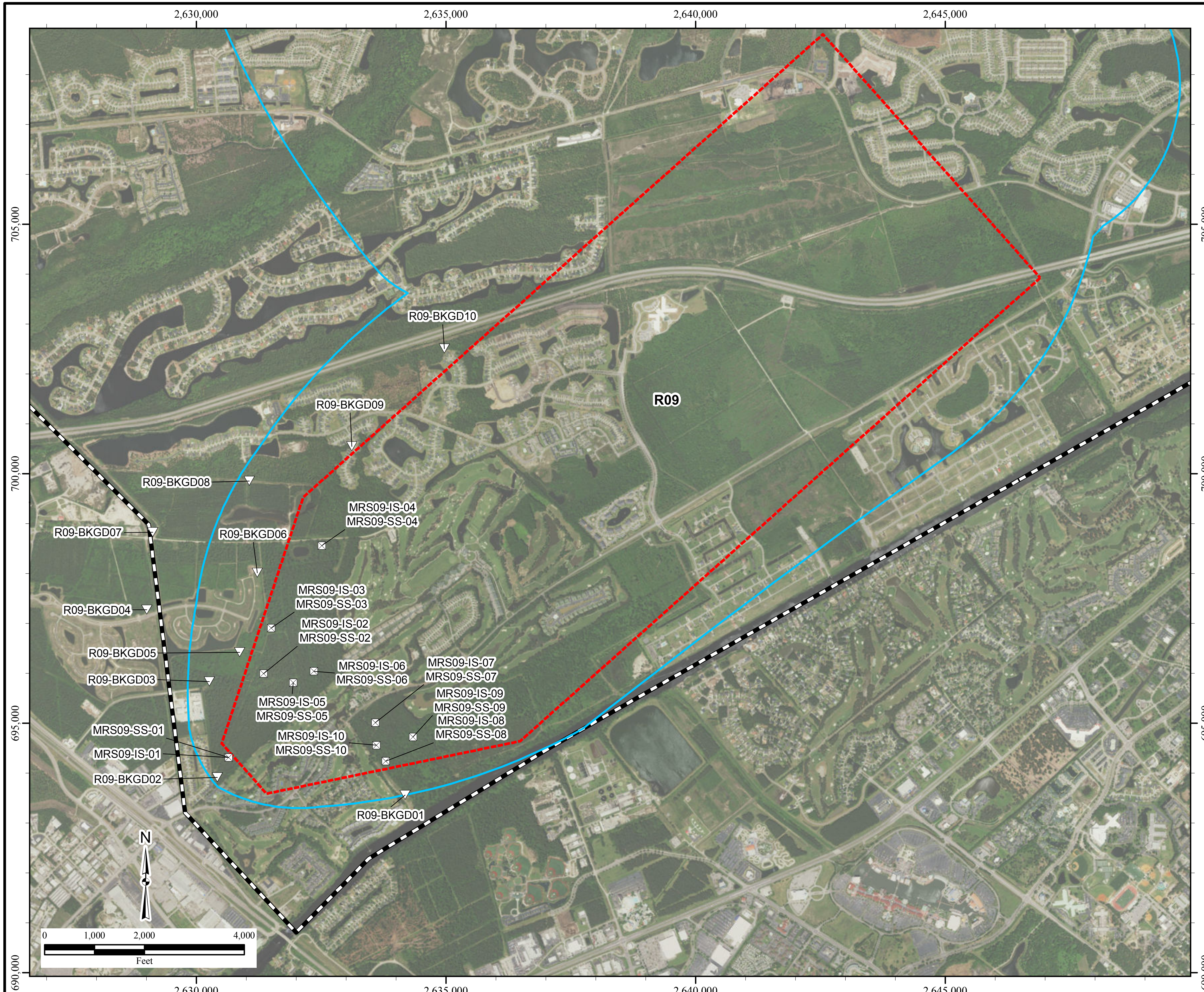
Figure 4.12
MRS-R09
Sample Locations



Legend

- ▽ Background Sample
- ⊠ Soil Sample*
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

*=Discrete surface soil samples were collected at the center of the incremental sample.
MRS=munitions response site
RI=Remedial Investigation

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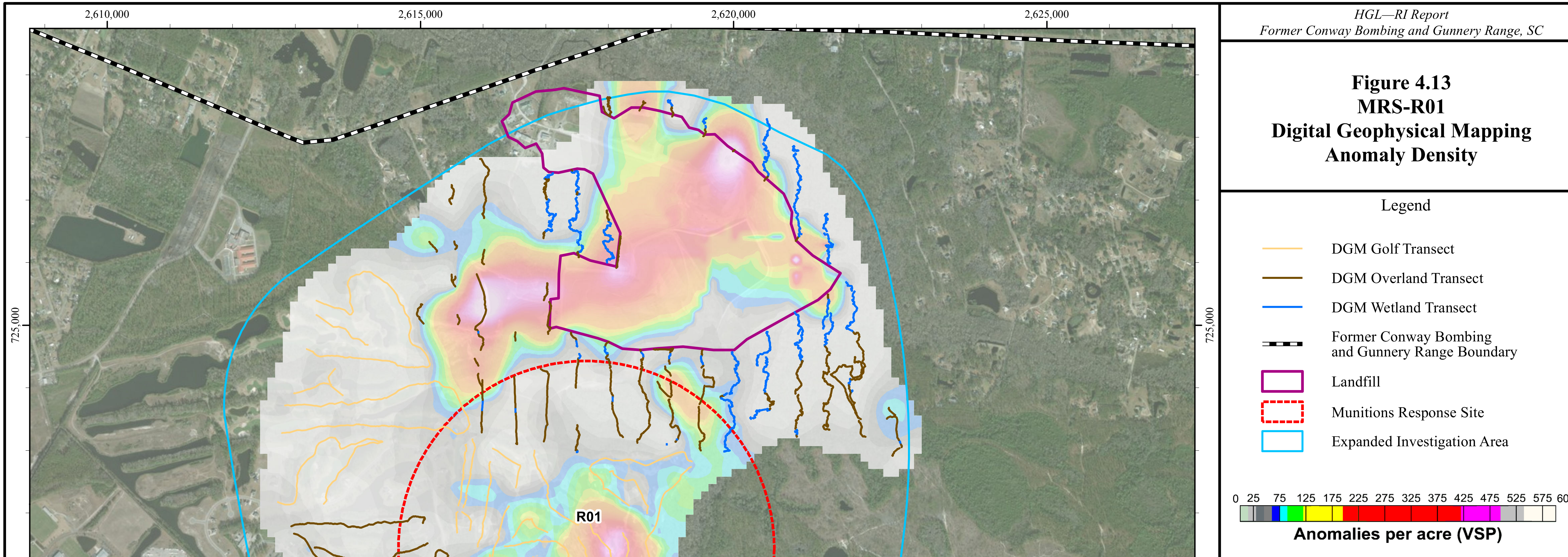
Figure 4.13
MRS-R01
Digital Geophysical Mapping
Anomaly Density



Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

DGM=digital geophysical mapping
MRS=munitions response site
RI=Remedial Investigation
VSP=Visual Sample Plan

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5.0 REVISED CONCEPTUAL SITE MODEL AND RI RESULTS

5.0.1 This chapter describes the results of the MEC and MC investigations, the estimated extent of MEC and MC contamination at the project site, and the revised CSM based on site characterization. The following subchapters detail the results of the field investigation completed for each MRS.

5.1 MEC INVESTIGATION

5.1.1 Introduction

5.1.1.1 As described in Chapter 4.2, to meet the project DQOs for MEC characterization, a combination of DGM transects and intrusively investigated grids and analog mag and dig transect segments were used for RI investigations within the former Conway BGR. All DGM grids were reviewed by the project geophysicist IAW the Work Plan. The disposal documentation for all MDAS recovered in the MRSs during this RI, including the signed DD Forms 13481A, is included in Appendix A. The subchapters below include a summary of the MEC characterization developed for each MRS during the RI field activities. Figure 5.1, Figure 5.2a, Figure 5.2b, and Figure 5.3 show the MEC contamination boundaries. The following subchapters discuss the field activities completed in each MRS and results of the investigation for MEC.

5.1.2 MRS-R01, Range II MEC Investigation

5.1.2.1 MRS-R01 encompasses approximately 649 acres, and the expanded investigation area is 2,629 acres (See Section 4.4.2). Analog and DGM transects and grid DGM surveys were completed within MRS-R01 and the surrounding expanded investigation area, and based on the DGM data, anomaly densities were mapped as shown in Figure 4.13. One large area of high anomaly density was discovered in the north of the investigation area. Based on discussions with the county, this was discovered to be an abandoned modern county landfill and thus was ignored for the purposes of the RI. In addition, analog mag and dig transects were completed near areas of identified MEC contamination to provide additional delineation data. The quantities of data collected within the MRS-R01 investigation areas are summarized in Table 5.1. A total of 631 targets or polygons potentially representing subsurface MEC were intrusively investigated. As shown in Table 5.2, approximately 13 percent of these records were associated with MD (no MEC was identified). Investigation of targets or polygons resulted in 84 targets that contained MD items, 33 targets that contained SAA (.50 caliber) and 286 anomalies associated with other debris (metals from items other than munitions, such as bolts, cans, rebar, metal wire, hinges, and metal plates). The remaining 14 targets were described by the field teams as follows:

- Shared targets that resulted from another nearby target, where anomalies were resolved as nearby anomalies were investigated and removed
- “no contact” locations where an anomaly source could not be identified due to topography or of magnetic rocks),
- blind seed items, or
- grid corner nails.

5.1.2.2 Table 5.1 summarizes the RI field activities completed, Table 5.2 provides details on the results of the RI field investigation and Table 5.3 summarizes the MD located. No MEC items were found; however, MEC contamination has been confirmed in the past. MDAS (MD) identified were as follows:

- 0.50 caliber projectiles;
- 2.25-inch Rocket;
- M38A2 practice bomb; and
- M41 Fragmentation bomb.

Table 5.1
Summary of RI Field Activities Completed – MRS-R01

Activity Description	Unit	Quantity
Brush Clearance (all Transect types)	Miles	7.74
Overland Mag and Count Transects	Miles	0.64
Wetland Mag and Count Transects	Miles	1.89
Residential Mag and Count Transects	Miles	0.25
Overland DGM Transects	Miles	8.71
Wetland DGM Transects	Miles	5.82
Golf Course DGM Transects	Miles	16.2
DGM Grids	Grids	50
	Equivalent Acres	2.48
DGM Grids Intrusively Investigated	Grids	47
	Equivalent Acres	2.31
Characterization DGM Grids in Background Areas Intrusively Investigated	Grids	38
	Equivalent Acres	1.79
Background Mag and Dig Transects (4.5-ft)	Miles	7.34
	Acres	4.00
QC Transects	Miles	0.94
Background DGM Grids	Grids	12
	Equivalent Acres	2.54
Background Grids Intrusively Investigated*	Grids	12
	Equivalent Acres	2.54
EE/CA DGM Grids Intrusively Investigated in Background Areas	Grids	9
	Equivalent Acres	0.52
Intrusively Investigated Anomalies (within Grids)	Each	688

Table 5.2
Summary of Intrusive Investigation Results – MRS-R01

Anomaly Type	Number of Records*
MEC	0
MD	84
SAA	33
Other Debris (non-munitions-related metal and other cultural debris)	286
Shared Targets	44
No Contacts	14
Blind Seed Items and Grid Corner Nails	283

*Sum will not match total Intrusively Investigated Anomalies in Table 5.1 due to multiple items found within the same hole.

Table 5.3
Summary of MD Recovered – MRS-R01

MD Item	Pieces
100-lb M38A2 Practice bomb	48
2.25-inch SCAR	28
20-lb M41 Fragmentation Bomb	2
Unidentified fragments	2
Small Arms Ammunition (casings or projectiles)	33

5.1.3 MRS-R02, Range III MEC Investigation

5.1.3.1 MRS-R02 encompasses a total of 1,961 acres, and the expanded investigation area is 5,823 acres (See Section 4.4.2). Analog and DGM transects and grid DGM surveys were completed within MRS-R02 and the surrounding expanded investigation area. In addition, analog mag and dig transects were completed near areas of identified MEC contamination or where needed due to refusal of residents to evacuate, for additional delineation data. The quantities of data collected within MRS-R02 are summarized in Table 5.4. A total of 192 targets or polygons potentially representing subsurface MEC were intrusively investigated. As shown in Table 5.5, none of these records were associated with either MEC or MD (no MEC was identified). Investigation of targets or polygons resulted in 3 targets that contained SAA (.50 caliber) and 2 anomalies associated with other debris (metals from items other than munitions, such as chain links, bolts, banding, spacers, pins, and nails). The remaining 169 targets were described by the field teams as follows:

- Shared targets that resulted from another nearby target, where anomalies were resolved as nearby anomalies were investigated and removed,
- “no contact” locations where an anomaly source could not be identified due to topography or of magnetic rocks),
- blind seed items, or
- grid corner nails.

5.1.3.2 Table 5.4 summarizes the RI field activities completed and Table 5.5 provides details on the results of the RI field investigation. No MEC items were found during the RI field activities. Only SAA items were located during these RI field activities. However, numerous privately funded (non-USACE) removal actions have been conducted in the past that confirmed MEC present within the MRS. USACE also conducted a previous RI (EODT, 2012). The 2012 RI documented MEC items present at the boundaries of the MRS, without reaching a conclusion on the extent of MEC. See Section 5.3.1.2 for additional information.

Table 5.4
Summary of RI Field Activities Completed – MRS-R02

Activity Description	Unit	Quantity
Brush Clearance (all Transect types)	Miles	13.33
Overland Mag and Count Transects	Miles	0.36
Wetland Mag and Count Transects	Miles	1.33
Residential Mag and Count Transects	Miles	0
Overland DGM Transects	Miles	7.41
Wetland DGM Transects	Miles	2.19
Golf Course DGM Transects	Miles	0
Characterization DGM Grids	Grids	36
	Equivalent Acres	2.07
Characterization DGM Grids Intrusively Investigated	Grids	30
	Equivalent Acres	1.72
Characterization DGM Grids in Background Areas Intrusively Investigated	Grids	30
	Equivalent Acres	1.72
Background Mag and Dig Transects (4.5-ft)	Miles	4.5
	Acres	2.45
QC Transects	Miles	0.26
Background DGM Grids	Grids	4
	Equivalent Acres	0.75
Background Grids Intrusively Investigated*	Grids	6
	Equivalent Acres	1.08
EE/CA DGM Grids Intrusively Investigated in Background Areas	Grids	32
	Equivalent Acres	1.84
Intrusively Investigated Anomalies (within Grids)	Each	202

Table 5.5
Summary of Intrusive Investigation Results – MRS-R02

Anomaly Type	Number of Records*
MEC	0
MD	0
SAA	3
Other Debris (non-munitions-related metal and other cultural debris)	2
Shared Targets	4
No Contacts	1
Blind Seed Items and Grid Corner Nails	169

*Sum will not match total Intrusively Investigated Anomalies in Table 5.4 due to multiple items found within the same hole.

5.1.4 MRS-R03, Range IV MEC Investigation

5.1.4.1 MRS-R03 is comprised of approximately 888 acres, and the expanded investigation area is 2,812 acres (see section 4.4.2). Analog and DGM transects and grid DGM surveys were completed within the MRS-R03 and surrounding expanded investigation area. In addition, analog mag and dig transects were completed near areas of identified MEC contamination or refusal of residents to evacuate to provide additional delineation data. The quantities of data collected with MRS-R03 are summarized in Table 5.6. A total of 225 targets or polygons potentially representing subsurface MEC were intrusively investigated. As shown in Table 5.7, the investigation of targets or polygons resulted in no MEC, 56 anomalies that contained MD items, and 15 anomalies associated with other debris (metals from items other than munitions, such as rods, springs, grounding rods, t-posts, and wire bundles). The remaining 158 targets were described by the field teams as follows:

- Shared targets that resulted from another nearby target, where anomalies were resolved as nearby anomalies were investigated and removed
- “no contact” locations where an anomaly source could not be identified due to topography or of magnetic rocks),
- blind seed items, or
- grid corner nails.

5.1.4.2 Table 5.6 summarizes the RI field activities completed, Table 5.7 provides details on the results of the RI field investigation and Table 5.8 summarizes the MD located. No MEC items were found during the RI field activities. However, numerous privately funded (non-USACE) removal actions have been conducted in the past that confirmed MEC present within the MRS. USACE also conducted a previous RI (EODT, 2012). The 2012 RI documented MD from 100-lb practice bombs and recommended further investigation, without reaching a conclusion on the extent of MEC. See Section 5.3.1.2 for additional information. Pieces of munitions that were classified as MD were from the M38A2 practice bomb.

Table 5.6
Summary of RI Field Activities Completed – MRS-R03

Activity Description	Unit	Quantity
Brush Clearance (all Transect types)	Miles	3.31
Overland Mag and Count Transects	Miles	0.61
Wetland Mag and Count Transects	Miles	0.51
Residential Mag and Count Transects	Miles	0
Overland DGM Transects	Miles	0.31
Wetland DGM Transects	Miles	0.16
Golf Course DGM Transects	Miles	0
Characterization DGM Grids	Grids	28
	Equivalent Acres	1.61
Characterization DGM Grids Intrusively Investigated	Grids	28
	Equivalent Acres	1.61
Characterization DGM Grids in Background Areas Intrusively Investigated	Grids	26
	Equivalent Acres	1.49
Background Mag and Dig Transects (4.5-ft)	Miles	4.17
	Acres	2.28
QC Transects	Miles	0.63
Background DGM Grids	Grids	3
	Equivalent Acres	0.52
Background Grids Intrusively Investigated*	Grids	5
	Equivalent Acres	0.96
EE/CA DGM Grids Intrusively Investigated in Background Areas	Grids	59
	Equivalent Acres	3.39
Intrusively Investigated Anomalies (within Grids)	Each	227

Table 5.7
Summary of Intrusive Investigation Results – MRS-R03

Anomaly Type	Number of Records*
MEC	0
MD	56
SAA	0
Other Debris (non-munitions-related metal and other cultural debris)	15
Shared Targets	4
No Contacts	3
Blind Seed Items and Grid Corner Nails	155

*Sum will not match total Intrusively Investigated Anomalies in Table 5.6 due to multiple items found within the same hole.

Table 5.8
Summary of MD Recovered – MRS-R03

MD Item	Pieces
M38A2 practice bomb	56

5.1.5 MRS-R09, Machine Gun/Rifle Range MEC Investigation

5.1.5.1 MRS-R09 encompasses approximately 2,056 acres and the expanded investigation area is 2,366 acres. The area of the range fan that extend into MRS-R02 were investigated under MRS-R02. DGM transects and grid DGM surveys were completed within the southern portion of MRS-R09 that does not overlap with MRS-R02. In addition, analog mag and dig transects were completed near areas of identified MEC contamination or refusal of residents to evacuate to provide additional delineation data. The quantities of data collected within MRS-R09 are summarized in Table 5.9. A total of 162 targets or polygons potentially representing subsurface MEC were intrusively investigated. As shown in Table 5.10, none of these records were associated with either MEC or MD (no MEC was identified). Investigation of targets or polygons resulted in 8 targets that contained SAA (.50 caliber) and 26 anomalies associated with other debris (metals from items other than munitions, such as cans, railroad nails, wire, scrap metal, wire baskets, metal spikes, latches, and metal debris). The remaining 92 targets were described by the field teams as follows:

- Shared targets that resulted from another nearby target, where anomalies were resolved as nearby anomalies were investigated and removed
- “no contact” locations where an anomaly source could not be identified due to topography or of magnetic rocks),
- blind seed items, or
- grid corner nails.

5.1.5.2 Table 5.9 summarizes the RI field activities completed and Table 5.10 provides details on the results of the RI field investigation. No MEC items were found, no MD items were found, and only SAA was located.

Table 5.9
Summary of RI Field Activities Completed – MRS-R09

Activity Description	Unit	Quantity
Brush Clearance (all Transect types)	Miles	4.03
Overland Mag and Count Transects	Miles	0.28
Wetland Mag and Count Transects	Miles	0.24
Residential Mag and Count Transects	Miles	0
Overland DGM Transects	Miles	3.38
Wetland DGM Transects	Miles	0.35
Golf Course DGM Transects	Miles	4.82
Characterization DGM Grids	Grids	10
	Equivalent Acres	0.57
Characterization DGM Grids Intrusively Investigated	Grids	10
	Equivalent Acres	0.57
Characterization DGM Grids in Background Areas Intrusively Investigated	Grids	10
	Equivalent Acres	0.57
Background Mag and Dig Transects (4.5-ft)	Miles	0
	Acres	0.00
QC Transects	Miles	0
Background DGM Grids	Grids	8
	Equivalent Acres	1.84
Background Grids Intrusively Investigated*	Grids	8
	Equivalent Acres	1.84
EE/CA DGM Grids Intrusively Investigated in Background Areas	Grids	0
	Equivalent Acres	0.00
Intrusively Investigated Anomalies (within Grids)	Each	162

Table 5.10
Summary of Intrusive Investigation Results – MRS-R09

Anomaly Type	Number of Records*
MEC	0
MD	0
SAA	8
Other Debris (non-munitions-related metal and other cultural debris)	26
Shared Targets	8
No Contacts	3
Blind Seed Items and Grid Corner Nails	89

*Sum will not match total Intrusively Investigated Anomalies in Table 5.9 due to multiple items found within the same hole.

5.2 MC INVESTIGATION

5.2.1 Overview

5.2.1.1 The sampling strategy and methods used for the RI are presented in Chapter 4.3. The following subchapters describe the analytical results. Any MC detected at concentrations above its screening value was considered to be a COPC or COPEC, and was retained for further evaluation in the Chapter 7.2 risk assessment.

5.2.2 Quality Control and Quality Assurance

5.2.2.1 The soil sampling activities were conducted IAW the Work Plan for the RI within the former Conway BGR. In addition, the Work Plan and the included QAPP addressed the DQOs, analytical methods, specific QA, and QC activities, laboratory requirements, and data assessment activities designed to achieve the data quality goals of the project.

5.2.3 Analytical Data Validation

5.2.3.1 Data validation reviews for laboratory data were performed by the HGL's subcontracted data validator, LDC, for all sample results IAW the requirements contained in the QAPP. The data validation was conducted as Stage 2B evaluation of QC summary results for sample holding times, initial and continuing calibrations, initial and continuing calibration blanks, surrogates, internal standards, interference check samples, MS/MSD, laboratory duplicates, laboratory triplicates, laboratory control sample/laboratory control sample duplicates, serial dilutions, laboratory blanks, equipment blanks, and field triplicate samples. A summary of the analytical data and copies of the data validation reports are included as Appendix B.

5.2.4 Analytical Results for Remedial Investigation Munitions Constituents Samples

5.2.4.1 The analytical results of soil samples collected during the RI from MRS-R01, MRS-R02, MRS-R03, and MRS-R09 are presented in Table 5.11, (presented at the end of this chapter due to the number of pages). The human health COPC screening for each of the MRSs is presented in various tables in Appendix B, and discussed in Chapter 7.2.3. No COPCs were identified for MRS-R01, MRS-R02, and MRS-R09 from the RI data. One COPC: Cd, was identified in MRS-R02 (see Chapter 7.2.3).

5.2.4.2 COPEC screening for the RI data from each of the MRSs is presented in Table B5.2 of Appendix B, and discussed in Chapter 7.2.5. In summary, the initial screening identified Cd, Hg, and Zn as COPECs for MRS-R02; and Pb and Zn as COPECs for MRS-R09. No COPECs were identified for MRS-R01 and MRS-R03.

5.2.5 Analytical Results for Historical Munitions Constituents Soil Sampling

5.2.5.1 As stated in Chapter 2.4, limited surface soil sampling was conducted at former Conway BGR during previous investigations. Results from the previous investigations were combined with the data from this RI for a more complete evaluation of the presence or absence of MC contamination at the MRSs.

5.2.5.2 Both historical data and data collected for this RI were included in the BLRA (see Chapter 7.2). As stated in Section 2.4, an MC investigation of soil and surface water was conducted at the Goodson site, located within MRS-R02 (Parsons, 2006). A total of 16 composite samples (including one duplicate sample and one background sample) were collected in August of 2005 in areas identified by field crews as containing bomb craters. The soil samples were collected from 0 to 6 inches bgs, and analyzed for explosives, barium, Cd, Pb, Hg, and Zn.

5.2.5.3 Three samples were collected from one location in both MRS-R01 and MRS-R02 during the 2012 RI. Six samples were collected from two locations in MRS-R03. Samples were collected in August of 2010, and analyzed for explosives, barium, Cd, Pb, Hg, and Zn. Due to lack of ROE, MRS-R09 was not characterized for MC during the 2012 RI.

5.2.5.4 The COPC screening of historical data for MRS-R01, MRS-R02, and MRS-R03, is presented in various tables in Appendix B, and discussed in Chapter 7.2.3. No historical data was available for MRS-R09.

5.2.5.5 Based on the historical composite sample results, as reported in the 2012 RI (EODT, 2012), and the historical composite sample results reported in the 2006 MC Sampling, Analysis, and Evaluation of FUDS (Parsons, 2006) COPECs were evaluated (see Section 7.2.5).

5.3 EXTENT OF MEC AND MC CONTAMINATION

5.3.1 Extent of MEC Contamination

5.3.1.0.1 Using the data from the current RI and previous characterization and removal action efforts, an evaluation was performed to estimate the extent of any MEC contamination identified. The two primary objectives of this process are: (1) to achieve the RI objective to characterize the extent of contamination, and (2) to define areas that will be evaluated in the subsequent FS.

5.3.1.0.2 The sources of data used to estimate the MEC contamination boundary in each MRS included the following:

- Intrusive results for the DGM grids collected by HGL;
- Anomaly density from the DGM and analog transects collected by HGL;
- Anomaly density from DGM, analog, and visual reconnaissance transects performed in previous characterization efforts;
- MEC and MD results from previously completed removal actions (see Section 2.4); and
- ROE.

5.3.1.0.3 No MEC contamination was identified in MRS-09, and no MEC contaminated area is recommended to be established. The contamination boundary for each of the remaining MRSs was located within 250-ft of known data. After the initial boundary was drawn, the information from previous investigations, including available historical data, was used to adjust the boundary. Boundaries are shown on Figures 5.1 through 5.3, and all data used to establish those boundaries are shown on the historical figures (Figures 2.4 through 2.6). Where current and previous data extend near large, contiguous parcels where no ROE was granted, all surrounding data was evaluated to interpolate the boundary.

5.3.1.1 MRS-R01, Range II MEC Contamination Delineation

5.3.1.1.1 The MEC contaminated area within MRS-R01 is exhibited on Figure 5.1. The placement of the MEC contamination boundary was designed to have an accuracy of at least 250 ft; for example, at all times the boundary was drawn to be plus or minus 250 ft from a known RI data point or historical data point, whether from transect density data, grid intrusive results, or mag and dig transect segment data. Historical investigation data was also considered. The MEC contamination boundary was extrapolated where ROE was not granted or was withdrawn before sufficient data could be collected. Areas with refused or withdrawn ROE were not assessed in the RI.

5.3.1.1.2 There is a large parcel of land in the eastern portion of MRS-R01 where ROE was not granted (Figure 4.1). In this region, geophysical and intrusive information from the previous Parsons EE/CA was evaluated to determine a reasonable approximation for the boundary (Figure 2.4a and Figure 2.4b). Additionally, historical investigations and removal actions located evidence of MEC (M38A2 practice bomb spotting charges and 20lb bomb fragments) on the west and southwest areas of MRS-R01. Additional data was gathered during the RI field activities in both areas (Figure 4.5) to strengthen the confidence of the MEC contamination boundary on the west side.

5.3.1.1.3 An estimate of the vertical extent of MEC was provided by an evaluation of all intrusive results. MD was encountered from 0-5 ft bgs. MD was found on the ground surface. The deepest MD found was at 5-ft bgs, where teams encountered an area where M38A2 practice bombs were buried (possibly by workers during golf course construction, though this is unknown). At most of the locations where MD was found, the item was located within 0 to 4-ft bgs. The munitions found during the RI were consistent with historically reported finds: MD from M38 practice bombs, minor amounts of MD from M41 Fragmentation Bomb, and MD from 2.25 inch MK4 MOD 0 Subcaliber Practice Rocket. The area within the MEC contamination boundary is approximately 296 acres. The area outside this MEC contamination boundary may still contain MEC; however, the potential for encountering MEC in these areas is low. Areas with refused or withdrawn ROE were not investigated during the RI. The surrounding area is found to be not MEC contaminated according to the RI data and all previous investigations. This MEC contaminated area is recommended to be separated from uncontaminated areas delineation IAW MRS delineation under FUDS (see further discussion in Chapter 5.3.1.5) and is recommended for evaluation in the FS. The MEC contaminated portion of 296 acres is recommended to proceed to the FS phase and the remaining 353 acres of the MRS is recommended for no further action.

5.3.1.2 MRS-R02, Range III MEC Contamination Delineation

5.3.1.2.1 The MEC contaminated area within MRS-R02 is exhibited on Figure 5.2a and Figure 5.2b. The placement of the MEC contamination boundary was designed to have an accuracy of at least 250 ft; for example, at all times the boundary was drawn to be plus or minus 250 ft from a known RI data point or historical data point, whether from transect density data, grid intrusive results, or mag and dig transect segment data. Historical investigation data was also considered (See Section 2.4.3). The privately funded (non-USACE) removal actions conducted in the past confirmed MEC present within the MRS. MEC has been identified (post-removal actions) by workers during construction activities within the MRS. USACE also conducted a previous RI (EODT, 2012). The 2012 RI documented MEC items present at the boundaries of the MRS, without reaching a conclusion on the extent of MEC. The 2016 RI data gathered supplemented existing data to define the extent and resolve the MEC contamination boundary. The MEC contamination boundary was extrapolated where ROE was not granted or was withdrawn before sufficient data could be collected. Areas with refused or withdrawn ROE were not assessed in the RI.

5.3.1.2.2 There are parcels of land in MRS-R02 that are excluded from this investigation as a result of multiple federal settlement agreements between the landowner and the U.S. Government (Figure 5.2a and Figure 5.2b). RI data was used to extrapolate the MEC-contaminated area across these parcels; however, the U.S. Government has been relieved of liability at these properties. There was also refusal of ROE on the southeast portion of the MRS, where MRS-R09 occurs (Figure 4.2). In all areas, geophysical and intrusive information from previous investigations was evaluated to determine a reasonable approximation for the boundary (Figure 2.5a and Figure 2.5b). The MEC contamination boundary was revised to exclude grids and historical locations where single pieces of MD or SAA only were detected. Additionally, historical investigations and removal actions previously located evidence of MEC, up to the MRS-R02 boundary. Additional data was gathered during the RI field activities surrounding MRS-R02 to verify that MEC contamination did not extend further outward (Figure 4.6) and to strengthen the confidence of the MEC contamination boundary.

5.3.1.2.3 An estimate of the vertical extent of MEC in historical investigations was difficult to evaluate, based on the varied and non-USACE compliant data sets available from the historical information. No MEC was encountered during the RI. MEC and MD were encountered, historically, from 0-7 ft bgs and on the surface. The MEC and MD found within the MRS-R02 include:

- 1.1-inch Mark 2 projectile;
- 100-lb M38A2 Practice Bomb;
- M48 20-lb Practice Bomb;
- 4-lb Incendiary AN-M54;
- 6-lb Incendiary AN-M69X;
- 250-lb M57 Bomb;
- 2.25-inch SCAR;
- 2.36-inch rocket
- 5-inch HVAR, Mk 1;
- 2.75-inch Mk4 FFAR;
- M63 37mm projectile; and
- SAA.

5.3.1.2.4 The area within the MEC contamination boundary is approximately 1,525 acres. The area outside this MEC contamination boundary may still contain MEC; however, the potential for encountering MEC in these areas is low. Areas with refused or withdrawn ROE were not investigated during the RI. The surrounding area is found to be not MEC contaminated according to the RI data and all previous investigations. This MEC contaminated area is recommended to be separated from uncontaminated areas delineation IAW MRS delineation under FUDS (see further discussion in Chapter 5.3.1.5) and is recommended for evaluation in the FS. The MEC contaminated acreage of 1,525 acres is recommended to proceed to the FS phase and the remaining 436 acres of the MRS is recommended for no further action.

5.3.1.3 MRS-R03, Range IV MEC Contamination Delineation

5.3.1.3.1 The MEC contaminated area within MRS-R03 is exhibited on Figure 5.3. The placement of the MEC contamination boundary was designed to have an accuracy of at least 250 ft; for example, at all times the boundary was drawn to be plus or minus 250 ft from a known RI data point or historical data point, whether from transect density data, grid intrusive results, or mag and dig transect segment data. Historical investigation data was also considered (See Section 2.4.3). The privately funded (non-USACE) removal actions conducted in the past confirmed MD from 100-lb practice bombs present within the MRS. USACE also conducted a previous RI (EODT, 2012). The 2012 RI recommended further investigation at this MRS. The 2016 RI data gathered supplemented existing data to define the extent and resolve the MEC contamination boundary. The MEC contamination boundary was extrapolated where ROE was not granted or was withdrawn before sufficient data could be collected. Areas with refused or withdrawn ROE were not assessed in the RI.

5.3.1.3.2 There is a large parcel of land in the southern portion of MRS-R03 where ROE was not granted (Figure 4.3). In this region, geophysical and intrusive information from the previous investigations was evaluated to determine a reasonable approximation for the boundary (Figure 2.6a). Historical investigations were conducted mainly in the central portion of MRS-R03 and MEC had been located at the boundary of those investigations. Additional data was gathered during the RI field activities (Figure 4.6) to verify that MEC contamination did not extend further outward from the previous investigation extents and to strengthen the confidence of the MEC contamination boundary. Extremely low density of MD fragments was identified in grid 3005 to the south, but was surrounded by other investigation (transects and grids) which showed no MD present and the grid was not included in the MEC contamination boundary. Where required due to flooded wetlands, data was gathered surrounding the wetlands, to interpolate the boundary across flooded areas.

5.3.1.3.3 An estimate of the vertical extent of MEC was provided by an evaluation of all intrusive results. MD was encountered from 0-3.5 ft bgs. MD was found on the ground surface. The deepest MD found was at 3.5-ft bgs. The munitions found during the RI were consistent with historically reported finds: 4-lb incendiary bombs; 20-lb fragmentation bombs; and 100-lb practice bombs. The area within the MEC contamination boundary is approximately 495 acres. The area outside this MEC contamination boundary may still contain MEC; however, the potential for encountering MEC in these areas is low. Areas with refused or withdrawn ROE were not investigated during the RI. The surrounding area is found to be not MEC contaminated according to the RI data and all previous investigations. This MEC contaminated area is recommended to be separated from uncontaminated areas delineation IAW MRS delineation under FUDS (see further discussion in Chapter 5.3.1.5) and is recommended for evaluation in the FS. The MEC contaminated acreage of 495 acres is recommended to proceed to the FS phase and the remaining 393 acres of the MRS is recommended for no further action.

5.3.1.4 MRS-R09, MG/RR MEC Contamination Delineation

5.3.1.4.1 No MEC was identified in MRS-R09. Only SAA (.50caliber projectiles) were identified during the RI field activities. The acreage of MRS-R09 that is not part of the MRS-R02 MEC contaminated area, should be recommended for no further action.

5.3.1.5 MRS Realignment/Delineation in FUDSMIS

5.3.1.5.1 MRS realignment is the process of restructuring the data in the FUDSMIS for FUDS properties with MMRP projects that were in FUDSMIS before October 1, 2008. Realignment ensures that each MRS will be part of an MRA and will be equivalent to an MMRP project at FUDS properties. Delineation refers to the process of revising MMRP projects/MRSs by further defining MRSs at previously identified MRAs as necessary for more efficient project management. Further defining of MRSs can occur numerous times over the life of an MMRP project as new information becomes available. At the time of RI reporting, FUDMIS lists the MRA (Project I04SC0025) with a size of 55,854 acres, of which these MRSs are a portion.

5.3.1.5.2 As described in Section 4.2, characterization data was collected from inside the current FUDSMIS MRS boundaries and in expanded investigation areas as required to meet statistical requirements for evaluation of background. All current RI data and all historical investigation data were compiled for development of the MEC contamination boundary. All acreage which is outside the MEC contaminated areas summarized below is recommended for No Further Action. Based on MEC contamination boundaries determined during the RI, the following delineation for MRSs in FUDMIS is proposed:

- MRS-01: 296 acres, the MEC-contaminated area of the former MRS-R01.
- MRS-02: 1,525 acres, the MEC-contaminated area of the former MRS-R02.
- MRS-03: 495 acres, the MEC-contaminated area of the former MRS-R03.
- MRS-R09: No MEC contamination was identified; the portion of MRS-R09 that is not part of MRS-R02 MEC contaminated area should be recommended for no further action.

5.3.1.5.3 The proposed MRS-01, MRS-02 and MRS-03 are recommended for further evaluation in the FS. The area of MRS-R09 that is not part of the MRS-R02 MEC contaminated area is recommended for no further action.

5.3.2 Extent of MC Contamination

5.3.2.1 The evaluation of MC contamination was completed for each MRS. MC contamination was assessed in surface soil collected from 0 to 0.5 ft bgs. As discussed in Chapters 5.2, 7.2.3, and 7.2.5, COPCs and COPECs were identified only in MRS-R01, MRS-R02, and MRS-R03, based on samples collected during this RI and during multiple historical investigations. The screening of the analytical results against background concentrations and health-based screening values identified one COPC: Cd in MRS-R02; however, after evaluation the Cd was determined to be no threat to human health under unrestricted land use. The initial screening identified Cd, Hg, and Zn as COPECs for MRS-R02; and Pb and Zn as COPECs for MRS-R09. No COPECs were identified for MRS-R01 and MRS-R03. The SLERA evaluated the exposure of plants, soil invertebrates, mammals, and birds to contaminants at MRS-R01, MRS-R02, MRS-R03, and MRS-R09. No threats were identified for exposure of ecological receptors to soil in all four MRSs. Although Cd and Hg have been identified as COPECs for MRS-R02, the constituents are not components of the munitions used or found within MRS-R02 and are therefore not MC.

5.3.2.2 All COPCs and COPECs were retained for further evaluation in the Chapter 7.2 BLRA and SLERA. Based on the information provided in Chapter 7.2, it was concluded that no MC is present on site at levels that present a risk to human health or the environment. Therefore, MC sampling performed during this RI, and during previous investigations, does not indicate a release of MC.

5.4 STATUS OF DATA QUALITY OBJECTIVES

5.4.0.1 The RI DQOs are described in Subchapter 3.5. The overall project DQOs are structured to obtain data to sufficiently characterize the nature and extent of any MEC and/or MC contamination present at the project sites. Specific DQOs were established for both the MEC and MC investigations and are presented in Table 3.4a through Table 3.4e. This subchapter addresses the status of each of these DQOs at the completion of the RI.

5.4.1 MEC Characterization

5.4.1.1 As shown in Table 3.4a through Table 3.4e, the MEC DQOs for the MRSs included conducting DGM surveys (of transects and grids), intrusive investigation of grids, and mag and dig transect segments. The DGM grid surveys were followed by an intrusive investigation of individual anomalies to fully characterize the nature and extent of identified anomalies. Mag and dig transect segments were also performed to delineate the MEC contamination boundary. The MEC characterization activities were conducted IAW the performance requirements for RI reports as provided in the Work Plan. To achieve these MEC DQOs, DGM surveys and intrusive investigations were conducted across the project site, with the exception of parcels where ROE was refused or withdrawn, or where areas were flooded with water and investigation could not be conducted. Based on the summary provided above and other information presented in Chapter 5.1 and 5.3, in this report, the data obtained during this RI is considered sufficient to characterize the nature and extent of MEC contamination at the project site and the MEC DQOs for this RI are determined to have been achieved where ROE was available.

5.4.2 MC Characterization

5.4.2.1 As shown in Table 3.4a through 3.4e, the MC DQOs for evaluating the presence or absence of MC contamination included the collection and analysis of ISM soil samples and discrete soil samples from each MRS and development of background concentrations for metals.

These samples were analyzed for MC as defined in the approved Work Plan (HGL, 2015a) and the results were compared to screening values to evaluate the presence or absence of MC. Conclusions regarding the presence or absence of MC were to be made based on the comparison of detected concentrations to screening values. The analytes detected were compared to screening values and COPCs were developed. The BLRA is presented in Chapter 7.2. The data obtained during this RI are sufficient to evaluate the presence or absence of MC contamination at the project site and the MC DQOs for this RI have been achieved.

5.5 REVISED CONCEPTUAL SITE MODEL

5.5.1 Summary

5.5.1.1 Based on the results of the MEC and MC characterizations conducted and as presented in Subchapters 5.1 and 5.2, the preliminary CSM described in Subchapter 3.1 was reviewed and updated to reflect any new applicable information. The revised CSMs (represented in Figures 5.4 and 5.5) are completed for the proposed delineated MRSs and summarize the most current information for the site. The MEC and MC exposure pathways described in this revised CSM are discussed further in the following subchapters.

5.5.2 MEC Exposure Pathways

5.5.2.1 MRS-R01: The RI data gathered along with existing historical data was evaluated for MRS-R01. The preliminary MEC CSM for the project site indicated potentially complete MEC exposure pathways at MRS-R01 for residents, construction workers, trespassers, and authorized land users. The RI data gathered did not identify any changes necessary for the land uses or receptors previously identified. The post-RI MEC CSM for MRS-R01 is shown in Figure 5.4a.

5.5.2.2 MRS-R02: The RI data gathered along with existing historical data was evaluated for MRS-R02. The preliminary MEC CSM for the project site indicated potentially complete MEC exposure pathways at MRS-R02 for residents, construction workers, trespassers, and authorized land users. The RI data gathered did not identify any changes necessary for the land uses or receptors previously identified. The post-RI MEC CSM for MRS-R02 is shown in Figure 5.4b.

5.5.2.3 MRS-R03: The RI data gathered along with existing historical data was evaluated for MRS-R03. The preliminary MEC CSM for the project site indicated potentially complete MEC exposure pathways at MRS-R03 for residents, construction workers, trespassers, and authorized land users. The RI data gathered did not identify any changes necessary for the land uses or receptors previously identified. The post-RI MEC CSM for MRS-R03 is shown in Figure 5.4c.

5.5.2.4 MRS-R09: The RI data gathered along with existing historical data was evaluated for MRS-R09. The preliminary MEC CSM for the project site indicated potentially complete MEC exposure pathways at MRS-R09 for residents, construction workers, trespassers, and authorized land users. The RI data gathered did not identify any changes necessary for the land uses or receptors previously identified. The post-RI MEC CSM for MRS-R09 is shown in Figure 5.4d.

5.5.3 MC Exposure Pathways

5.5.3.1 An exposure assessment for MC includes identification of potential exposure pathways, receptors, and exposure scenarios, as well as quantification of exposure to MC. In order for MC exposure pathways to be complete, the following must be present:

- A source for contamination
- An environmental transport and/or exposure medium
- A point of exposure where contaminants contact a receptor
- A likely route of exposure at the point of exposure

Based on the determination of the BLRA (Chapter 7.2) there is no unacceptable risk to human health or ecological receptors, a source of MC is not present. In absence of a source of MC contamination, there are no complete exposure pathways for MC. The revised CSMs for MC within the proposed delineated MRSs are included in Figures 5.5a through 5.5d.

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Table 5.11
Laboratory Analytical Results

		280-83117-1	280-83117-10	280-83117-11	280-83117-12	280-83117-13	280-83117-14	280-83117-15	280-83117-16	280-83117-17	280-83117-18	280-83117-19	280-83117-2	280-83117-20
Analyte	**Units**	**MRS02-IS-01**	**MRS02-SS-01**	**MRS02-SS-02**	**MRS02-SS-03**	**MRS02-SS-04**	**MRS02-SS-05**	**MRS02-SS-06**	**MRS02-SS-07**	**MRS02-SS-08**	**MRS02-SS-09**	**MRS02-SS-10**	**MRS02-IS-02**	**MRS03-IS-01**
1,3,5-Trinitrobenzene	μg/kg	40 U											37 U	40 U
1,3-Dinitrobenzene	μg/kg	40 U											37 U	40 U
2,4,6-Trinitrotoluene	μg/kg	99 U											93 U	100 U
2,4-Dinitrotoluene	μg/kg	40 U											37 U	40 U
2,6-Dinitrotoluene	μg/kg	40 U											37 U	40 U
2-Amino-4,6-dinitrotoluene	μg/kg	99 U											93 U	100 U
2-Nitrotoluene	μg/kg	99 U											93 U	100 U
3-Nitrotoluene	μg/kg	99 U											93 U	100 U
4-Amino-2,6-dinitrotoluene	μg/kg	99 U											93 U	100 U
4-Nitrotoluene	μg/kg	99 U											93 U	100 U
HMX	μg/kg	40 U											37 U	40 U
Lead	mg/kg		0.42	7.5	0.5	1.8	1.8	3.2	2.6	2.9	2.2	1.4		
Nitrobenzene	μg/kg	99 U											93 U	100 U
Nitroglycerin	μg/kg	400 U											370 U	400 U
PETN	μg/kg	990 U											930 U	1000 U
RDX	μg/kg	99 U											93 U	100 U
Tetryl	μg/kg	99 U											93 U	100 U
Zinc	mg/kg		0.88 U	0.95 J	0.94 U	1.3 J	0.58 J	3.2	2.1 J	1.2 J	0.86 J	0.71 J		

Notes:
U – Analyte undetected at the Limit of Detection.
J – Analyte was positively identified. Reported value may not be accurate or precise.
Four equipment blanks were collected (EB-MRS01, EB-MRS-02, EB-MRS-03, and EB-MRS09) with resulting non-detect lead concentrations of 0.7 μg/L.

Table 5.11 (continued)
Laboratory Analytical Results

		280-83117-21	280-83117-22	280-83117-23	280-83117-24	280-83117-25	280-83117-26	280-83117-27	280-83117-28	280-83117-29	280-83117-3	280-83117-30	280-83117-31	280-83117-32
Analyte	**Units**	**MRS03-IS-09**	**MRS03-SS-01**	**MRS03-SS-09**	**R03-BKGD02**	**R03-BKGD03**	**R03-BKGD04**	**R03-BKGD05**	**R03-BKGD06**	**R03-BKGD07**	**MRS02-IS-03**	**R03-BKGD08**	**R02-BKGD01**	**R02-BKGD02**
1,3,5-Trinitrobenzene	μg/kg	37 U									40 U			
1,3-Dinitrobenzene	μg/kg	37 U									40 U			
2,4,6-Trinitrotoluene	μg/kg	93 U									100 U			
2,4-Dinitrotoluene	μg/kg	37 U									40 U			
2,6-Dinitrotoluene	μg/kg	37 U									40 U			
2-Amino-4,6-dinitrotoluene	μg/kg	93 U									100 U			
2-Nitrotoluene	μg/kg	93 U									100 U			
3-Nitrotoluene	μg/kg	93 U									100 U			
4-Amino-2,6-dinitrotoluene	μg/kg	93 U									100 U			
4-Nitrotoluene	μg/kg	93 U									100 U			
HMX	μg/kg	37 U									40 U			
Lead	mg/kg		2.7	1.9	2.0	0.71	0.93	0.82	1.2	1.5		1.2	5.6	2.4
Nitrobenzene	μg/kg	93 U									100 U			
Nitroglycerin	μg/kg	370 U									400 U			
PETN	μg/kg	930 U									1000 U			
RDX	μg/kg	93 U									100 U			
Tetryl	μg/kg	93 U									100 U			
Zinc	mg/kg		0.68 J	0.4 J	5.0	1.9	0.3 J	0.37 J	0.44 J	0.66 J		0.61 J	8.4	1.8 J

Notes:
U – Analyte undetected at the Limit of Detection.
J – Analyte was positively identified. Reported value may not be accurate or precise.
Four equipment blanks were collected (EB-MRS01, EB-MRS-02, EB-MRS-03, and EB-MRS09) with resulting non-detect lead concentrations of 0.7 μg/L.

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Table 5.11 (continued)
Laboratory Analytical Results

		280-83117-33	280-83117-34	280-83117-35	280-83117-36	280-83117-37	280-83117-38	280-83117-4	280-83117-40	280-83117-41	280-83117-42	280-83117-44	280-83117-45	280-83117-46	280-83117-47
Analyte	**Units**	**R02-BKGD03**	**R02-BKGD04**	**R02-BKGD05**	**R02-BKGD06**	**R02-BKGD07**	**R02-BKGD08**	**MRS02-IS-04**	**R02-BKGD10**	**MRS01-IS-01**	**MRS01-IS-02**	**MRS01-IS-04**	**MRS01-IS-05**	**MRS01-IS-06**	**MRS01-IS-07**
1,3,5-Trinitrobenzene	µg/kg							40 U		40 U	37 U	40 U	37 U	38 U	38 U
1,3-Dinitrobenzene	µg/kg							40 U		40 U	37 U	40 U	37 U	38 U	38 U
2,4,6-Trinitrotoluene	µg/kg							99 U		100 U	93 U	99 U	92 U	94 U	95 U
2,4-Dinitrotoluene	µg/kg							40 U		40 U	37 U	40 U	37 U	38 U	38 U
2,6-Dinitrotoluene	µg/kg							40 U		40 U	37 U	40 U	37 U	38 U	38 U
2-Amino-4,6-dinitrotoluene	µg/kg							99 U		100 U	93 U	99 U	92 U	94 U	95 U
2-Nitrotoluene	µg/kg							99 U		100 U	93 U	99 U	92 U	94 U	95 U
3-Nitrotoluene	µg/kg							99 U		100 U	93 U	99 U	92 U	94 U	95 U
4-Amino-2,6-dinitrotoluene	µg/kg							99 U		100 U	93 U	99 U	92 U	94 U	95 U
4-Nitrotoluene	µg/kg							99 U		100 U	93 U	99 U	92 U	94 U	95 U
HMX	µg/kg							40 U		40 U	37 U	40 U	37 U	38 U	38 U
Lead	mg/kg	2.6	2.4	2.4	18.0	0.88	1.4		1.3						
Nitrobenzene	µg/kg							99 U		100 U	93 U	99 U	92 U	94 U	95 U
Nitroglycerin	µg/kg							400 U		400 U	370 U	400 U	370 U	380 U	380 U
PETN	µg/kg							990 U		1000 U	930 U	990 U	920 U	940 U	950 U
RDX	µg/kg							99 U		100 U	93 U	99 U	92 U	94 U	95 U
Tetryl	µg/kg							99 U		100 U	93 U	99 U	92 U	94 U	95 U
Zinc	mg/kg	0.58 J	5.0	0.88 J	1.4 J	1.2 J	0.54 J		1.5 J						

Notes:
U – Analyte undetected at the Limit of Detection.
J – Analyte was positively identified. Reported value may not be accurate or precise.
Four equipment blanks were collected (EB-MRS01, EB-MRS-02, EB-MRS-03, and EB-MRS09) with resulting non-detect lead concentrations of 0.7 µg/L.

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Table 5.11 (continued)
Laboratory Analytical Results

		280-83117-48	280-83117-49	280-83117-5	280-83117-50	280-83117-51	280-83117-52	280-83117-53	280-83117-54	280-83117-55	280-83117-56	280-83117-57	280-83117-58	280-83117-59	280-83117-6
Analyte	**Units**	**MRS01-IS-08**	**MRS01-IS-09**	**MRS02-IS-05**	**MRS01-IS-10**	**R01-BKGD01**	**R01-BKGD02**	**R01-BKGD03**	**R01-BKGD04**	**R01-BKGD05**	**R01-BKGD06**	**R01-BKGD07**	**R01-BKGD08**	**R01-BKGD09**	**MRS02-IS-06**
1,3,5-Trinitrobenzene	μg/kg	38 U	38 U	40 U	40 U										37 U
1,3-Dinitrobenzene	μg/kg	38 U	38 U	40 U	40 U										37 U
2,4,6-Trinitrotoluene	μg/kg	95 U	96 U	99 U	100 U										92 U
2,4-Dinitrotoluene	μg/kg	38 U	38 U	40 U	40 U										37 U
2,6-Dinitrotoluene	μg/kg	38 U	38 U	40 U	40 U										37 U
2-Amino-4,6-dinitrotoluene	μg/kg	95 U	96 U	99 U	100 U										92 U
2-Nitrotoluene	μg/kg	95 U	96 U	99 U	100 U										92 U
3-Nitrotoluene	μg/kg	95 U	96 U	99 U	100 U										92 U
4-Amino-2,6-dinitrotoluene	μg/kg	95 U	96 U	99 U	100 U										92 U
4-Nitrotoluene	μg/kg	95 U	96 U	99 U	100 U										92 U
HMX	μg/kg	38 U	38 U	40 U	40 U										130
Lead	mg/kg					2.8	5.2	7.4	4.2	2.9	5.1	1.4	16.0	2.7	
Nitrobenzene	μg/kg	95 U	96 U	99 U	100 U										92 U
Nitroglycerin	μg/kg	380 U	380 U	400 U	400 U										370 U
PETN	μg/kg	950 U	960 U	990 U	1000 U										920 U
RDX	μg/kg	95 U	96 U	99 U	100 U										92 U
Tetryl	μg/kg	95 U	96 U	99 U	100 U										92 U
Zinc	mg/kg					6.1	2.6	67.0	4.0	1.2 J	3.4	0.33 J	9.6	0.84 U	

Notes:
U – Analyte undetected at the Limit of Detection.
J – Analyte was positively identified. Reported value may not be accurate or precise.
Four equipment blanks were collected (EB-MRS01, EB-MRS-02, EB-MRS-03, and EB-MRS09) with resulting non-detect lead concentrations of 0.7 μg/L.

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Table 5.11 (continued)
Laboratory Analytical Results

		280-83117-60	280-83117-61	280-83117-62	280-83117-63	280-83117-64	280-83117-65	280-83117-66	280-83117-67	280-83117-68	280-83117-69	280-83117-7	280-83117-70	280-83117-8
Analyte	**Units**	**R01-BKGD10**	**MRS01-SS-01**	**MRS01-SS-02**	**MRS01-SS-03**	**MRS01-SS-04**	**MRS01-SS-05**	**MRS01-SS-06**	**MRS01-SS-07**	**MRS01-SS-08**	**MRS01-SS-09**	**MRS02-IS-07**	**MRS01-SS-10**	**MRS02-IS-08**
1,3,5-Trinitrobenzene	μg/kg											40 U		38 U
1,3-Dinitrobenzene	μg/kg											40 U		38 U
2,4,6-Trinitrotoluene	μg/kg											99 U		95 U
2,4-Dinitrotoluene	μg/kg											40 U		38 U
2,6-Dinitrotoluene	μg/kg											40 U		38 U
2-Amino-4,6-dinitrotoluene	μg/kg											99 U		95 U
2-Nitrotoluene	μg/kg											99 U		95 U
3-Nitrotoluene	μg/kg											99 U		95 U
4-Amino-2,6-dinitrotoluene	μg/kg											99 U		95 U
4-Nitrotoluene	μg/kg											99 U		95 U
HMX	μg/kg											40 U		38 U
Lead	mg/kg	2.1	7.6	3.1	2.4	10.0	2.8	8.7	2.1	4.4	2.8		3.9	
Nitrobenzene	μg/kg											99 U		95 U
Nitroglycerin	μg/kg											400 U		380 U
PETN	μg/kg											990 U		950 U
RDX	μg/kg											99 U		95 U
Tetryl	μg/kg											99 U		95 U
Zinc	mg/kg	5.2	6.6	6.2	2.2 J	9.5	3.8	1.3 J	1.3 J	15.0	8.6		0.94 J	

Notes:
U – Analyte undetected at the Limit of Detection.
J – Analyte was positively identified. Reported value may not be accurate or precise.
Four equipment blanks were collected (EB-MRS01, EB-MRS-02, EB-MRS-03, and EB-MRS09) with resulting non-detect lead concentrations of 0.7 μg/L.

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Table 5.11 (continued)
Laboratory Analytical Results

		280-83117-9	280-83168-1	280-83168-10	280-83168-11	280-83168-12	280-83168-13	280-83168-14	280-83168-15	280-83168-16	280-83168-17	280-83168-18	280-83168-19	280-83168-2
Analyte	**Units**	**MRS02-IS-10**	**MRS09-SS-01**	**MRS09-SS-10**	**R09-BKGD01**	**R09-BKGD02**	**R09-BKGD03**	**R09-BKGD04**	**R09-BKGD05**	**R09-BKGD06**	**R09-BKGD07**	**R09-BKGD08**	**R09-BKGD09**	**MRS09-SS-02**
1,3,5-Trinitrobenzene	μg/kg	40 U												
1,3-Dinitrobenzene	μg/kg	40 U												
2,4,6-Trinitrotoluene	μg/kg	99 U												
2,4-Dinitrotoluene	μg/kg	40 U												
2,6-Dinitrotoluene	μg/kg	40 U												
2-Amino-4,6-dinitrotoluene	μg/kg	99 U												
2-Nitrotoluene	μg/kg	99 U												
3-Nitrotoluene	μg/kg	99 U												
4-Amino-2,6-dinitrotoluene	μg/kg	99 U												
4-Nitrotoluene	μg/kg	99 U												
HMX	μg/kg	40 U												
Lead	mg/kg		11.0 J	25.0 J	11.0 J	10.0 J	15.0 J	19.0 J	13.0 J	3.5 J	3.1 J	3.3 J	2.6 J	19.0 J
Nitrobenzene	μg/kg	99 U												
Nitroglycerin	μg/kg	400 U												
PETN	μg/kg	990 U												
RDX	μg/kg	99 U												
Tetryl	μg/kg	99 U												
Zinc	mg/kg		7.6 J	23.0 J	5.6 J	13.0 J	7.9 J	7.7 J	10.0 J	3.1 J	3.3 J	2.2 J	2.0 J	5.8 J

Notes:
U – Analyte undetected at the Limit of Detection.
J – Analyte was positively identified. Reported value may not be accurate or precise.
Four equipment blanks were collected (EB-MRS01, EB-MRS-02, EB-MRS-03, and EB-MRS09) with resulting non-detect lead concentrations of 0.7 μg/L.

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Table 5.11 (continued)
Laboratory Analytical Results

		280-83168-20	280-83168-21	280-83168-22	280-83168-23	280-83168-24	280-83168-25	280-83168-26	280-83168-27	280-83168-28	280-83168-29	280-83168-3	280-83168-30	280-83168-31
Analyte	**Units**	**R09-BKGD10**	**MRS03-SS-02**	**MRS03-SS-03**	**MRS03-IS-02**	**MRS03-IS-03**	**MRS03-IS-04**	**MRS03-IS-05**	**MRS03-IS-06**	**MRS03-IS-07**	**MRS03-IS-08**	**MRS09-SS-03**	**MRS03-IS-10**	**MRS03-IS-02T1**
1,3,5-Trinitrobenzene	µg/kg				36 U	39 U	37 U	37 U	39 U	39 U	39 U		39 U	40 U
1,3-Dinitrobenzene	µg/kg				36 U	39 U	37 U	37 U	39 U	39 U	39 U		39 U	40 U
2,4,6-Trinitrotoluene	µg/kg				91 U	96 U	94 U	92 U	98 U	98 U	97 U		97 U	100 U
2,4-Dinitrotoluene	µg/kg				36 U	39 U	37 U	37 U	39 U	39 U	39 U		39 U	40 U
2,6-Dinitrotoluene	µg/kg				36 U	39 U	37 U	37 U	39 U	39 U	39 U		39 U	40 U
2-Amino-4,6-dinitrotoluene	µg/kg				91 U	96 U	94 U	92 U	98 U	98 U	97 U		97 U	100 U
2-Nitrotoluene	µg/kg				91 U	96 U	94 U	92 U	98 U	98 U	97 U		97 U	100 U
3-Nitrotoluene	µg/kg				91 U	96 U	94 U	92 U	98 U	98 U	97 U		97 U	100 U
4-Amino-2,6-dinitrotoluene	µg/kg				91 U	96 U	94 U	92 U	98 U	98 U	97 U		97 U	100 U
4-Nitrotoluene	µg/kg				91 U	96 U	94 U	92 U	98 U	98 U	97 U		97 U	100 U
HMX	µg/kg				36 U	39 U	37 U	37 U	39 U	39 U	39 U		39 U	40 U
Lead	mg/kg	7.3 J	0.82	7.2								19.0 J		
Nitrobenzene	µg/kg				91 U	96 U	94 U	92 U	98 U	98 U	97 U		97 U	100 U
Nitroglycerin	µg/kg				360 U	390 U	370 U	370 U	390 U	390 U	390 U		390 U	400 U
PETN	µg/kg				910 U	960 U	940 U	920 U	980 U	980 U	970 U		970 U	1000 U
RDX	µg/kg				91 U	96 U	94 U	92 U	98 U	98 U	97 U		97 U	100 U
Tetryl	µg/kg				91 U	96 U	94 U	92 U	98 U	98 U	97 U		97 U	100 U
Zinc	mg/kg	1.9 J	0.37 J	10.0								20.0 J		

Notes:
U – Analyte undetected at the Limit of Detection.
J – Analyte was positively identified. Reported value may not be accurate or precise.
Four equipment blanks were collected (EB-MRS01, EB-MRS-02, EB-MRS-03, and EB-MRS09) with resulting non-detect lead concentrations of 0.7 µg/L.

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Table 5.11 (continued)
Laboratory Analytical Results

		280-83168-32	280-83168-33	280-83168-34	280-83168-35	280-83168-36	280-83168-37	280-83168-38	280-83168-39	280-83168-4	280-83168-40	280-83168-41	280-83168-42	280-83168-43
Analyte	**Units**	**MRS03-IS-02T2**	**MRS09-IS-01**	**MRS09-IS-02**	**MRS09-IS-03**	**MRS09-IS-04**	**MRS09-IS-05**	**MRS09-IS-06**	**MRS09-IS-07**	**MRS09-SS-04**	**MRS09-IS-08**	**MRS09-IS-09**	**MRS09-IS-10**	**MRS09-IS-05T1**
1,3,5-Trinitrobenzene	μg/kg	36 U	40 U	39 U	39 U	39 U	40 U	37 U	40 U		40 U	37 U	39 U	38 U
1,3-Dinitrobenzene	μg/kg	36 U	40 U	39 U	39 U	39 U	40 U	37 U	40 U		40 U	37 U	39 U	38 U
2,4,6-Trinitrotoluene	μg/kg	91 U	100 U	98 U	97 U	97 U	99 U	92 U	99 U		100 U	93 U	97 U	96 U
2,4-Dinitrotoluene	μg/kg	36 U	40 U	39 U	39 U	39 U	40 U	37 U	40 U		40 U	37 U	39 U	38 U
2,6-Dinitrotoluene	μg/kg	36 U	40 U	39 U	39 U	39 U	40 U	37 U	40 U		40 U	37 U	39 U	38 U
2-Amino-4,6-dinitrotoluene	μg/kg	91 U	100 U	98 U	97 U	97 U	99 U	92 U	99 U		100 U	93 U	97 U	96 U
2-Nitrotoluene	μg/kg	91 U	100 U	98 U	97 U	97 U	99 U	92 U	99 U		100 U	93 U	97 U	96 U
3-Nitrotoluene	μg/kg	91 U	100 U	98 U	97 U	97 U	99 U	92 U	99 U		100 U	93 U	97 U	96 U
4-Amino-2,6-dinitrotoluene	μg/kg	91 U	100 U	98 U	97 U	97 U	99 U	92 U	99 U		100 U	93 U	97 U	96 U
4-Nitrotoluene	μg/kg	91 U	100 U	98 U	97 U	97 U	99 U	92 U	99 U		100 U	93 U	97 U	96 U
HMX	μg/kg	36 U	40 U	39 U	39 U	39 U	40 U	37 U	40 U		40 U	37 U	39 U	38 U
Lead	mg/kg									8.0 J				
Nitrobenzene	μg/kg	91 U	100 U	98 U	97 U	97 U	99 U	92 U	99 U		100 U	93 U	97 U	96 U
Nitroglycerin	μg/kg	360 U	400 U	390 U	390 U	390 U	400 U	370 U	400 U		400 U	370 U	390 U	380 U
PETN	μg/kg	910 U	1000 U	980 U	970 U	970 U	990 U	920 U	990 U		1000 U	930 U	970 U	960 U
RDX	μg/kg	91 U	100 U	98 U	97 U	97 U	99 U	92 U	99 U		100 U	93 U	97 U	96 U
Tetryl	μg/kg	91 U	100 U	98 U	97 U	97 U	99 U	92 U	99 U		100 U	93 U	97 U	96 U
Zinc	mg/kg									3.7 J				

Notes:
U – Analyte undetected at the Limit of Detection.
J – Analyte was positively identified. Reported value may not be accurate or precise.
Four equipment blanks were collected (EB-MRS01, EB-MRS-02, EB-MRS-03, and EB-MRS09) with resulting non-detect lead concentrations of 0.7 μg/L.

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Table 5.11 (continued)
Laboratory Analytical Results

		280-83168-44	280-83168-45	280-83168-46	280-83168-47	280-83168-48	280-83168-49	280-83168-5	280-83168-50	280-83168-51	280-83168-52	280-83168-53	280-83168-54	280-83168-55
Analyte	**Units**	**MRS09-IS-05T2**	**R03-BKGD09**	**R03-BKGD10**	**MRS03-SS-04**	**MRS03-SS-05**	**MRS03-SS-06**	**MRS09-SS-05**	**MRS03-SS-07**	**MRS03-SS-08**	**MRS03-SS-10**	**R02-BKGD09**	**R03-BKGD01**	**MRS02-IS-09**
1,3,5-Trinitrobenzene	μg/kg	39 U												38 U
1,3-Dinitrobenzene	μg/kg	39 U												38 U
2,4,6-Trinitrotoluene	μg/kg	98 U												95 U
2,4-Dinitrotoluene	μg/kg	39 U												38 U
2,6-Dinitrotoluene	μg/kg	39 U												38 U
2-Amino-4,6-dinitrotoluene	μg/kg	98 U												95 U
2-Nitrotoluene	μg/kg	98 U												95 U
3-Nitrotoluene	μg/kg	98 U												95 U
4-Amino-2,6-dinitrotoluene	μg/kg	98 U												95 U
4-Nitrotoluene	μg/kg	98 U												95 U
HMX	μg/kg	39 U												38 U
Lead	mg/kg		0.86	3.8	2.7	4.3	1.2	19.0 J	3.3	2.5	8.5	21.0	3.8	
Nitrobenzene	μg/kg	98 U												95 U
Nitroglycerin	μg/kg	390 U												380 U
PETN	μg/kg	980 U												950 U
RDX	μg/kg	98 U												95 U
Tetryl	μg/kg	98 U												95 U
Zinc	mg/kg		2.6	17.0	5.6	8.1	1.1 J	7.2 J	1.9 J	5.6	11.0	4.2 J	1.3 J	

Notes:
U – Analyte undetected at the Limit of Detection.
J – Analyte was positively identified. Reported value may not be accurate or precise.
Four equipment blanks were collected (EB-MRS01, EB-MRS-02, EB-MRS-03, and EB-MRS09) with resulting non-detect lead concentrations of 0.7 μg/L.

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Table 5.11 (continued)
Laboratory Analytical Results

		280-83168-56	280-83168-57	280-83168-6	280-83168-7	280-83168-8	280-83168-9
Analyte	**Units**	**MRS02-IS-09T1**	**MRS02-IS-09T2**	**MRS09-SS-06**	**MRS09-SS-07**	**MRS09-SS-08**	**MRS09-SS-09**
1,3,5-Trinitrobenzene	μg/kg	38 U	37 U				
1,3-Dinitrobenzene	μg/kg	38 U	37 U				
2,4,6-Trinitrotoluene	μg/kg	94 U	93 U				
2,4-Dinitrotoluene	μg/kg	38 U	37 U				
2,6-Dinitrotoluene	μg/kg	38 U	37 U				
2-Amino-4,6-dinitrotoluene	μg/kg	94 U	93 U				
2-Nitrotoluene	μg/kg	94 U	93 U				
3-Nitrotoluene	μg/kg	94 U	93 U				
4-Amino-2,6-dinitrotoluene	μg/kg	94 U	93 U				
4-Nitrotoluene	μg/kg	94 U	93 U				
HMX	μg/kg	38 U	37 U				
Lead	mg/kg			18000 J	6800 J	30000 J	21000 J
Nitrobenzene	μg/kg	94 U	93 U				
Nitroglycerin	μg/kg	380 U	370 U				
PETN	μg/kg	940 U	930 U				
RDX	μg/kg	94 U	93 U				
Tetryl	μg/kg	94 U	93 U				
Zinc	mg/kg			7100 J	2700 J	69000 J	40000 J

Notes:
U – Analyte undetected at the Limit of Detection.
J – Analyte was positively identified. Reported value may not be accurate or precise.
Four equipment blanks were collected (EB-MRS01, EB-MRS-02, EB-MRS-03, and EB-MRS09) with resulting non-detect lead concentrations of 0.7 μg/L.

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FIGURES

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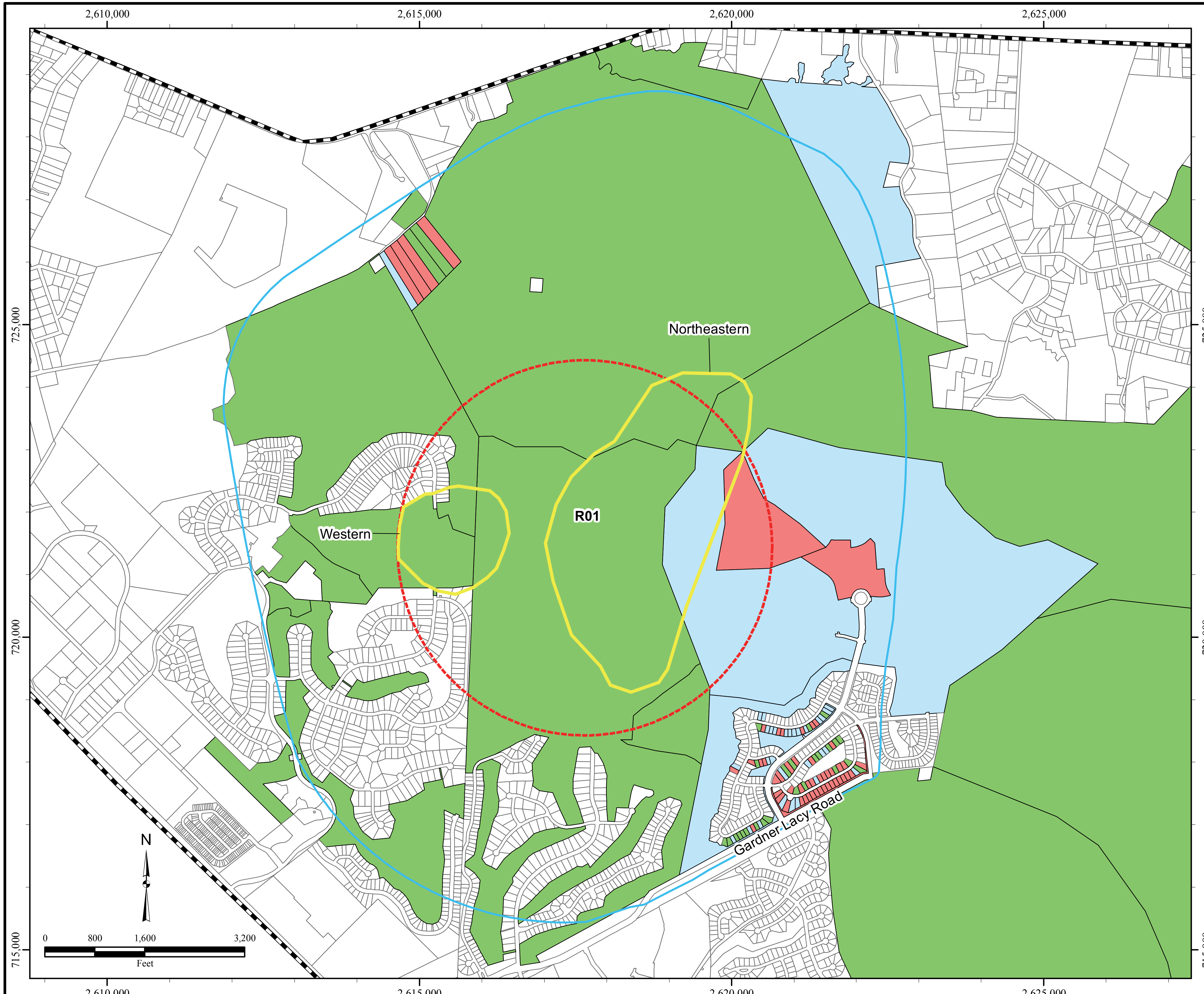

Figure 5.1
MRS-R01
Remedial Investigation
MEC Delineation

Legend

Former Conway Bombing and Gunnery Range Boundary

MEC Contamination Area

Munitions Response Site

Expanded Investigation Area

ROE Status

Accepted

Refused

Mailed

Not Mailed

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

MEC=munitions and explosives of concern
MRS=munitions response site
RI=Remedial Investigation
ROE=right of entry

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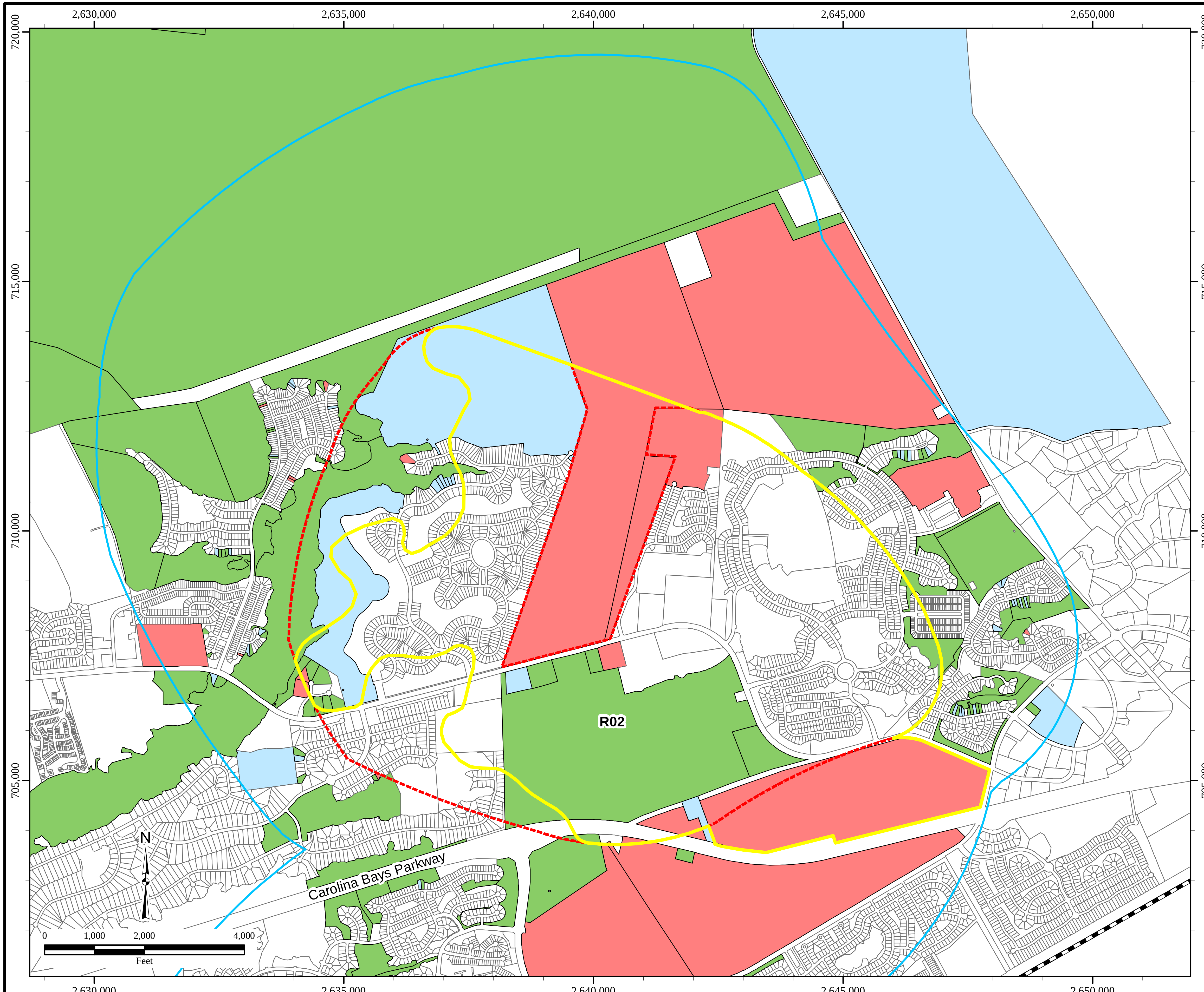
(5-1)R01_MECDelineation.mxd
4/14/2017 JAR
Source: HGL, USGS, USACE

HGL HydroGeoLogic, Inc

Figure 5.2a
MRS-R02
Remedial Investigation
MEC Delineation



Legend

- Former Conway Bombing and Gunnery Range Boundary
- MEC Contamination Area
- Munitions Response Site
- Expanded Investigation Area

<u>ROE Status</u>

- Accepted
- Refused
- Mailed
- Not Mailed

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

MEC=munitions and explosives of concern
MRS=munitions response site
RI=Remedial Investigation
ROE=right of entry

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(5-2a)R02_MECDelineation.mxd
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Source: HGL, USGS, USACE

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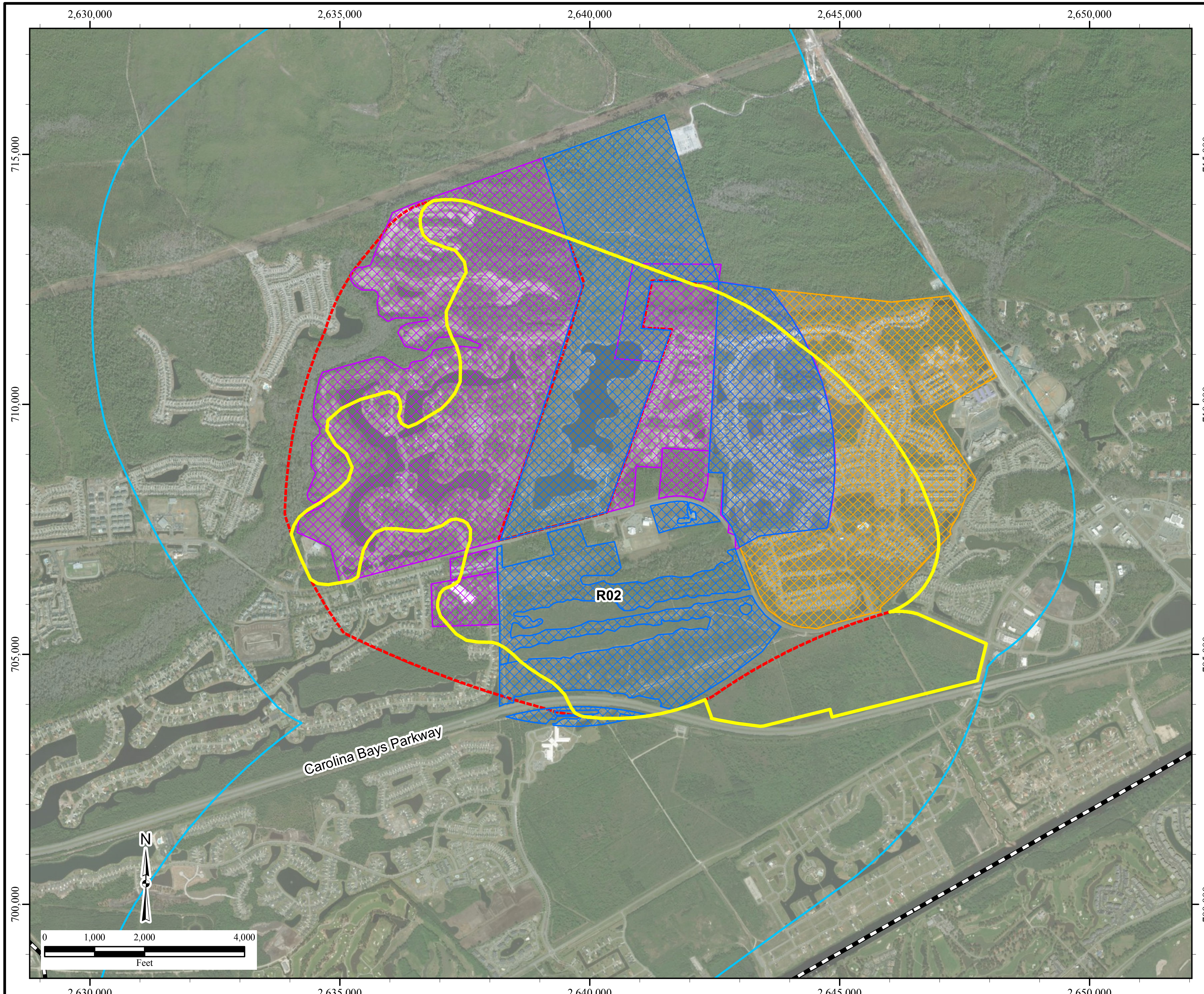
Figure 5.2b
MRS-R02
Remedial Investigation
MEC Delineation
and Agreement Areas



Legend

- Former Conway Bombing and Gunnery Range Boundary
- MEC Contamination Area
- Federal Settlement Agreement Area
- SCDHEC Consent Agreement Area
- SCDHEC Consent and Federal Settlement Agreement Areas
- Munitions Response Site
- Expanded Investigation Area

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.
Other SCDHEC Consent Agreement Areas may overlap with Federal Settlement Agreement Areas. The SCDHEC Consent Agreement Areas shown are those not also within a Federal Settlement Agreement.

DOD=Department of Defense
MEC=munitions and explosives of concern
MRS=munitions response site
RI=Remedial Investigation
SCDHEC=South Carolina Department of Health and Environmental Control

\\Gst-srv-01\HGLGIS\Conway_MSIW\RI\(5-2b)R02_MECDelineationAgreements.mxd
5/9/2018 JAR
Source: HGL, USGS, USACE
ArcGIS Online Imagery

HGL HydroGeoLogic, Inc

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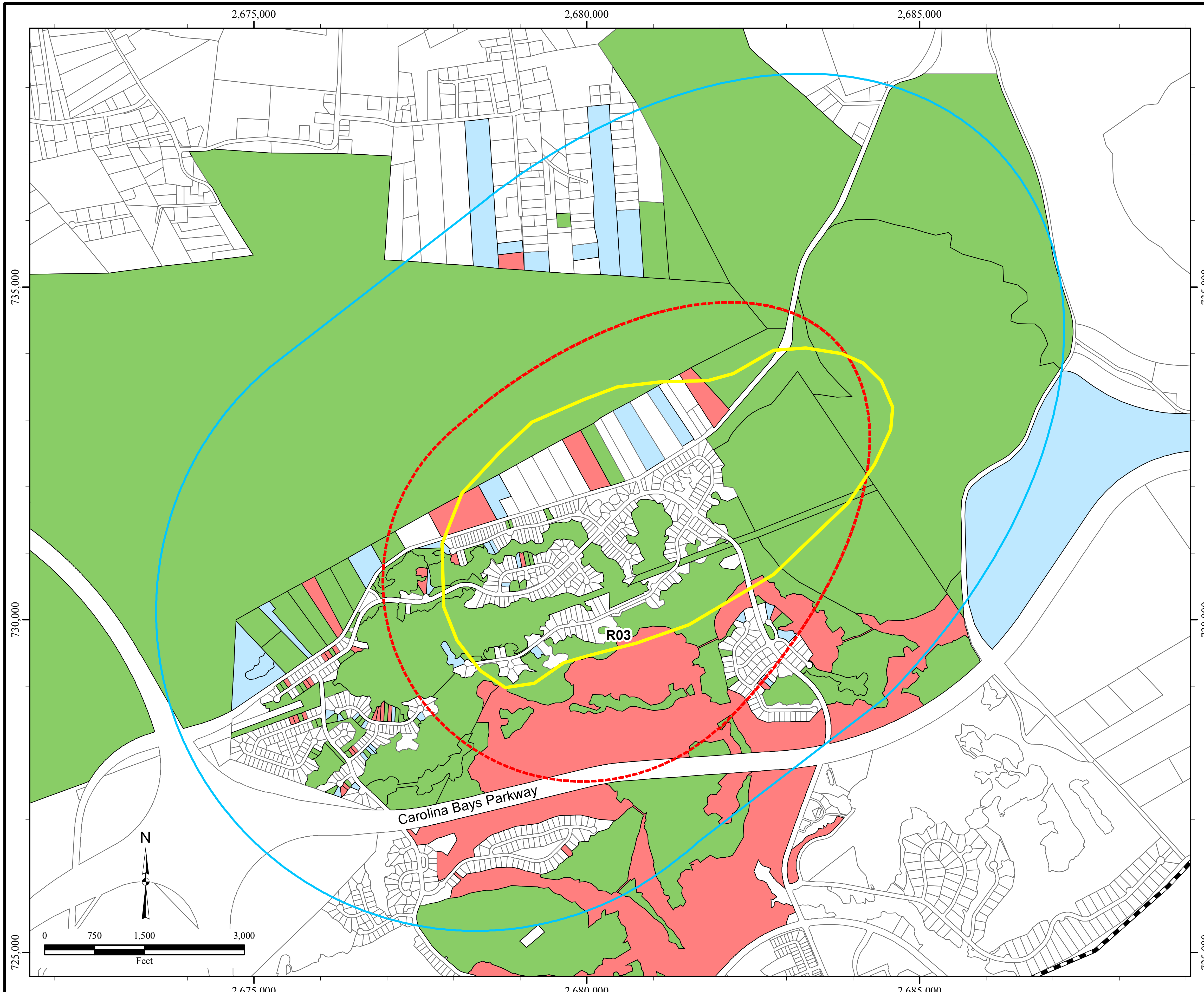
Figure 5.3
MRS-R03
Remedial Investigation
MEC Delineation



Legend

- Former Conway Bombing and Gunnery Range Boundary
- MEC Contamination Area
- Munitions Response Site
- Expanded Investigation Area

ROE Status

- Accepted
- Refused
- Mailed
- Not Mailed

Notes:
Coordinates in South Carolina State Plane, NAD83, feet.

MEC=munitions and explosives of concern
MRS=munitions response site
RI=Remedial Investigation
ROE=right of entry

\\Gst-srv-01\HGLGIS\Conway_MSIW\RI
(5-3)R03_MECDelineation.mxd
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Source: HGL, USGS, USACE

HGL HydroGeoLogic, Inc

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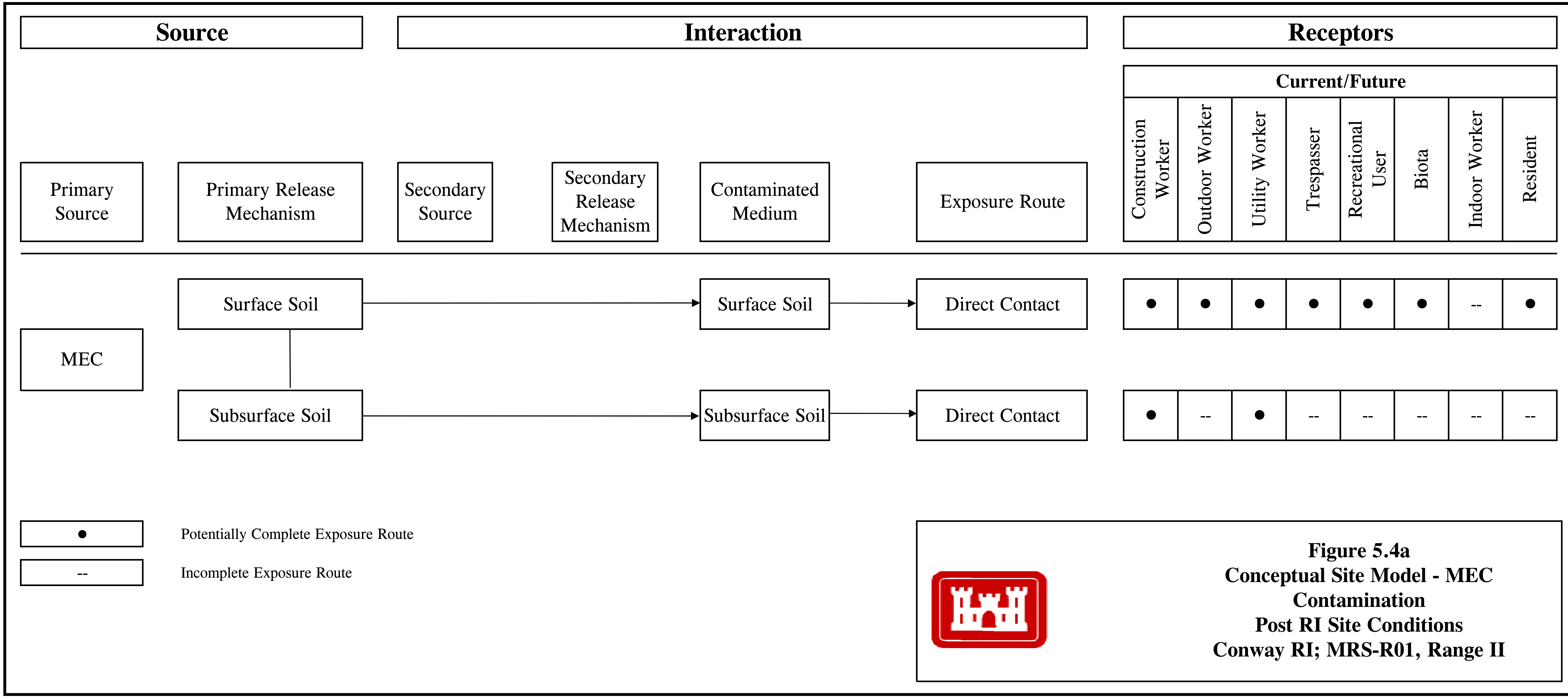

Figure 5.4a
Conceptual Site Model - MEC Contamination
Post RI Site Conditions
Conway RI; MRS-R01, Range II

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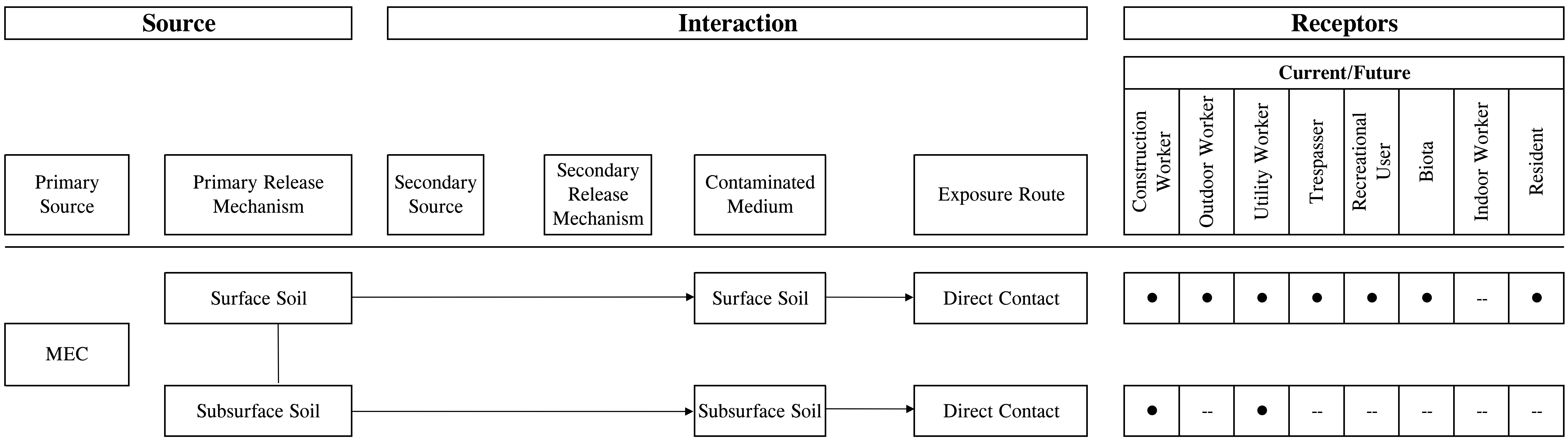

●	Potentially Complete Exposure Route
--	Incomplete Exposure Route

Figure 5.4b
Conceptual Site Model - MEC Contamination
Post RI Site Conditions
Conway RI; MRS-R02, Range III

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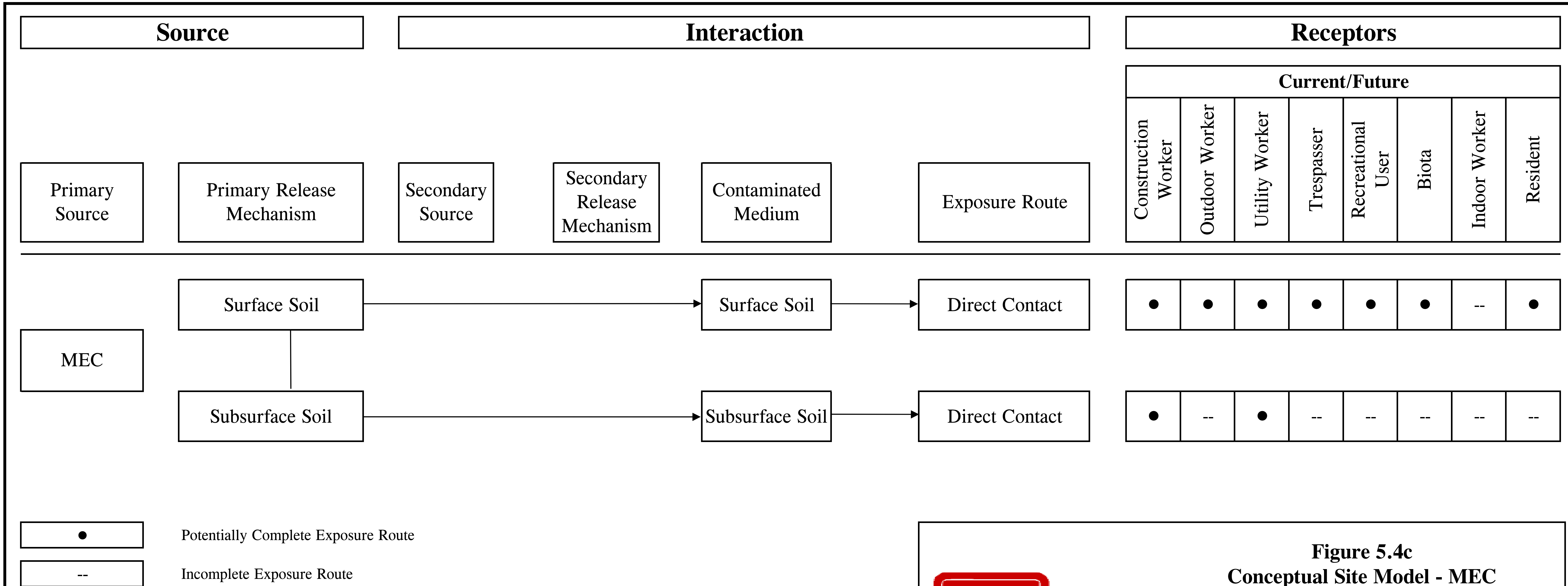

Figure 5.4c
Conceptual Site Model - MEC Contamination
Post RI Site Conditions
Conway RI; MRS-R03, Range IV

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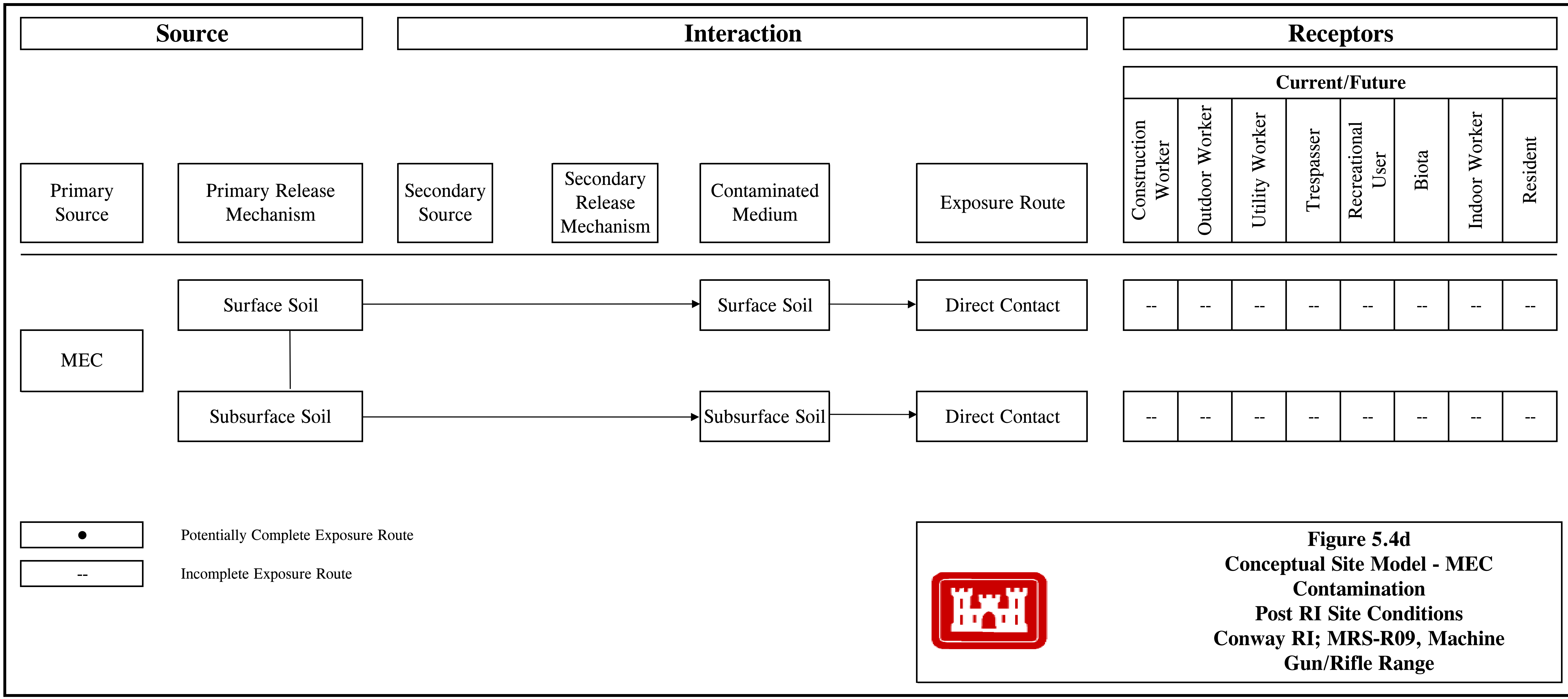

Figure 5.4d
Conceptual Site Model - MEC Contamination
Post RI Site Conditions
Conway RI; MRS-R09, Machine Gun/Rifle Range

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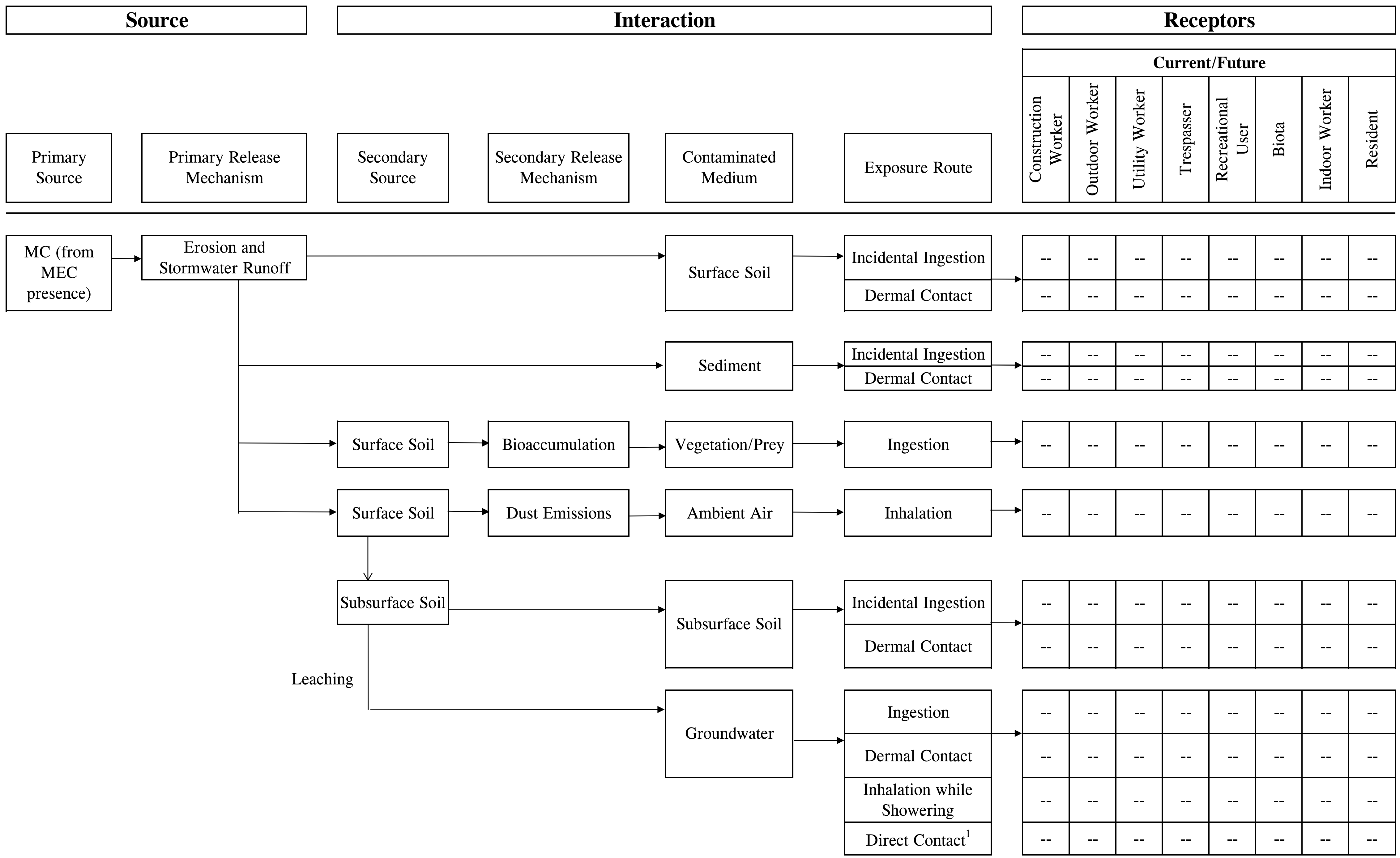

●	Potentially Complete Exposure Route
--	Incomplete Exposure Route

Note: No release of MC has been identified in surface soil. No source is present for migration to other media.

[1] If the shallow groundwater is sampled, potential effects to the transition zone community will be evaluated.

Figure 5.5a
Conceptual Site Model - MC Contamination
Post RI Site Conditions
Conway RI; MRS-R01, Range II

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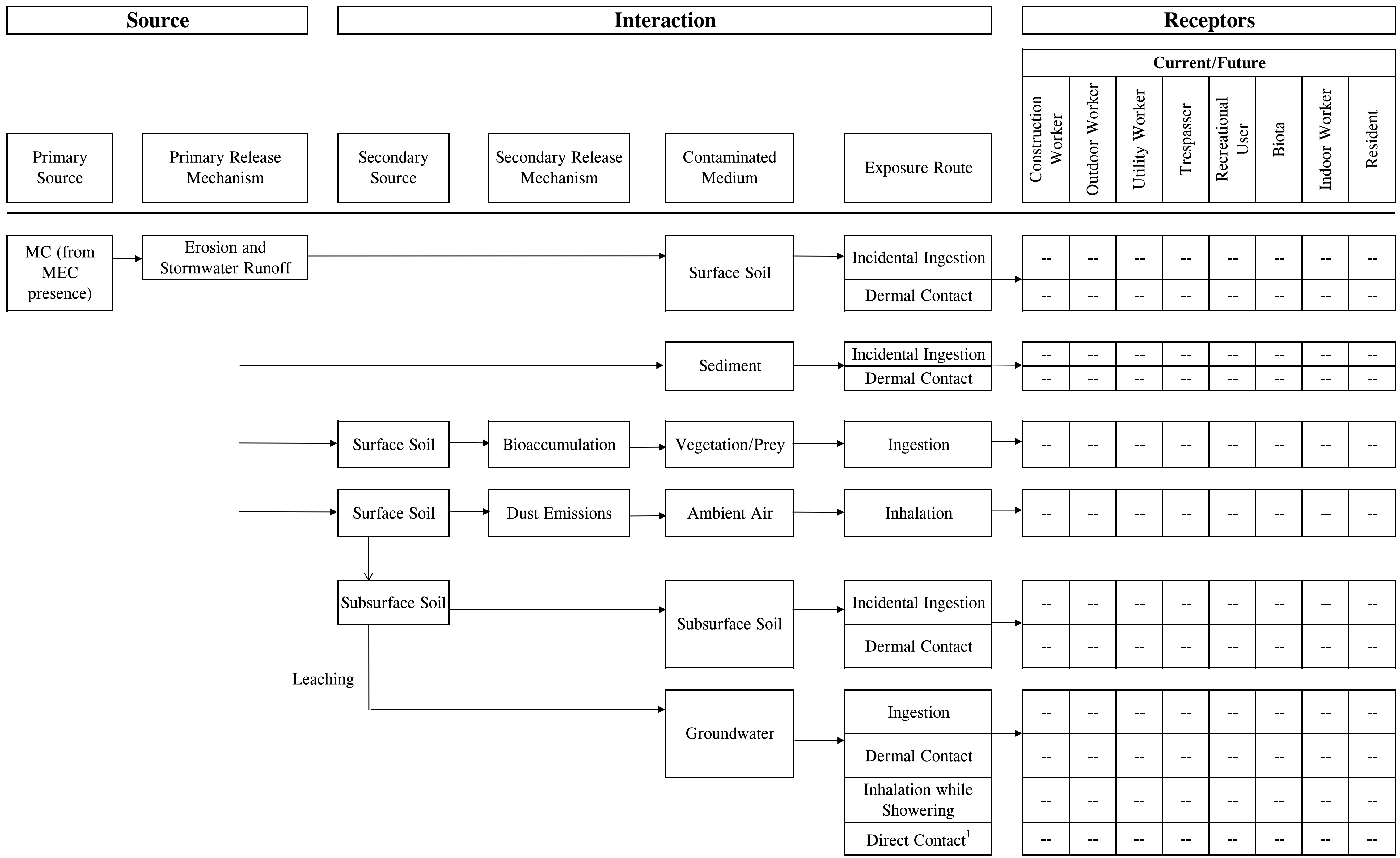
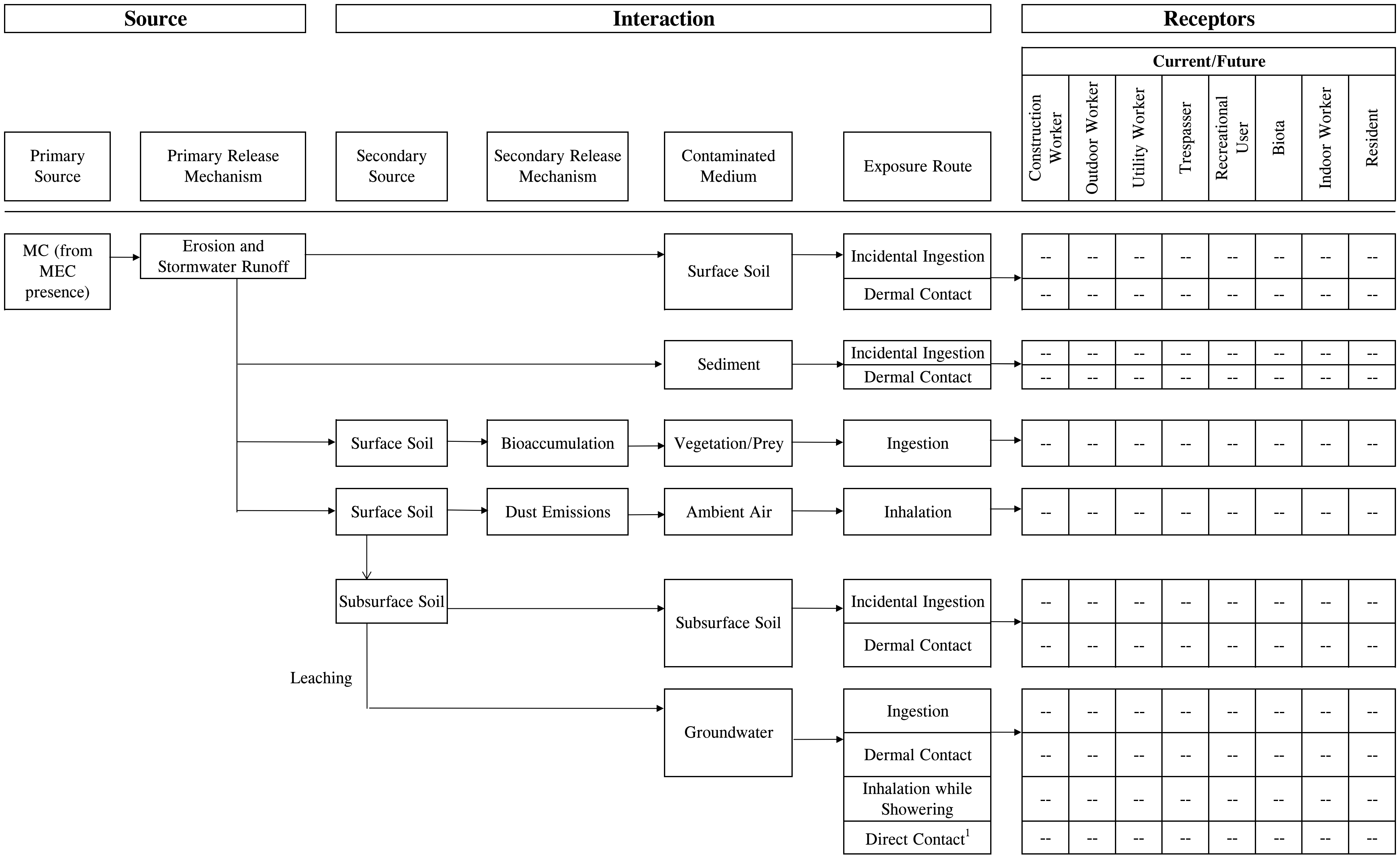


●	Potentially Complete Exposure Route
--	Incomplete Exposure Route

Note: No release of MC has been identified in surface soil. No source is present for migration to other media.

[1] If the shallow groundwater is sampled, potential effects to the transition zone community will be evaluated.

Figure 5.5b
Conceptual Site Model - MC Contamination
Post RI Site Conditions
Conway RI; MRS-R02, Range III



●	Potentially Complete Exposure Route
--	Incomplete Exposure Route

Note: No release of MC has been identified in surface soil. No source is present for migration to other media.

[1] If the shallow groundwater is sampled, potential effects to the transition zone community will be evaluated.

Figure 5.5c
Conceptual Site Model - MC Contamination
Post RI Site Conditions
Conway RI; MRS-R03, Range IV

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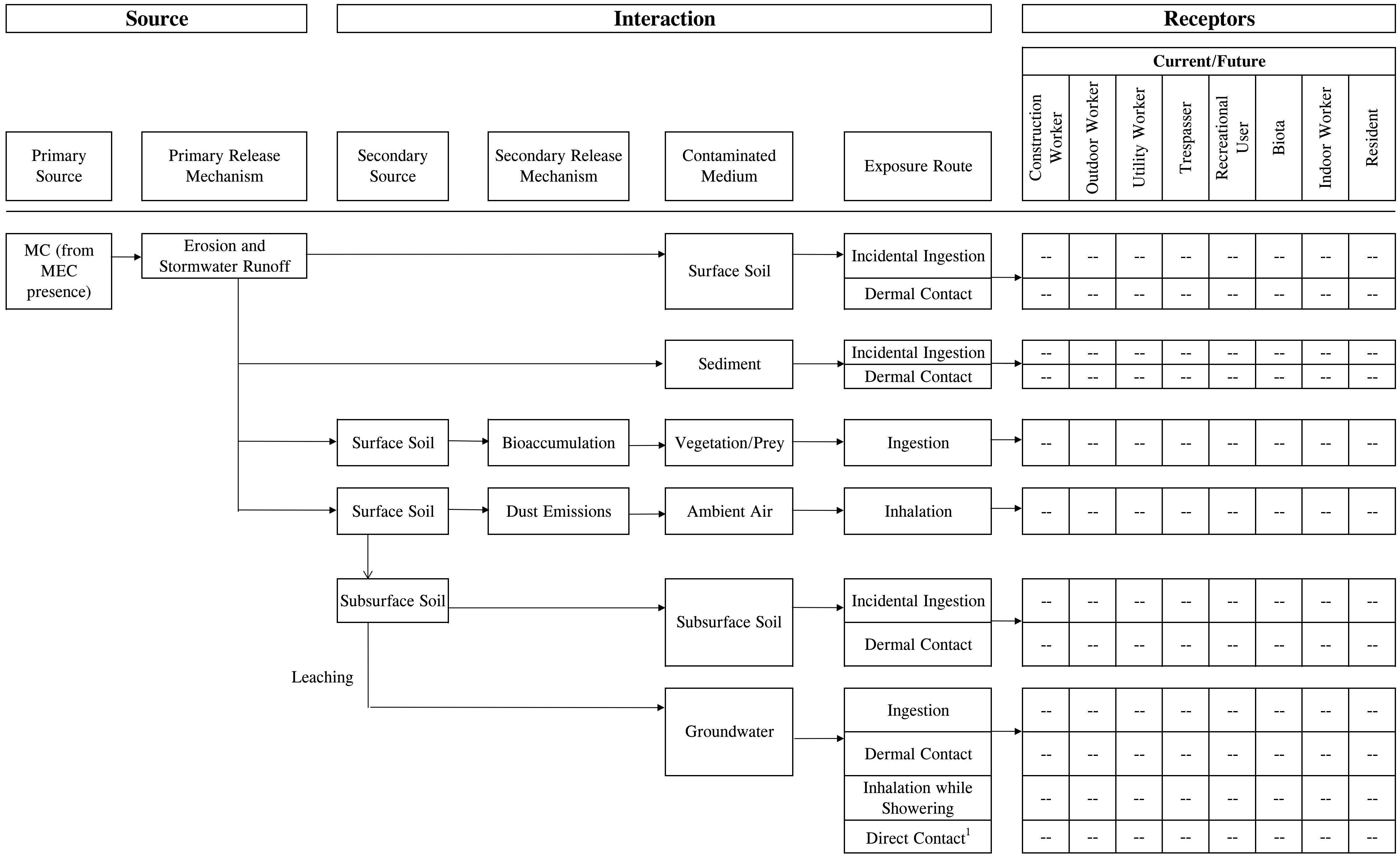

●	Potentially Complete Exposure Route
--	Incomplete Exposure Route

Note: No release of MC has been identified in surface soil. No source is present for migration to other media.

[1] If the shallow groundwater is sampled, potential effects to the transition zone community will be evaluated.

Figure 5.5d
Conceptual Site Model - MC Contamination
Post RI Site Conditions
Conway RI; MRS-R09, Machine Gune/Rifle Range

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6.0 MUNITIONS CONSTITUENTS

6.0.1 Contaminant release and migration is evaluated for MC contamination, if present, due to the risk posed to receptors from exposure to contaminated media and the migration of chemicals through environmental media. The presence of MEC may result in a release of MC to a site and migration of MC may occur due to releases by normal detonation, low order detonations, demolition, or where deterioration of the MEC item exposes MC to climate. MC may include the filler, secondary explosives, propellants of the munitions, or components of the munitions cases. If a release of MC is documented, the fate and transport of MC contaminants present in or released to the environment must be evaluated to support the overall evaluation of human health and/or the environment risks. As described in Chapter 7.2, no MC were identified within the MRSs at concentrations posing a risk to human health or ecological receptors. For this reason, the fate and transport of MC is not evaluated for the site.

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7.0 BASELINE RISK ASSESSMENT FOR MC AND EXPLOSIVE HAZARDS RISK ASSESSMENT FOR UXO/DMM/MC

7.0.1 The risk assessment assesses both chemical hazards and explosive hazards. The BLRA was performed to evaluate potential risks to human health and the environment from potential chemical releases associated with historical use of the four MRSs included in this RI Report. In addition, the MEC HA is used to evaluate the magnitude and primary causes of the explosive hazards at the site. The results of the MEC HA and BLRA are used to aid in the development, evaluation, and selection of appropriate response alternatives.

7.1 MEC RISK ASSESSMENT

7.1.1 Risk Matrices

7.1.1.1 For the evaluation of MEC explosive hazards, a baseline risk assessment was performed utilizing Risk Matrices (Appendix K) developed for the proposed delineated MRSs, in accordance with the interim guidance document *Trial Period for Risk Management Methodology at Formerly Used Defense Sites Military Munitions Response Program Projects* (USACE, 2017). This methodology determines if unacceptable risk exists for MEC and aides the development of Remedial Action Objectives to identify remedial action alternatives to be evaluated in the FS. The existing (i.e., baseline) conditions at the three recommended MRSs and the no further action MRS, using the risk matrices are presented in Appendix K. This information will provide the baseline for the assessment of response alternatives to be conducted in the FS. Three of the four MRSs (MRS-R01, MRS-R02, and MRS-R03) have an unacceptable risk due to explosive hazards. Based on the MEC contamination present, an unacceptable risk exists for human receptors to be exposed to explosive hazards at these three MRSs.

7.2 RISK ASSESSMENT FOR MC

7.2.0.1 This BLRA was conducted to evaluate potential risks to human health and the environment from chemical releases associated with historical use of four MRSs investigated in this RI Report. The BLRA includes a quantitative HHRA and SLERA. The HHRA and SLERA were prepared IAW USACE and USEPA guidance, as well as the Final RI/FS Work Plan for the Former Conway BGR (HGL, 2015a).

7.2.0.2 As described in Section 7.2.2, the BLRA included an evaluation of site data relative to naturally occurring (background) concentrations. Chemicals exceeding background concentrations are referred to in the BLRA as contaminants. Contaminants were further evaluated by comparing detected concentrations to applicable screening values. Contaminants that exceed screening values are referred to as COPCs (for human receptors) or COPECs (for ecological receptors) and were further evaluated in the BLRA. The approach and results of the BLRA are described in the subsections below.

7.2.1 Data used in the BLRA

7.2.1.1 The analytical results used in this BLRA were obtained from all current and historical datasets. The analytical results collected for the 2016 RI are composed of ISM soil samples (explosive analysis) and discrete soil samples (Pb and Zn analyses) collected from MRS-R01, MRS-R02, MRS-R03, and MRS-R09. The historical datasets consist of soil samples identified in the 2012 EODT RI Report (EODT, 2012) and MC Sampling, Analysis, and Evaluation Report (Parson 2006). The historical datasets include ISM soil samples (explosives and metals) collected in MRS-R01, MRS-R02 and MRS-R03 in addition to composite soil samples (explosives and metals) collected in MRS-R02. In addition, the 2012 EODT RI Report identified seven ISM samples (7063-MIS-001 through 7063-MIS-007) with limited sampling information, such as replicate sample results. The 2012 EODT RI Report used the sampling identification acronym "MIS" to indicated ISM samples. To ensure that all historical results were considered, these samples were included in the ISM sample dataset.

7.2.1.2 As described in the work plan, soil is the principal medium of concern. No other media were sampled. The soil datasets used in the BLRA consist of:

- MRS-R01, Range II:
  - Pb and Zn: 10 discrete soil samples collected during the 2016 field investigation.
  - Select metals: 1 ISM sample collected in triplicate during the 2012 RI.
  - Explosives: 9 ISM soil samples collected during the 2016 field investigation (10 samples) and 2012 RI (1 sample).
- MRS-R02, Range II:
  - Pb and Zn: 10 discrete soil samples collected during the 2016 field investigation.
  - Select metals: 14 composite soil samples collected during the 2006 MC Evaluation Report.
  - Select metals: 8 ISM soil samples collected in triplicate from the 2012 RI, which includes the 7 samples with limited sampling information as noted above.
  - Explosives: 14 composite soil samples collected during the 2006 MC Evaluation Report.
  - Explosives: 18 ISM soil samples collected from the 2012 RI (8 samples) and ISM samples from the 2016 field investigation (10 samples).
- MRS-R03, Range IV:
  - Pb and Zn: 10 discrete soil samples collected during the 2016 field investigation.
  - Select metals: 2 ISM soil samples collected in triplicate identified in the 2012 RI.
  - Explosives: 10 ISM soil samples collected (one in triplicate) during the 2016 field investigation (10 samples) and 2012 RI (2 samples).
- MRS-R09, MG/RR:
  - Pb and Zn:10 discrete soil samples collected during the 2016 field investigation.

- ○ Explosives: 10 ISM soil samples (one collected in triplicate) during the 2016 field investigation.

7.2.2 Evaluation of Background Data

7.2.2.1 Prior to identification of COPCs for each MRS, the analytical results were compared to the background data. The background samples include:

- One ISM sample analyzed for barium, Cd, Pb, Hg, and Zn. This sample was used for comparison of ISM data from all MRSs.
- One composite sample analyzed for barium, Cd, Pb, Hg, and Zn. This sample was used for comparison of composite data from MRS-R02.
- 40 discrete soil samples analyzed for Pb and Zn with ten samples collected at each of the four MRSs. The background results for the individual MRSs were treated as separate datasets and were not pooled. Thus, the Pb and Zn results for the individual MRSs were compared to the MRS-specific background data.

7.2.2.2 For the discrete samples, both the background and site datasets had sufficient Pb and Zn detections to support statistical comparisons using hypothesis testing. The following approach was used for these comparisons. All calculations were performed with the USEPA software ProUCL, version 5.0.00.

- An outlier analysis to a 5 percent significance level was performed on the site datasets.
- The upper tolerance limits (UTLs) were calculated for the background datasets.
- The distributions of the site data and background data were identified. For the site data, outliers were removed from the datasets prior to evaluating the data's distribution.
- If both datasets were normally distributed and had all detect results, the site and background data were compared using the student's t-test. If one or both datasets were not normally distributed or if a dataset had a non-detect result, then the data were compared using the Wilcoxon-Mann Whitney test. For non-detect results, the reporting limit was entered into the ProUCL program. ProUCL is capable of performing statistical analyses on datasets with non-detect results.
- For samples with field duplicate results, the maximum detection was used as the concentration for that location. If an analyte was positively detected in only one sample, the positive detection was used. If an analyte was not detected in either the parent sample or field duplicate, the lower of the reporting limits was used. If the result was qualified as "B", which indicates the analyte was detected in the blank sample, the result was considered to be a non-detect result.
- Outliers were compared to the UTLs. Outliers greater than the UTL were identified as contamination.
- Box-and-whisker plots were prepared to support the statistical comparisons.

7.2.2.3 The results of the background comparisons for the discrete data are presented in Appendix B, Table B-1. The ProUCL outputs and box-and-whisker plots are presented in

Appendix B, Table B-2. As presented in Table B-1, Pb and Zn in discrete soil samples from MRS-R01 and MRS-R02 were identified as naturally occurring. The Wilcoxon-Mann Whitney test for Zn at MRS-R09 concluded that site concentrations are equal to or less than background values. Inspection of the box-and-whisker plots, however, suggests that Zn is a contaminant. Accordingly, Zn was identified as a contaminant for MRS-R09.

7.2.2.4 Because only one ISM background sample was collected, a qualitative comparison of the site ISM data to the background data was performed. This comparison is summarized in Tables B-5. Detections of Cd at MRS-R02, barium at MRS-R03, and Zn at MRS-R03 are less than the ISM background result. These three metals are identified as naturally occurring in the ISM samples. For the remaining metals detected in the MRSs, one or more detections exceed the ISM background result. These metals are evaluated below. To provide additional information, Pb and Zn ISM results were also compared to mean detections of the discrete background samples. Mean detections were used because the ISM results represent a composite sample.

- Barium at MRS-R01: The maximum detection of 8.88 mg/kg for the triplicate sample is only slightly greater than the background result of 7.5 mg/kg. Barium at MRS-R01 is identified as naturally occurring.
- Pb at MRS-R01: The maximum detection of 4.88 mg/kg for the triplicate sample is only slightly greater than the ISM background result of 2 mg/kg, and is less than the discrete mean concentration of 4.98 mg/kg. Pb at MRS-R01 is identified as naturally occurring.
- Hg at MRS-R01: The maximum detection of 0.0252 mg/kg for the triplicate sample is approximately 3 times the ISM background result. Hg is identified as a contaminant at MRS-R01.
- Zn at MRS-R01: The detection of 3.46 mg/kg is approximately equal to the background ISM result of 3.3 mg/kg. Zn in the ISM sample at MRS-R01 is identified as naturally occurring.
- Barium at MRS-R02: As shown in the box-and-whisker plot, most of the barium detections are greater than the ISM background result. Barium is identified as a contaminant for MRS-R02.
- Pb at MRS-R02: Although the Pb detections are greater than the ISM background value of 2 mg/kg, the maximum site detection of 5.9 mg/kg is only slightly greater than the mean background concentration of 5.8 mg/kg for the discrete samples. This comparison suggests that the concentrations in the ISM samples reflect background conditions. Pb at MRS-R02 is identified as naturally occurring.
- Hg at MRS-R02: All Hg detections are greater than the ISM background result. Hg is identified as a contaminant for MRS-R02.
- Zn at MRS-R02: As shown on the box-and-whisker plots, most of the Zn detections are greater than the ISM background value. Zn detections in the ISM samples are also greater than the mean concentration of the discrete background samples. Zn is identified as a contaminant for MRS-R02.

- Pb at MRS-R03: The maximum ISM detection is greater than both the background ISM result and mean concentration for the discrete background samples. Pb is identified as a contaminant for MRS-R03.
- Hg at MRS-R03: The two ISM samples from MRS-R03 were analyzed in triplicate. Of the six triplicate results, only the maximum is greater than the background ISM result of 0.008 mg/kg. Hg at MRS-R03 is identified as naturally occurring.

7.2.2.5 Similar to the ISM dataset, only one composite background sample was collected. Accordingly, a qualitative comparison of the site composite data to the background data was performed as presented in Table B-5. Based on the box-and-whisker plots and the comparison of maximum detections to background values, all metal composite samples are greater than the associated composite background result. Accordingly, barium, Cd, Pb, Hg, and Zn at MRS-R02 are identified as a contaminant.

7.2.3 Human Health Evaluation

7.2.3.1 Exposure Assessment

7.2.3.1.1 Exposure Setting and Conceptual Site Model

7.2.3.1.1.1 The human health evaluation is based on the current and future land use at each MRS. Current land use within the Former Conway BGR includes timber harvesting as well as agricultural, residential, and recreational uses. Portions of the area have been converted into a golf course and residential housing. The current land use for each MRS is listed below.

- MRS-R01, Range II: residential, recreational, and commercial/industrial (forestry);
- MRS-R02, Range III: residential, commercial/industrial, and recreational;
- MRS-R03, Range IV: residential, commercial/industrial (forestry, hunting), and minor agricultural; and
- MRS-R09, MG/RR: residential, commercial/industrial (forestry, hunting) and, and minor agricultural.

7.2.3.1.1.2 Limited farmland remains in MRS-R03 and MRS-R09. It is expected that residential development will continue to expand at the former Conway BGR. In addition, the former Conway BGR is located in Game Zone 5. Under this zone, deer hunting is allowed from August 15 through August 31 (hunting with bow and arrow), and September 1 through January 1 (hunting with gun). Turkey hunting is allowed from April 1 through May 1.

7.2.3.1.1.3 Potential sources of contamination consist of historical use of impact ranges that were associated with the former Conway BGR. Potential exposure media and associated exposure routes are listed below:

- Soil: direct contact with surface soil (ingestion, dermal contact);
- Soil: inhalation of fugitive dust emissions from surface soil;
- Soil: food consumption via soil uptake of chemicals in prey animals; and

- Soil: food consumption via soil uptake of chemicals in foraged plants or crops grown on the site.

7.2.3.1.1.4 The potential migration pathways are presented in the CSM (Figure 3.2). Based on historical site activities at the former Conway BGR, it is unlikely that volatile organic compounds are present in soil. Volatile organic compounds are not constituents of the munitions used or found at the Conway BGR and therefore would not be considered MC. Accordingly, the inhalation of volatile compounds is not considered a complete pathway, and will not be included in the HHRA.

7.2.3.1.2 Receptors

7.2.3.1.2.1 The HHRA evaluated the health effects associated with potential exposures to contamination in soil under an unrestricted land use scenario. The following receptors could be present at the former Conway BGR under the current and potential future land use scenarios:

- Construction Worker,
- Outdoor Worker,
- Maintenance/Utility Worker,
- Trespasser,
- Recreational User/Hunter,
- Indoor Worker, and
- Resident.

7.2.3.1.2.2 The different receptors and potential exposure routes are summarized in Table B-3 of Appendix B.

7.2.4 Exposure Quantification

7.2.4.1 Screening to Identify Chemicals of Potential Concern

7.2.4.1.1 For each MRS, the metals determined to be naturally occurring were not identified as COPCs. In addition, analytes not detected in any of the surface soil samples were not identified as COPCs. The potential uncertainty associated with this approach was evaluated in the section below. COPCs were identified through the comparison of the maximum detected value of ISM, composite, or discrete soil samples to risk-based screening levels. Screening levels are the May 2016 USEPA residential soil RSLs (cancer risk = 1E-06, non-cancer hazard quotient [HQ] = 0.1).

7.2.4.1.2 The COPC screening for each MRS is presented in Table B-4.1 through Table B-4.4. No COPCs were identified for MRS-R01, MRS-R03, and MRS-R09. Only the maximum Cd detection of 7.9 mg/kg for the MRS-R02 composite sample exceeds the screening value. The screening value corresponds to a HQ of 0.1. Based on the ratio of the detection to the screening value, the maximum detection corresponds to an HQ of 0.11, which poses no threat to human health. Potential site contaminants at the MRSs pose no threat to human health.

7.2.4.2 Uncertainty Analysis

7.2.4.2.1 A number of assumptions are required in a risk assessment that introduce uncertainty to the risk and hazard estimates. These uncertainties associated with this assumption are evaluated below.

7.2.4.2.2 Because the BLRA only evaluated select metals and explosives, there is a potential that more chemicals are present at the MRSs than identified in the sampling and analysis effort. In order to minimize this uncertainty, the analytical suites were identified based on all potential contaminants associated with historical operations. Sample locations were also biased to those areas with the greatest potential for contamination as indicated by historical information and previous field investigations. For these reasons, it is unlikely that significant chemical contamination associated with historical site use went undetected. Further, the validation of all results reduces uncertainty in the results. Based on this information, the analytical results used in the risk assessment do not appear to have introduced substantial uncertainty.

7.2.4.2.3 Another potential uncertainty is associated with the sensitivity of each analytical method. Specifically, the analytical method may not be sensitive enough to detect potential site contaminants at concentrations that pose a threat to human health. In order to evaluate this potential uncertainty, the reporting limits for non-detect analytes are compared to the health-based screening values in Table B-6.1 through Table B-6.5.

7.2.4.2.4 For each MRS, the reporting limits are less than the May 2016 residential soil RSLs (cancer risk = 1E-06; non-cancer HQ = 0.1). Based on this comparison, analytical sensitivity is not a significant source of uncertainty at the former Conway BGR.

7.2.4.3 Human Health Risk Assessment Summary and Conclusions

7.2.4.3.1 In summary, screening of the analytical results against background concentrations and health-based screening values identified one COPC: Cd in MRS-R02. The maximum Cd detection corresponds to an HQ of 0.11 for a resident receptor, which indicates no threat to human health. In conclusion, site contaminants do not pose a threat to human health under an unrestricted land use.

7.2.5 Screening Level Ecological Risk Assessment

7.2.5.0.1 A SLERA for MRS-R01, MRS-R02, MRS-R03, and MRS-R09 was completed IAW the approach described in the Final RI/FS Work Plan (HGL, 2015a). The SLERA is presented in the subsections below.

7.2.5.1 Problem Formulation

7.2.5.1.0.1 The following problem formulation defines the potentially affected environment and preliminary constituents of concern of the former Conway BGR. The ecological setting, CSM, and endpoints are described below.

7.2.5.1.1 Ecological Setting and Conceptual Site Model

7.2.5.1.1.1 The former Conway BGR, located in Horry County, is within the Lower Atlantic Coastal Plain physiographic province. Topographically, the former Conway BGR slopes generally to the southeast with elevations ranging from nearly sea level to about 40 ft above sea level. The area is generally wooded with pine trees and thick underbrush. Several Carolina Bays (or swamps), wetlands, and small tributaries occur within the boundaries of the former Conway BGR. Along the southern edge of the former Conway BGR and parallel to the coastline lies the Intercoastal Waterway. Numerous rivers drain Horry County, including the Pee Dee, Little Pee Dee, and Waccamaw.

7.2.5.1.1.2 No biological survey has been completed for the sites. A species list provided by the SCDNR indicated that no state or federally listed threatened or endangered species are documented as existing within the former Conway BGR. However, it is possible that threatened or endangered species could prefer habitats present at the Former BGR. In order to evaluate the potential for these species to occur onsite, a list of threatened or endangered species occurring in Horry County was identified using the USFWS ESA list for Horry County as provided by the USFWS South Carolina Field Office and the SCDNR list of species potentially occurring in Horry County and summarized in the approved work plan (HGL, 2015b). Species identified from these documents that could be supported by habitats similar to those found at the former Conway BGR are:

- Bald eagle (*Haliaeetus leucocephalus*),
- Wood stork (*Mycteria Americana)*,
- Red-cockaded woodpecker (*Picoides borealis*),
- Least tern (*Sterna antillarum*),
- Rafinesque's Big-eared Bat (*Corynorhinus rafinesquii)*,
- American chaffseed (*Schwalbea americana*),
- Canby's dropwort (*Oxypolis canbyi*), and
- Pondberry (*Lindera melissifolia*).

7.2.5.1.1.3 Per the work plan, soil is the principal medium of concern in each MRS. Terrestrial ecological receptors, including plants, terrestrial invertebrates, and animals, can be exposed to soil in the ecologically active zone, which consists of the top two feet of soil. The SLERA evaluated both direct contact and, for birds and mammals, exposure to contaminants through uptake in the food chain.

7.2.5.1.2 Preliminary Assessment and Measurement Endpoints

7.2.5.1.2.1 PA and measurement endpoints for the MRSs are presented in Table B-7. An assessment endpoint represents a particular ecological value to be protected at each site. Measurement endpoints allow the quantification of potential ecological risk of the assessment endpoint. Terrestrial plants, invertebrates, avian and mammalian herbivores, avian and mammalian insectivores, and avian and mammalian carnivores were identified as assessment endpoints. For each assessment and measurement endpoint pair, a key ecological receptor (e.g., Eastern cottontail) that represents a specific trophic level in the ecosystem (e.g., terrestrial plants) is identified.

7.2.5.2 Technical Approach

7.2.5.2.1 A SLERA is performed on a two-step process. The first step is a preliminary evaluation that incorporates conservative assumptions. For example, maximum concentrations in soil are compared to benchmark values for the target community (e.g., terrestrial plants) and chemical consumption rates are compared to no observed adverse effect levels (NOAELs) for wildlife receptors (e.g., mammalian insectivore). As a conservative measure, the home range factor was set as one for initial food web. Based on this analysis, contaminants either were identified as not posing a risk or were retained for additional evaluation in the second step.

7.2.5.2.2 The second step of the SLERA provides a more realistic evaluation of potential risks. This step includes assessment of the spatial extent to which the dataset exceeds the benchmarks and the potential magnitude of impacts to the overall community. For wildlife receptors, central tendency food ingestion rates were used instead of maximum food ingestion rates, and chemical intakes were compared to lowest observed adverse effects levels (LOAELs) in addition to NOAELs. For the initial and refined food webs, the dietary composition of each species is assumed to be 100 percent of its associated representative trophic level. For the refined food web, a home range factor was applied if the size of the MRS was less than the home range of a given ecological receptor. The complete description of the SLERA approach is presented below.

7.2.5.3 Initial Screening

7.2.5.3.1 As with the HHRA, metals identified as naturally occurring were not identified as COPECs. For contaminants, the maximum detected concentration of discrete samples, maximum detected concentration of composite samples, or maximum detected concentration of ISM samples was compared to its ecological benchmarks. Metal results were screened against the USEPA Ecological Soil Screening Levels (Eco-SSLs) for each ecological receptor (plants, soil invertebrates, birds, and mammals). For metals that lacked Eco-SSLs for plants and/or terrestrial invertebrates, benchmarks were obtained from the following sources.

- Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten, 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision.
- Efroymson, R.A., M.E. Will, and G.W. Suter II, 1997b. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision.

7.2.5.3.2 Explosive compounds lack Eco-SSLs. For these analytes, ecological benchmarks were obtained from the Los Alamos National Laboratory ECORISK Database, version 3.2. Contaminants with detections greater than their benchmarks were retained for further analysis. Bioaccumulative chemicals that lack Eco-SSLs are included in the initial food web analysis presented below. The initial screening of the analytical results is described above.

7.2.5.3.1 MRS-R01, Range II

7.2.5.3.1.1 The discrete and ISM results from MRS-R01 are compared to the ecological benchmarks in Table B-5. No COPECs were identified for either the discrete nor ISM sample results. Although barium has an Eco-SSL for mammals, it lacks an Eco-SSL for birds. Because barium is not considered an important bioaccumulative chemical, it is unlikely to pose a threat via the food web. For this reason, barium is not retained as a COPEC for birds. Soil contaminants at MRS-R01 do not pose a threat to ecological receptors.

7.2.5.3.2 MRS-R02, Range III

7.2.5.3.2.1 As presented in Table B-5, no COPECs were identified based on the discrete or ISM data. The following analytes for the composite samples were identified as COPECs for MRS-R02.

- Cd – birds and mammals;
- Pb – birds;
- Hg – plants and invertebrates; and
- Zn – plants, soil invertebrates, bird and mammals

7.2.5.3.2.2 Similar to MRS-R01, although barium has no screening value for birds, this metal was not identified as a COPEC because it is not an important bioaccumulative chemicals. Cd, Pb, Hg, and Zn are retained for further evaluation with respect to the receptors listed above.

7.2.5.3.3 MRS-R03, Range IV

7.2.5.3.3.1 As shown in Table B-5, all contaminant detections are less than the ecological screening values. No COPECs were identified for MRS-R03. Soil contaminants at this MRS do not pose an ecological threat.

7.2.5.3.4 MRS-R09, Machine Gun/Rifle Range

7.2.5.3.4.1 Only discrete samples were collected at MRS-R09. The maximum detections for Pb and Zn exceed the Eco-SSL for birds. Both metals are retained for further evaluation with respect to birds.

7.2.5.3.4.2 In summary, the initial screening identified Cd, Hg, and Zn as COPECs for MRS-R02; and Pb and Zn as COPECs for MRS-R09. No COPECs were identified for MRS-R01 and MRS-R03.

7.2.5.4 <u>Initial Food Web Analysis for Terrestrial Wildlife</u>

7.2.5.4.1 Hg is the only bioaccumulative chemical that lacks a screening value for birds and mammals. Bioaccumulative chemicals are listed in Table 4-2 of *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment: Status and Needs* (USEPA, 2000). Hg was identified as a contaminant for MRS-R01 and MRS-R02. Accordingly, an initial food web analysis was conducted for Hg to evaluate potential threats to upper trophic level receptors in these two MRSs.

7.2.5.4.2 The potential effects to terrestrial wildlife receptors were assessed by comparing the estimated chemical intake for each receptor to the associated NOAEL. There are no equations or methods available to estimate intake by dermal contact and inhalation. Therefore, the estimation of chemical intake considered only the ingestion route, which includes incidental ingestion of contaminated soil and ingestion of chemicals accumulated in the tissue of the wildlife receptor's diet (plants, terrestrial invertebrates, mammals). The Hg bioaccumulation factors for plants, earthworms, and mammals were obtained from Bechtel Jacobs (1998), Sample, et al. (1998a), and Sample, et al. (1998b), respectively. The exposure assumptions (food ingestion rate, dietary components, etc.) used for each wildlife receptor is presented in Table B-8. The daily dose was calculated using the following equation:

$$ADD_i = AUF_i \cdot SUF_i \left(\frac{SIR_i \cdot C_s + \sum_{j=1}^{n} \left(Fr_{ij} \cdot FIR_{ij} \cdot C_j \right)}{BW_i} \right)$$

Where:

ADD_i = Average daily dose (ADD) for wildlife receptor species i (mg/kg-day)

AUF_i = Area use factor (AUF) for wildlife receptor species i (unitless)

SUF_i = Seasonal use factor (SUF) for wildlife receptor species i (unitless)

SIR_i = Daily incidental soil ingestion rate (SIR) wildlife receptor species i (kilogram / dry weight / day [kg dw/day])

C_s = Concentration of COPEC in soil (mg/kg dw)

Fr_{ij} = Fraction of diet of wildlife receptor species i composed of food item j (unitless)

FIR_{ij} = Daily food ingestion rate (FIR) of wildlife receptor species i (kg dw/day)

C_j = Concentration of COPEC in food item j (mg/kg dw)

n = The number of food items in the diet of wildlife receptor species i

BW = Body weight (kg fresh weight)

7.2.5.4.3 As shown in the initial food web (Table B-9), the NOAEL ecological quotient exceeds 1 for the American woodcock exposed to the maximum composite soil detection at MRS-R02. All NOAEL ecological quotients for the other receptors at MRS-R02 are less than 1. Hg is retained as a COPEC for the American woodcock in MRS-R02 and included in the refined food web evaluation. The ecological quotients for MRS-R01 are less than or equal to 1, indicating that Hg in MRS-R01 soil does not pose a threat to wildlife receptors.

7.2.5.5 Refined Analysis for Plants and Terrestrial Invertebrates

7.2.5.5.1 Mercury at MRS-R02

7.2.5.5.1.1 The maximum Hg detection reported for the composite soil samples from MRS-R02 is greater than both the plant benchmark of 0.3 mg/kg and invertebrate benchmark of 0.1 mg/kg. The 95 percent upper confidence limit (UCL) of the composite data for MRS-R02 is 0.193

mg/kg. This concentration is less than the plant benchmark, indicating that Hg does not pose a threat to the plant community at MRS-R02.

7.2.5.5.1.2 The 95 percent UCL is greater than the invertebrate benchmark of 0.1 mg/kg. The earthworm benchmark was based on a single study completed in 1983 (Efroymson, et al, 1997b). In a more recent study, earthworms were exposed to 22 mg/kg Hg in soil (described as a non-lethal dose) in order to assess the effect of pre-exposure to Hg on toxic response. The 50 percent lethal concentration (LC_{50}) for pre-exposed worms was 545 mg/kg, as compared to a LC_{50} of 170 mg/kg for non-pre-exposed worms. These results differ substantially from the findings of the 1983 study, in which there was a 65 percent decrease in survival of the test species at a concentration of 0.5 mg/kg (the benchmark value was obtained by dividing the 0.5 mg/kg concentration by 5). This comparison highlights the uncertainty associated with the benchmark value. The LC_{50} values from the 2007 study are 2-3 orders of magnitude greater than the Hg concentrations observed in the MRS-R02 soil samples. Based on the recent study, Hg in the MRS-R02 soil does not pose a threat to the terrestrial invertebrate community. Hg is not retained as a COPEC for this receptor.

7.2.5.5.2 Zinc at MRS-R02

7.2.5.5.2.1 Zn detections exceed both the plant and terrestrial invertebrate Eco-SSLs. As shown below, the Zn concentrations only slightly exceed the benchmarks:

- Plant benchmark:
  - Maximum detection of 420 mg/kg is 2.6 times the benchmark of 160 mg/kg.
  - 95 percent UCL of 161 mg/kg is slightly greater than the benchmark.
- Invertebrate benchmark:
  - Maximum detection of 420 mg/kg is 3.5 times the benchmark of 120 mg/kg.
  - 95 percent UCL of 161 mg/kg is 1.3 times the benchmark.

7.2.5.5.2.2 Of the 14 composite soil samples analyzed for Zn, only two had Zn concentrations greater than the benchmarks. In addition, all ISM results are less than the benchmarks. Based on the limited frequency and low ratios by which the benchmarks were exceeded, Zn in the MRS-R02 soil poses minimal threat to the plant and invertebrate communities. Zn is not retained as a COPEC for these receptors.

7.2.5.6 Refined Food Web Analysis for Terrestrial Wildlife

7.2.5.6.1 As described above, the following chemicals were retained for further evaluation with respect to upper trophic level receptors:

- MRS-R02 (composite samples):
  - Cd – birds and mammals,
  - Pb – birds,
  - Hg – avian insectivore,
  - Zn – birds and mammals.
- MRS-R09 (discrete samples): Pb and Zn – avian receptors

7.2.5.6.2 The initial screening and food web analysis were based on the comparison of the maximum detected value to Eco-SSLs or, in the case of Hg, maximum daily doses to NOAELs. This initial screening is a conservative approach that may overestimate potential exposure at the community level. The refined food web analysis incorporates the following components to better reflect site conditions.

- 95 percent UCL of the mean as determined by the ProUCL version 5.0.00.
- Comparison of the daily dose to the LOAEL as well as the NOAEL.

7.2.5.6.3 The size of each MRS included in the refined food web analysis is greater than the home range of each ecological receptor. Accordingly, the home range factor remained as one for the refined food web. As shown in the refined food web presented in Table B-10, the MRS-R02 NOAEL ecological quotients exceeded 1 for the Southern short-tailed shrew exposed to Cd (NOAEL ecological quotient of 5). NOAEL ecological quotients exceeded 1 for the American woodcock in MRS-R02 exposed to Cd (ecological quotient of 3), Pb (ecological quotient of 2), and Zn (ecological quotient of 2). In the MRS-R09, NOAEL ecological quotients exceeded 1 for the American woodcock exposed to Pb (ecological quotient of 2). All LOAEL ecological quotients were less than 1, indicating that the average daily dose for these receptors was greater than the dose associated with no effects but less than the dose associated with observed effects. Accordingly, no COPECs were retained for the mammalian insectivore community of MRS-R02 or the avian insectivore community of MRS-R02 and MRS-R09.

7.2.5.7 <u>Uncertainty Analysis</u>

7.2.5.7.1 Similar to the HHRA, the ecological risk assessment requires a number of assumptions that may introduce uncertainty to the risk estimates. These uncertainties are evaluated below.

7.2.5.7.2 As noted in above, there is limited uncertainty associated with the analytical data suite based on the review of historical information and previous investigations. However, the sensitivity of the analytical methods may not be sufficient to detect potential contaminants at concentrations that could pose a threat to ecological receptors. Similar to the HHRA, this uncertainty is assessed by comparing reporting limits for non-detect analytes to ecological screening values. As presented on Tables B-6.1 through B-6.2, the only reporting limit greater than an ecological benchmark is the maximum reporting limit for 1,3-dinitrobenzene. The maximum reporting limit for this explosive is less than twice the benchmark. Thus, it is unlikely that 1,3-dinitrobenzene is present in the MRS soils at concentrations that would pose a threat to ecological receptors. Analytical sensitivity does not contribute to the SLERA's uncertainty.

7.2.6 Ecological Risk Assessment Summary and Conclusions

7.2.6.1 The SLERA evaluated the exposure of plants, soil invertebrates, mammals, and birds to contaminants at MRS-R01, MRS-R02, MRS-R03, and MRS-R09. The SLERA considered terrestrial plants, soil invertebrates, birds, and mammals. Food web modeling was conducted to assess potential exposure of birds and mammals to bioaccumulative chemicals. No threats were identified for exposure of ecological receptors to soil in all four MRSs.

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8.0 SUMMARY OF RESULTS

8.1 SUMMARY

8.1.1 MEC and MC Nature and Extent

8.1.1.1 MEC

8.1.1.1.1 The extent of MEC contamination at the four MRSs was determined based on the RI field investigation and evaluation of previous investigation results. As described in Subchapters 5.2.1, 5.2.3, and 5.2.4, MEC contamination was identified in MRS-R01, MRS-R02, and MRS-R03. The RI was conducted IAW the approved Work Plan and to meet the established DQOs. MEC contamination boundaries were determined within the MRSs and the types of munitions and depths that items may be found were determined. Based on MEC contamination boundaries determined during the RI, the following MRS delineation is proposed:

- MRS-01: 296 acres, the MEC-contaminated area of the former MRS-R01.
- MRS-02: 1,525 acres, the MEC-contaminated area of the former MRS-R02.
- MRS-03: 495 acres, the MEC-contaminated area of the former MRS-R03.
- MRS-R09: No MEC contamination was identified; the portion of MRS-R09 that is not part of the MRS-R02 MEC contaminated area should be recommended for no further action.

8.1.1.1.2 The proposed MRS-01, MRS-02 and MRS-03 are recommended for further evaluation in the FS. The area of MRS-R09 that is not part of the MRS-R02 MEC contaminated area is recommended for no further action.

8.1.1.2 Munitions Constituents

8.1.1.2.1 During the RI/FS activities, ISM surface soil samples were collected within the all four MRSs and in background areas and analyzed for explosives and metals. The RI results as well as historical MC sampling investigation were evaluated as part of this RI. No MC was detected at levels constituting a risk to human health or the environment, indicating there is no MC contamination. The results of the BLRA for MC are summarized below.

8.1.2 BLRA for MC

8.1.2.1 MC contamination was assessed in surface soil collected from 0 to 0.5 ft bgs. As discussed in Chapters 5.2, 7.2.3, and 7.2.5. The screening of the analytical results against background concentrations and health-based screening values identified one COPC: Cd in MRS-R02; however, after evaluation the Cd was determined to be no threat to human health under unrestricted land use. The initial screening identified Cd, Hg, and Zn as COPECs for MRS-R02; and Pb and Zn as COPECs for MRS-R09. No COPECs were identified for MRS-R01 and MRS-R03. The SLERA showed that no threats were identified for exposure of ecological receptors to soil in all four MRSs. Based on the information provided in Chapter 7.2, it was concluded that no MC is present on site at levels that present a risk to human health or the environment. Therefore, MC sampling performed during this RI, and during previous investigations, does not indicate a release of MC.

8.1.3 MEC Risk Assessment

8.1.3.1 For the evaluation of MEC explosive hazards, a baseline risk assessment was performed utilizing Risk Matrices. The existing (i.e., baseline) conditions at the three recommended MRSs (MRS-01, MRS-02, and MRS-03) and the no further action MRS were evaluated. Based on the MEC contamination present, an unacceptable risk exists for human receptors to be exposed to explosive hazards at the three recommended MRSs.

8.2 CONCLUSIONS

8.2.1 Recommendations for FS

8.2.1.1 The conclusions of this RI and the MEC HA show that MEC contamination was identified within MRS-R01, MRS-R02 and MRS-R03 and does pose an unacceptable risk due to explosive hazards to current and future receptors. No MEC contamination was identified in MRS-R09. The BLRA for MC identified no actionable risk to human or ecological receptors at any of the MRSs.

- The RAOs for the 296 acres of MRS-R01 recommended for evaluation in an FS is to reduce the unacceptable risk due to the presence of 100-pound (lb) M38A2 Practice bomb; 20-lb M41 Fragmentation Bomb; 2.25-inch Sub-Caliber Aircraft Rocket (SCAR); and MK1 50-lb Practice Bombs, within the MEC contamination boundary shown on Figure 5.1 to a depth of 5-ft bgs to address likelihood of exposure to construction workers, indoor/outdoor workers, maintenance/utility workers, trespassers, recreational users, and residents via direct contact such that a negligible risk scenario is achieved.

- The RAOs for the 1,525 acres of MRS-R02 recommended for evaluation in an FS is to reduce the unacceptable risk due to the presence of ·1.1-inch Mark 2 projectiles; 100-lb M38A2 Practice Bombs; M48 20-lb Practice Bomb; 5-inch high velocity aircraft rocket (HVAR) Mk 1; 4-lb Incendiary AN-M54; 6-lb Incendiary AN-M69X; 250-lb M57 Bomb; practice 2.5-inch rocket; 2.36-inch rockets; 5-inch HVAR, Mk 1; 5-inch Mk 24 Mod 0 Zuni Rocket; Mk4 2.75-inch Folding-Fin Aircraft Rocket (FFAR); M16 Smoke Grenade; AN-M110 A1 Bomb Fuze and M63 37mm Projectiles within the MEC contamination boundary shown on Figure 5.2a and Figure 5.2b to a depth of 6-ft bgs to address likelihood of exposure to construction workers, indoor/outdoor workers, maintenance/utility workers, trespassers, recreational users, and residents via direct contact such that a negligible risk scenario is achieved.

- The RAOs for the 495 acres of MRS-R03 recommended for evaluation in an FS is to reduce the unacceptable risk due to the presence of 4-lb Incendiary AN-M54; M48 20-lb Practice Bomb; 100-lb M38A2 Practice bomb; and Mk4 2.75-inch FFAR within the MEC contamination boundary shown on Figure 5.3 to a depth of 3.5-ft bgs to address likelihood of exposure to construction workers, indoor/outdoor workers, maintenance/utility workers, trespassers, recreational users, and residents via direct contact such that a negligible risk scenario is achieved.

8.2.1.2 The site was recommended for future FUDSMIS delineation as proposed for MRS-R01, MRS-R02 and MRS-R03. An unacceptable risk for MEC has been identified at these MRSs and the MRSs are recommended for inclusion in an FS to develop potential remedial alternatives capable of reducing MEC site hazards. No further action for MC is recommended in these MRSs. The southern portion of MRS-R09 that does not overlap with MRS-R02 is an uncontaminated area recommended for no further action for MEC and MC. The collected data and the associated characterization described in this report are considered sufficient to characterize the project site, to identify and evaluate associated potential MEC hazards or MC risks, and to support the recommended FS.

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